DECEMBER · 1950

electronics

A McGRAW-HILL PUBLICATION

(A) SIMULTANEOUS TRANSMISSION—12-mc video band

(B) MIXED-HIGHS TRANSMISSION—4.2-mc video band

(C) COLOR COMPONENT of B, three 0.1-mc bands

(D) MIXED-HIGHS COMPONENT of B, 0.1 to 4 mc

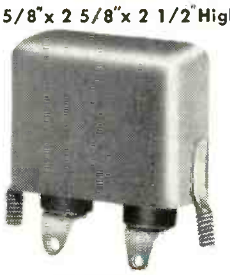
MIXED HIGHS IN COLOR TELEVISION

PERMALLOY DUST TOROIDS FOR MAXIMUM STABILITY...

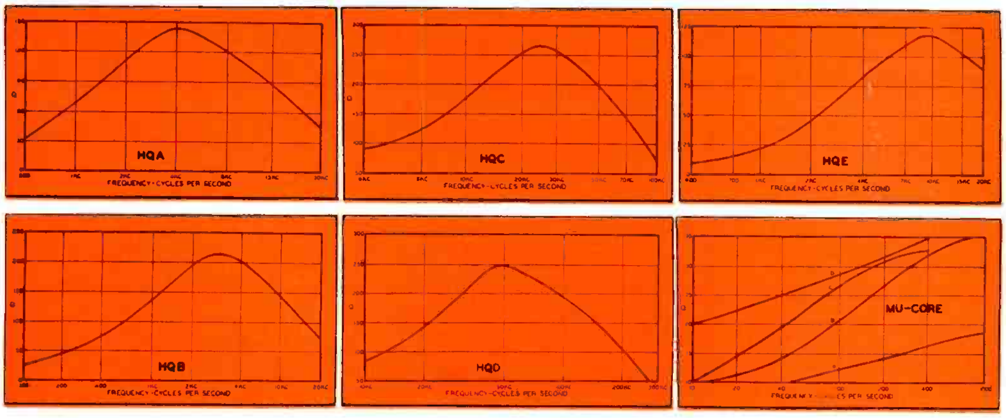
The UTC type HQ permalloy dust toroids are ideal for all audio, carrier and supersonic applications. HQA coils have Q over 100 at 5,000 cycles...HQB coils, Q over 200 at 4,000 cycles...HQC coils, Q over 200 at 30 KC...HQD coils, Q over 200 at 60 KC...HQE (miniature) coils, Q over 120 at 10 KC. The toroid dust core provides very low hum pickup...excellent stability with voltage change...negligible inductance change with temperature, etc. Precision adjusted to 1% tolerance. Hermetically sealed.

HQA, HQC, HQD CASE
1 13/16" Dia. x 1 3/16" High

HQB CASE
1 5/8" x 2 5/8" x 2 1/2" High



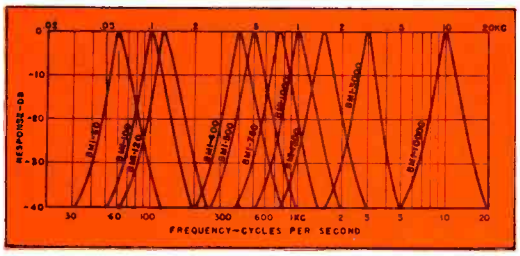
HQE CASE
1/2" x 1 5/16" x 1 3/16" High

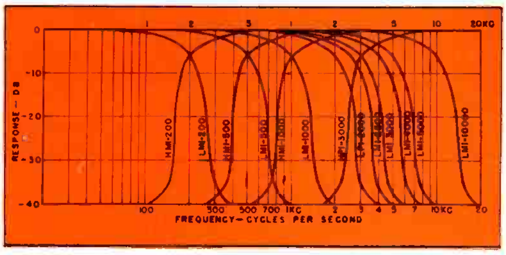


Type No.	Inductance Value	Net Price	Type No.	Inductance Value	Net Price	Type No.	Inductance Value	Net Price
HQA-1	5 mhy.	$7.00	HQA-16	7.5 hy.	$15.00	HQC-1	1 mhy.	$13.00
HQA-2	12.5 mhy.	7.00	HQA-17	10. hy.	16.00	HQC-2	2.5 mhy.	13.00
HQA-3	20 mhy.	7.50	HQA-18	15. hy.	17.00	HQC-3	5 mhy.	13.00
HQA-4	30 mhy.	7.50	HQB-1	10 mhy.	16.00	HQC-4	10 mhy.	13.00
HQA-5	50 mhy.	8.00	HQB-2	30 mhy.	16.00	HQC-5	20 mhy.	13.00
HQA-6	80 mhy.	8.00	HQB-3	70 mhy.	16.00	HQD-1	.4 mhy.	15.00
HQA-7	125 mhy.	9.00	HQB-4	120 mhy.	17.00	HQD-2	1 mhy.	15.00
HQA-8	200 mhy.	9.00	HQB-5	.5 hy.	17.00	HQD-3	2.5 mhy.	15.00
HQA-9	300 mhy.	10.00	HQB-6	1. hy.	18.00	HQD-4	5 mhy.	15.00
HQA-10	.5 hy.	10.00	HQB-7	2. hy.	19.00	HQD-5	15 mhy.	15.00
HQA-11	.75 hy.	10.00	HQB-8	3.5 hy.	20.00	HQE-1	5 mhy.	6.00
HQA-12	1.25 hy.	11.00	HQB-9	7.5 hy.	21.00	HQE-2	10 mhy.	6.00
HQA-13	2. hy.	11.00	HQB-10	12. hy.	22.00	HQE-3	50 mhy.	7.00
HQA-14	3. hy.	13.00	HQB-11	18. hy.	23.00	HQE-4	100 mhy.	7.50
HQA-15	5. hy.	14.00	HQB-12	25. hy.	24.00	HQE-5	200 mhy.	8.00

UTC INTERSTAGE AND LINE FILTERS

FILTER CASE M
1 3/16" x 1 11/16"
1 5/8" - 2 1/2" High





These U.T.C. stock units take care of most common filter applications. The interstage filters, BMI (band pass), HMI (high pass), and LMI (low pass), have a nominal impedance at 10,000 ohms. The line filters, BML (band pass), HML (high pass), and LML (low pass), are intended for use in 500/600 ohm circuits. All units are shielded for low pickup (150 mv/gauss) and are hermetically sealed.

STOCK FREQUENCIES
(Number after letters is frequency)
Net Price $25.00

BMI-60	BMI-1500	LMI-200	BML-400
BMI-100	BMI-3000	LMI-500	BML-1000
BMI-120	BMI-10000	LMI-1000	HML-200
BMI-400	HMI-200	LMI-2000	HML-500
BMI-500	HMI-500	LMI-3000	LML-1000
BMI-750	HMI-1000	LMI-5000	LML-2500
BMI-1000	HMI-3000	LMI-10000	LML-4000
			LML-12000

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

DECEMBER • 1950

ELECTRONICS: December, 1950; Vol. 23; No. 12. Published monthly with an additional issue in June, price 75¢ a copy for U. S. and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Buyers' Guide $2.00. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation. Subscription rates—United States and possessions, $6.00 a year, $9.00 for two years, $12.00 for three years. Canada (Canadian funds accepted), $10.00 a year, $16.00 for two years, $20.00 for three years. Latin American countries $15.00 for one year, $25.00 for two years, $30.00 for three years. All other countries $20.00 for one year, $30.00 for two years, $40.00 for three years. Please indicate position and company connection on all subscription orders. Entered as Second Class matter August 29, 1936, at Post Office, Albany, New York, under the act of March 3, 1879. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; Aldwych House, Aldwych, London, W.C. 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.

Let MARION help you . . .

. . . seal components *hermetically*

. . . speed up sub-assemblies

Marion portable, bench-type induction soldering unit . . . .

- SMALL
- COMPACT
- ADAPTABLE
- EFFICIENT
- ECONOMICAL
- EASY-TO-USE

A PRODUCTION TOOL This unit was designed to simplify and improve both the quality and quantity of production of many different assemblies in the electronic and electrical fields. It has been used successfully for many years in the manufacture of Marion hermetically sealed instruments. Assembly applications include magnet assemblies, relay armatures, connectors, capacitors and transformer cans and germanium diode assemblies; also jewelry, watches, toys, automotive parts, household fixtures, etc.

HERMETICALLY SEALED COMPONENTS Because of the present intense interest in hermetically sealed components, Marion offers the benefit of its experience in true glass-to-metal hermetic sealing with the Marion Induction Soldering Unit and Marion metalized (platinum film) glass. Marion platinum film base glass has been developed to permit higher sealing temperatures, greater thermal shock range and resoldering if necessary.

PROFIT FROM EXPERIENCE Investigate now. Submit your requirements. We will be glad to supply samples and quotations. Ask for bulletin. Marion Electrical Instrument Company, 401 Canal Street, Manchester, New Hampshire.

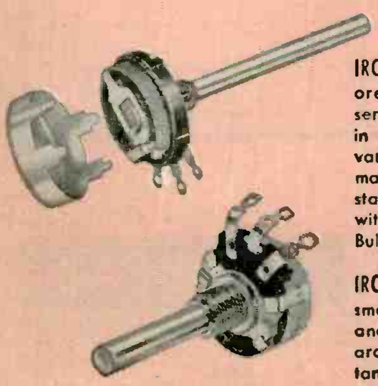
MANUFACTURERS OF MARION RUGGEDIZED INSTRUMENTS

marion meters

A complete line *for resistors too!*

Unusual *combinations of characteristics* required in today's critical electronic circuits demand a complete range of resistor types. Specializing in resistors, IRC makes the widest line in the industry. This means ease of procurement—a single dependable source of supply for *all* your resistance needs. It also means unbiased recommendations—no substitution of units "just as good". IRC's complete line of products; complete research and testing facilities; complete network of licensees for emergency production—all add up to complete satisfaction for you.

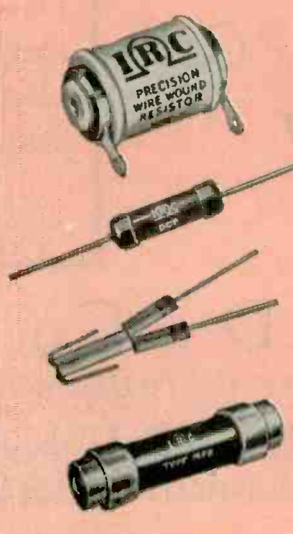
CONTROLS



IRC Type W Wire Wound Controls are designed for long, dependable service and balanced performance in every characteristic. These 2-watt variable wire wound units provide maximum adaptability to most rheostat and potentiometer applications within their power rating. Catalog Bulletin A-2.

IRC New Type Q Controls feature small $^{15}/_{16}$" size, rugged construction and superior performance. Increased arc of rotation permits some resistance ratios successful in larger IRC Controls. Catalog Bulletin A-4.

PRECISION RESISTORS



IRC Precision Wire Wounds offer a fine balance of accuracy and dependability for close-tolerance applications. Extensively used by leading instrument makers, they excel in every significant characteristic. Catalog Bulletin D-1.

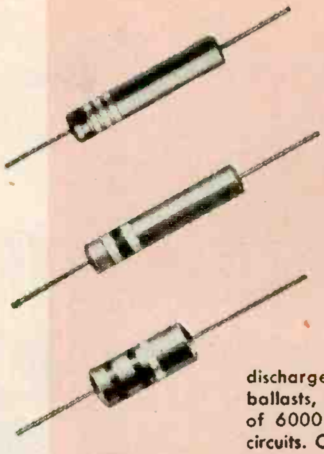
IRC Deposited Carbon PRECISTORS combine accuracy and economy for close-tolerance applications, where carbon compositions are unsuitable and wire-wound precisions too expensive. Catalog Bulletin B-4.

IRC Matched Pairs provide a dependable low-cost solution to close-tolerance requirements. Both Type BT and BW Resistors are available in matched pairs. Catalog Bulletin B-3.

IRC Sealed Precision Voltmeter Multipliers are suitable and dependable for use under the most severe humidity conditions. Each consists of several IRC Precisions mounted and interconnected, encased in a glazed ceramic tube. Catalog Bulletin D-2.

is essential

INSULATED COMPOSITION and WIRE WOUND RESISTORS

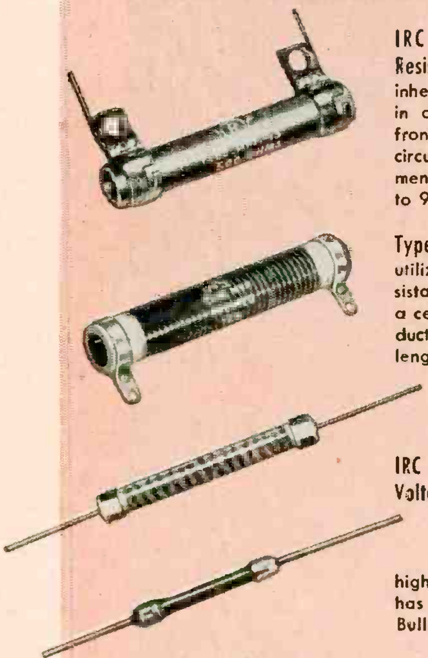


IRC Advanced Type BT Resistors meet and beat JAN-R-11 Specifications at 1/3, 1/2, 1 and 2 watts—combine extremely low operating temperature with excellent power dissipation. Catalog Bulletin B-1.

IRC Type BW Wire Wound Resistors are exceptionally stable, inexpensive units for low range requirements. Have excellent performance records in TV circuits, meters, analyzers, etc. Catalog Bulletin B-5.

IRC Type BTAV High Voltage Resistors, developed for use as discharge resistors in fluorescent "Quick Start" ballasts, withstand momentary peak surge of 6000 volts. Also suited to TV bleeder circuits. Catalog Bulletin B-1.

HIGH FREQUENCY and HIGH POWER RESISTORS



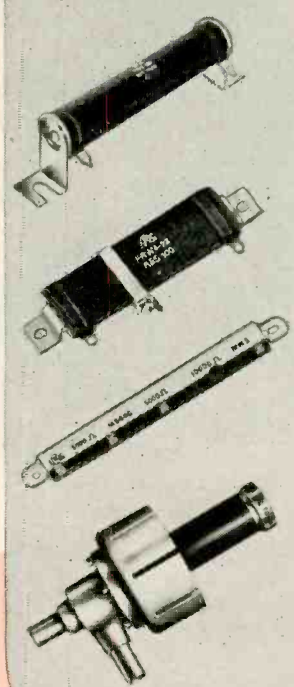
IRC Type MP High Frequency Resistors afford stability with low inherent inductance and capacity in circuits involving steep wave fronts, high frequency measuring circuits and radar pulse equipment. Available in sizes from 1/4 to 90 watts. Catalog Bulletin F-1.

Type MV High Voltage Resistors utilize IRC's famous filament resistance coating in helical turns on a ceramic tube to provide a conducting path of long, effective length. Result: Exceptional stability even in very high resistance values. Catalog Bulletin G-1.

IRC Type MVX High Ohmic, High Voltage Resistors meet requirements for a small high range unit with axial leads. Engineered for high voltage applications, MVX has exceptional stability. Catalog Bulletin G-2.

IRC Type MPM High Frequency Resistors are miniature units suitable for high frequency receiver and similar applications. Stable resistors with low inherent inductance and capacity. Body only 3/8" long. Catalog Bulletin F-1.

POWER RESISTORS



IRC Fixed and Adjustable Power Wire Wounds give balanced performance in every characteristic—are available in a full range of sizes, types and terminals for exacting, heavy-duty applications. Catalog Bulletin C-2.

IRC Type FRW Flat Wire Wound Resistors fulfill requirements of high wattage dissipation in limited space—may be mounted vertically or horizontally, singly or in stacks. Catalog Bulletin C-1.

IRC Type MW Wire Wound Resistors offer low initial cost, lower mounting cost, flexibility in providing taps, and saving in space. Completely insulated against moisture. Catalog Bulletin B-2.

IRC Type LP Water-Cooled Resistors for TV, FM and Dielectric Heating Applications. Cooled internally by high velocity stream of water; adjustable to local water pressure and power dissipation up to 5 K.W.A.C. Catalog Bulletin F-2.

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

25 YEARS YOUNG IN 1950!

IRC

INTERNATIONAL RESISTANCE COMPANY

PHILADELPHIA 8, PENNSYLVANIA

In Canada: International Resistance Company, Ltd., Toronto, Licensee

INTERNATIONAL RESISTANCE CO.
403 N. BROAD ST., PHILADELPHIA 8, PA.

Please send me Technical Data Bulletins checked below:

☐ Bulletin A-2 (W)	☐ Bulletin B-4 (DC)	☐ Bulletin F-1 (MP)
☐ Bulletin A-4 (Q)	☐ Bulletin B-5 (BW)	☐ Bulletin F-1 (MPM)
☐ Bulletin B-1 (BT)	☐ Bulletin C-1 (FRW)	☐ Bulletin F-2 (LP)
☐ Bulletin B-1 (BTAV)	☐ Bulletin C-2 (PWW)	☐ Bulletin G-1 (MV)
☐ Bulletin B-2 (MW)	☐ Bulletin D-1 (WW)	☐ Bulletin G-2 (MVX)
☐ Bulletin B-3 (M/P)	☐ Bulletin D-2 (MF)	

NAME..

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

J. F. ARNDT & CO., ADV. AGENCY

NO. 1 to 9 of a Series

Another Engineer's Problem Solved*

SUBJECT:

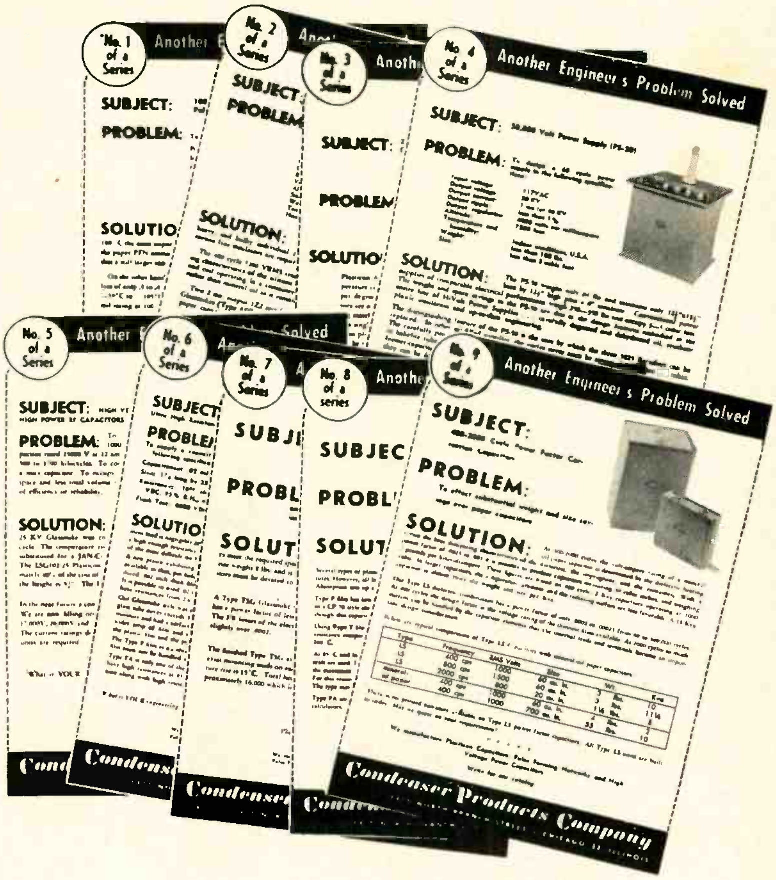
Plasticon Capacitors, Pulse Forming Networks and High Voltage Power Supplies.

PROBLEM:

To obtain Capacitors, Pulse Forming Networks and Power Supplies for your specific needs, regardless of how intricate.

SOLUTION:

Send your specifications to Condenser Products Company so that our experienced staff of engineers can solve your problems.



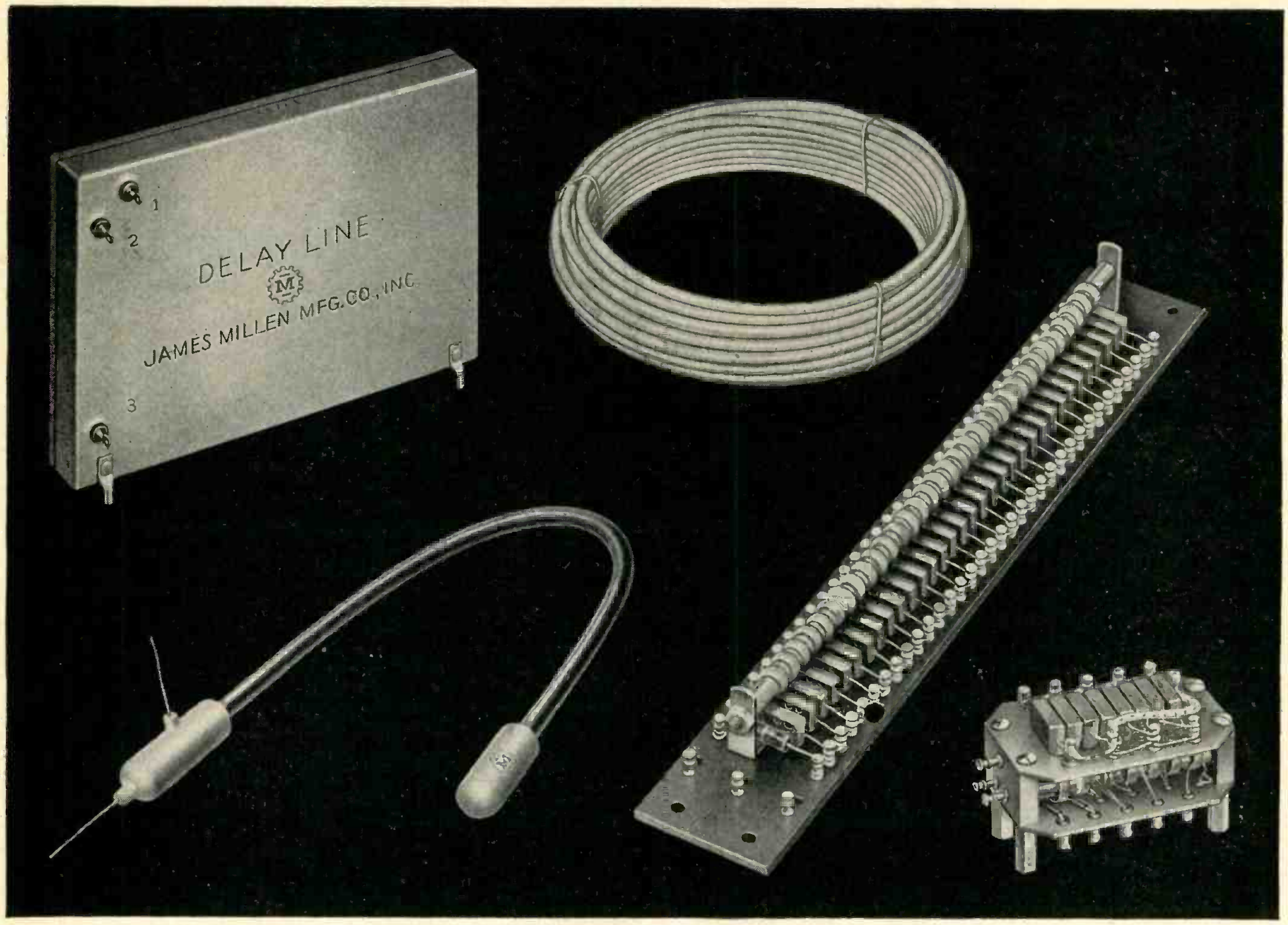
For the past nine months, we have been running advertisements illustrating some of the engineering problems which we have solved. Reprints are available upon request. These problems are listed below:—

- No. 1—100°C Miniature Pulse Forming Networks
- No. 2—8000 Volt Radar-Indicator Power Supply
- No. 3—Zero Temperature Coefficient Capacitors
- No. 4—50,000 Volt Power Supply (PS-50)
- No. 5—High Voltage, High Power RF Capacitors
- No. 6—Ultra High Resistance Capacitors
- No. 7—High Power, High Temperature RF Capacitors
- No. 8—High Temperature "Computer" Capacitors
- No. 9—400-2000 Cycle Power Factor Correction Capacitors

May we offer our solutions to your problems?
Your inquiries will receive immediate attention.

Condenser Products Company

1375 NORTH BRANCH STREET • CHICAGO 22, ILLINOIS



"Designed for Application"

DELAY LINES and NETWORKS

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.

Millen delays lines are illustrated and described in our Laboratory Equipment catalogue, a copy of which will be sent upon request.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

MALDEN, MASSACHUSETTS, U.S.A.

NOW

15,000 cps·7½* inches per sec. HALF TRACK!

... also available with **FULL TRACK HEADS**

REVOLUTIONARY ADVANCE IN TAPE RECORDING EFFICIENCY

- At 7½ inches per second Model 400 plays music essentially flat to 15,000 cps!
- Half-track record, erase, playback at 15 and 7½ i.p.s. Plays back full-track recorded tape.
- Has built-in record and playback amplifiers as well as a 4-inch "VU" meter.
- Fast forward and rewind require but 90 seconds for a full 2400-foot reel!
- Tape cost savings of 4 to 1 over any 15 i.p.s. single-track recorder of comparable fidelity!

* FOR THE FIRST TIME IN TAPE RECORDING HISTORY . . . 7½ i.p.s. HALF-TRACK PERFORMANCE THAT EQUALS OR EXCEEDS ORDINARY 15 i.p.s. FULL-TRACK RECORDING! A full 132 minutes of playing time on a single 2400-foot reel!

Greatest PORTABLE of them all!

AX-21

WEIGHT APPROX. 62 POUNDS
... in single portable case

MODEL 400

STANDARD OF THE GREAT RADIO SHOWS

AMPEX

MAGNETIC TAPE RECORDERS

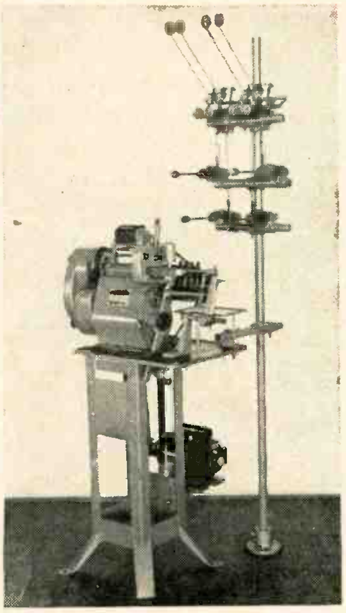
Complete specifications and other details of Model 400 Ampex Portable Magnetic Tape Recorder are available on request.

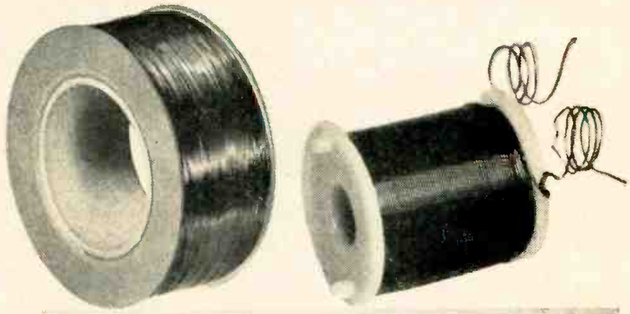
WRITE TODAY!

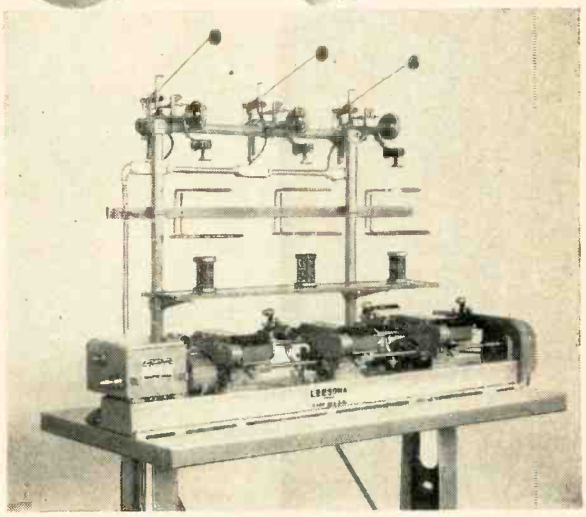
AMPEX ELECTRIC CORPORATION
SAN CARLOS, CALIFORNIA

If You Need Coils Like These . . .

you need UNIVERSAL Coil Winders







Lattice-type coils for television and radio. Wind one to four coils at once on the Universal No. 84 Coil Winder, with (in most cases) a single operator for two machines.

Speeds are from 400 to 950 rpm, and a counter control provides instant automatic stop upon completion of coil.

Quickly-adjustable "gainer" mechanism, which accurately positions wire turns, and strap-type tensions help you get accurate, uniform winding. In-built calibration facilitates change-over.

Write for Bulletin 84-LM.

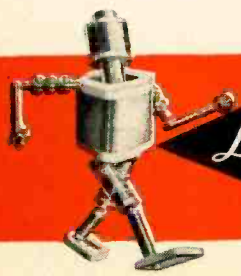
Non-insulated spool-wound coils. Wind coils on several heads at once, using the new Universal 102 High Speed Coil Winder, and synchronize output on the basis of handling time per coil.

Each head is individually operated, and you can so schedule the winding that certain heads will be producing while manual operations are performed on other heads.

With a maximum speed of 5000 rpm, the High-Speed 102 is efficient for coils having up to 15,000 turns. Oil seals make the machine *oil-tight*.

Write for Bulletin 102-LM.

UNIVERSAL WINDING COMPANY
P. O. Box 1605 Providence 1, R. I.



LEESONA

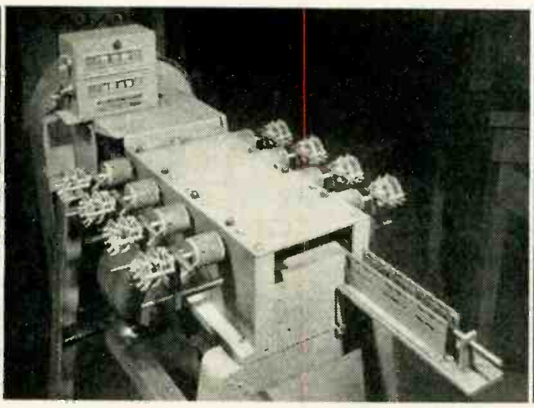
FOR WINDING COILS IN QUANTITY
ACCURATELY . . . AUTOMATICALLY
USE UNIVERSAL WINDING MACHINES

ADVENTURES IN ELECTRONIC DESIGN

TORTURE TESTS PROVE SWITCH PERFORMANCE

Turn it on. Turn it off. Do this 25,000 times or more and you'll get a good idea of the terrific punishment Centralab switches must be able to withstand. Day and night, skilled CRL engineers and specially designed testing machines put Centralab switches through torture tests no switch is ever asked to undergo in ordinary operation. What does this mean to you? Just this. You can be sure that Centralab gives you the smooth operation, positive indexing and accurate positioning you want in the switches you buy. What's more, you can be sure CRL switches will continue to provide these advantages for a long, long time.

Constant checking makes sure CRL switches give you desirable uniform low contact resistance. Here an engineer tests resistance by running 1 ampere through contacts.



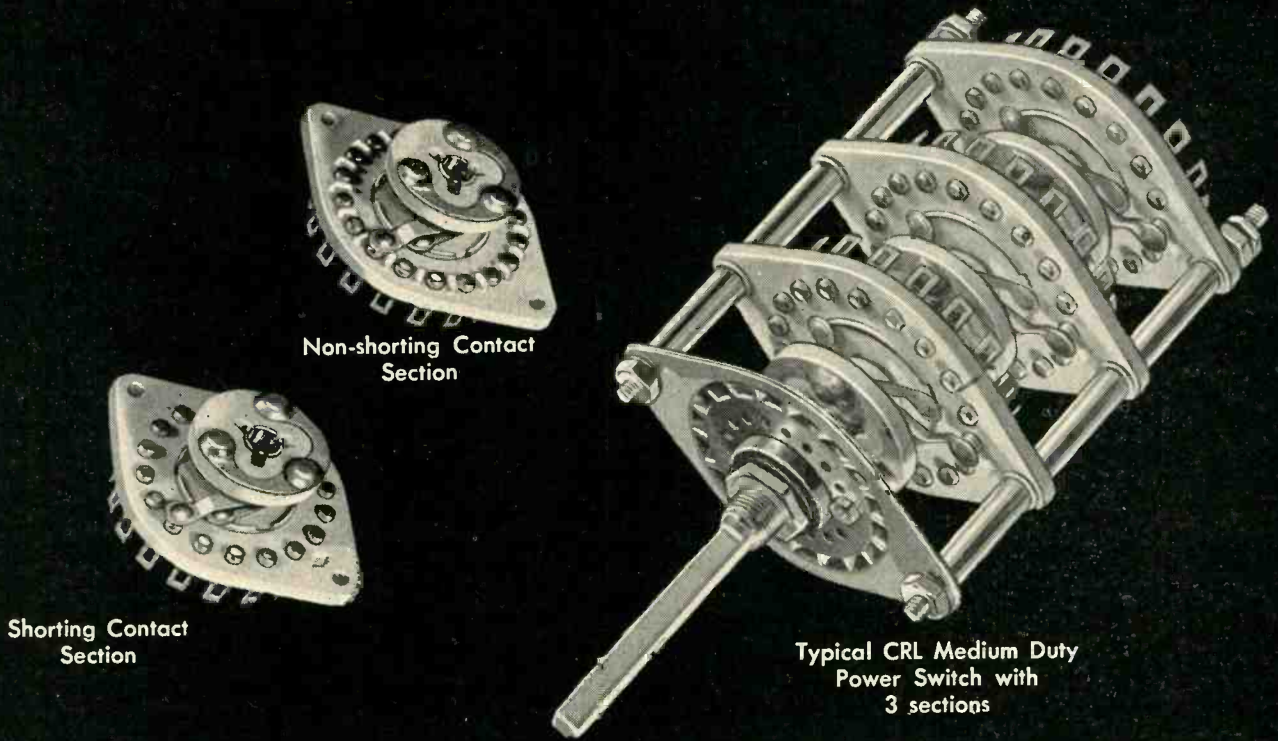
Accelerated life test machine rotates through fixed number of positions at 1000 cycles per hour . . . proves switch springs, clips and contacts stand up under long, hard use.

Resistance of switch insulation to atmospheric change is tested in controlled temperature and humidity chamber. Test helps avoid breakdown or leakage.

Centralab CRL ® — **DEVELOPMENTS THAT CAN HELP YOU**

Division of GLOBE-UNION INC. • Milwaukee

Centralab Components

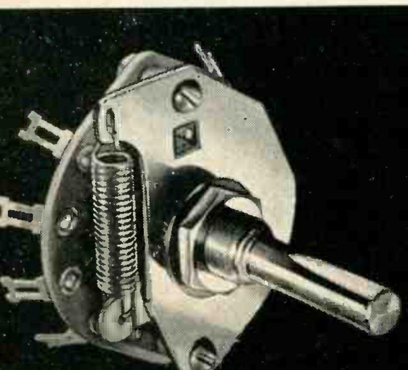


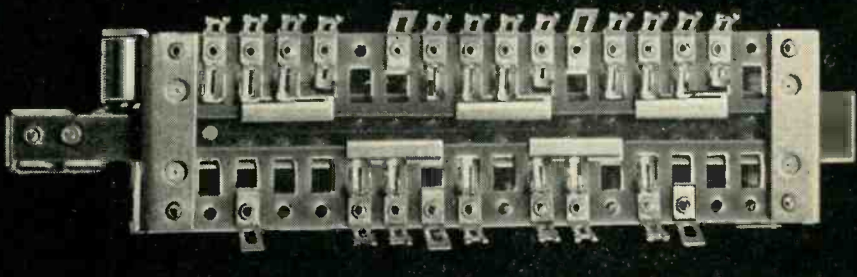
1 Yes, CRL's Medium Duty Power Switches are made to meet your individual needs . . . single, two or three poles . . . 18 contacts per section . . . up to 20 sections per shaft. Contacts and collector rings of coin silver, mounted on Grade L5 Steatite, compounded and produced right in our own plant . . . backed up by 20 years of ceramic manufacturing experience.

These switches are designed for R. F. or 7½ amp. 110-115 V. application. Voltage breakdown to ground, 3000 V. RMS 60 cycles.

The combination of rugged construction — coin silver contacting members, plus the high insulation resistance of Grade L5 Steatite, means trouble-free performance in x-ray, lab-test equipment, high voltage transmitters and other electronic gear.

For top-performing medium duty power switches, built for life-time service — in standard or custom built models — ask about CRL's "torture tested" power switch line. Our engineers will be glad to assist you.

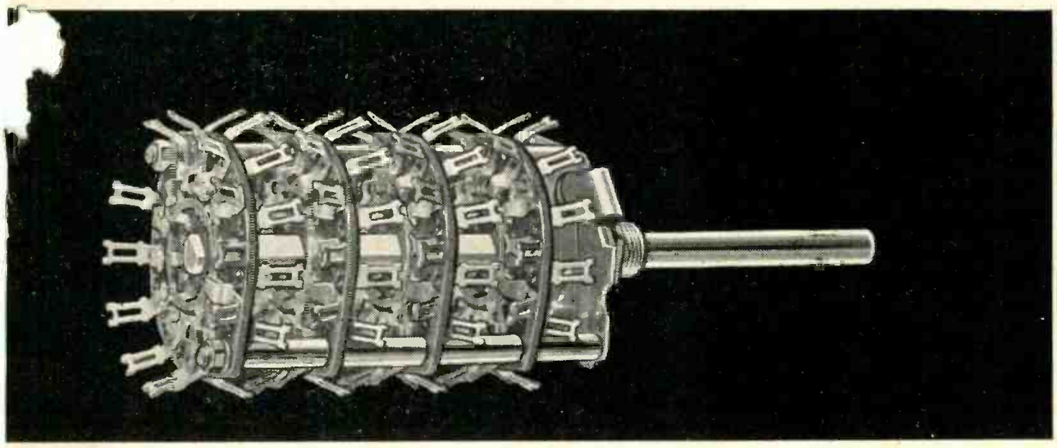


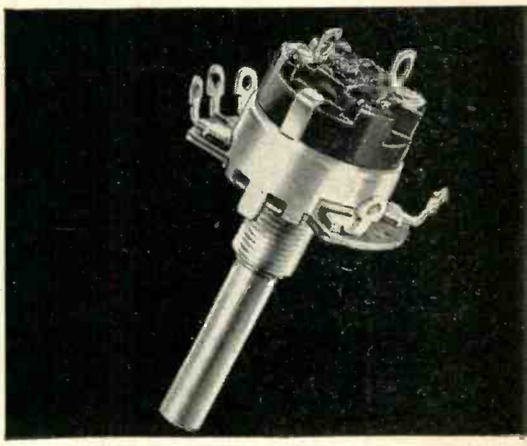


2 Great step forward in switching is CRL's New Rotary, Coil, Spring and Cam Index Switch. It gives you smoother action, longer life.

3 Centralab's development of a revolutionary, new *Slide Switch* vastly facilitates AM and FM set design! Flat, horizontal design saves valuable space, allows short leads, convenient location to coils, reduced lead inductances for increased efficiency in low and high frequencies. CRL Slide Switches are rugged and dependable.

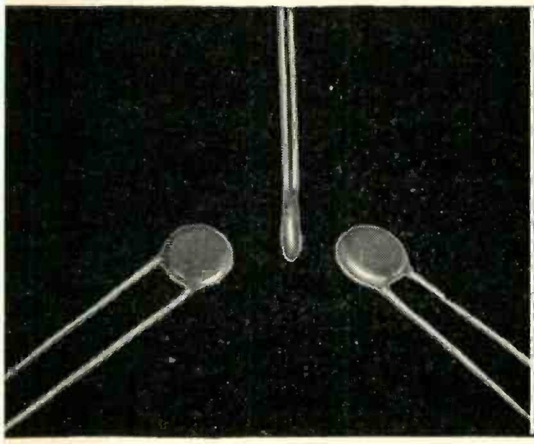
for Electronic Gear

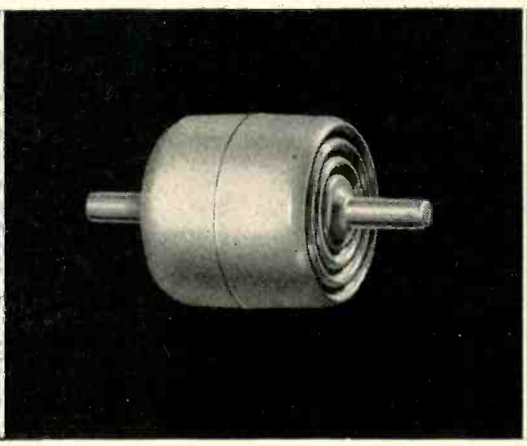


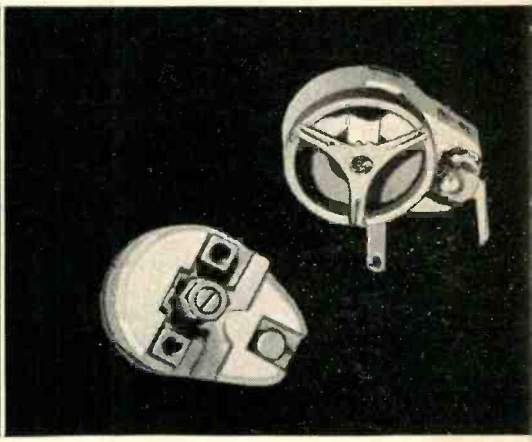


4 24 insulated clips per section assure variety of switching combinations. This double-wipe style switch can be CRL built to your specifications. Successfully used in TV up to 200 megacycles. Ratings: 1 amp at 6 v. Stator and rotor highest grade laminated phenolic. Clips silver-plated or silver alloy.

5 CRL's new high quality Model 2 Radiohm Controls specifically designed for TV, radio, other electronic equipment. Lower noise level, longer life.



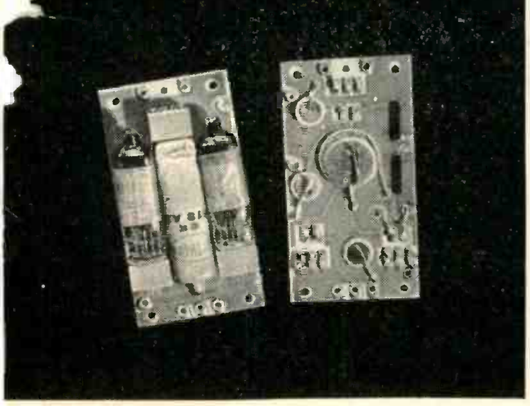


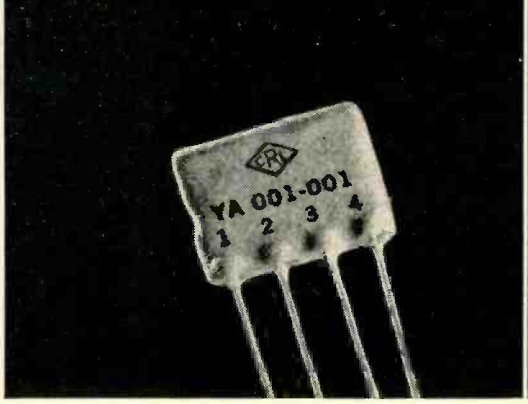


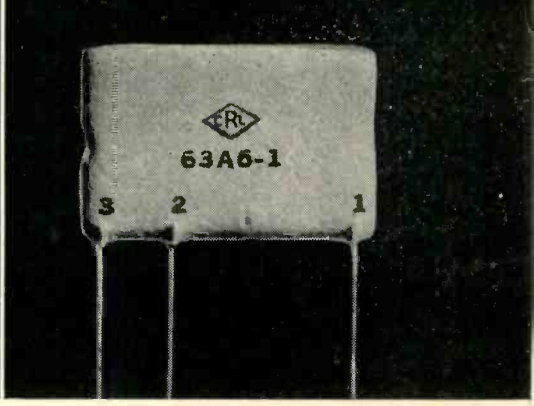
6 For by-pass or coupling applications, check Centralab's original line of ceramic disc Hi-Kaps. Disc Hi-Kaps are smaller than a dime.

7 Hi-Vo-Kaps (10-20-30 kv) are filter and by-pass capacitors combining high voltage, small size and variety of terminal connections to fit most TV needs.

8 Ceramic Trimmers are made in five basic types. Full capacity change within 180° rotation. Spring pressure maintains constant rotor balance.







9 Centralab's *Ampec*, above, is an integral assembly of tube sockets, capacitors, resistors and wiring combined into one miniature amplifier unit.

10 Couplate consists of plate and grid resistors, plate by-pass and coupling capacitors. Minimum soldered connections speed production.

11 This is the new CRL Vertical Integrator Network used in TV sets. Variations of this Centralab integrator plate are available on special order.

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42-101 — CERAMIC TRIMMERS — CRL trimmer catalog.
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42-18 — TC CAPACITORS — temperature compensating capacitors.
42-102 — CAPACITORS — high-voltage capacitors.
975 — FT HI-KAPS — feed-thru capacitors.

Centralab Switches

953 — SLIDE SWITCH — applies to AM and FM switching circuits.
970 — LEVER SWITCH — shows indexing combinations.
995 — ROTARY SWITCH — schematic application diagrams.
722 — SWITCH CATALOG — facts on CRL'S complete line of switches.

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Look to CENTRALAB in 1951! First in component research that means lower costs for the electronic industry. If you're planning new equipment, let Centralab's sales and engineering service work with you. For complete information on all CRL products, get in touch with your Centralab Representative. Or write direct.

CENTRALAB
Division of Globe-Union Inc.
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Division of GLOBE-UNION INC. • Milwaukee

The DUMONT TYPE 297

Oscillograph-record Camera

You've just advanced the film after making an exposure. That starts the Polaroid-Land "packaged" developing process. And while you're waiting for its completion—in just 60 seconds—you can start the next exposure or set of exposures. With the Type 297, once you've snapped the shutter, its self-contained, 60-second, developing process lets you forget about the variables of the darkroom.

And with such special oscillographic features as simultaneous viewing and recording, an illuminated data-card, sturdy and easily attached mounting, and overall economy of the Polaroid film, Du Mont has added even greater meaning to this excitingly fast method for "printing" the oscillograph image.

SPECIFICATIONS

LENS—Du Mont-Wollensak f/2.8 or f/1.9, 75mm, coated.

SHUTTER – Wollensak Alphax; shutter speeds of 1/25, 1/50, 1/100 sec. Time and Bulb.

FOCUS—Fixed. May be adjusted for special oscillographic work.

WRITING SPEED—Writing rates of 3.5 in μsec. have been recorded consistently at 12,000 volts accelerating potential.

PRINT SIZE – 3¼ x 4 ¼ in. – one, two, three, or more exposures per print.

IMAGE REDUCTION RATIO—2.25:1.

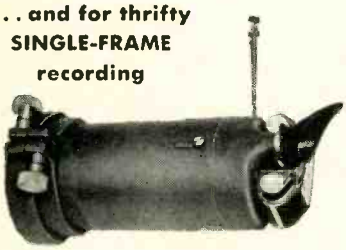
PHYSICAL SIZE—Length, 14⅝ in.; height, 10 in.; width, 6 in.

WEIGHT—12 lbs.

PRICE . . . . $285.00 with f/2.8 lens
$355.00 with f/1.9 lens

Write for bulletin on photographic techniques.

. . . and for thrifty
SINGLE-FRAME
recording



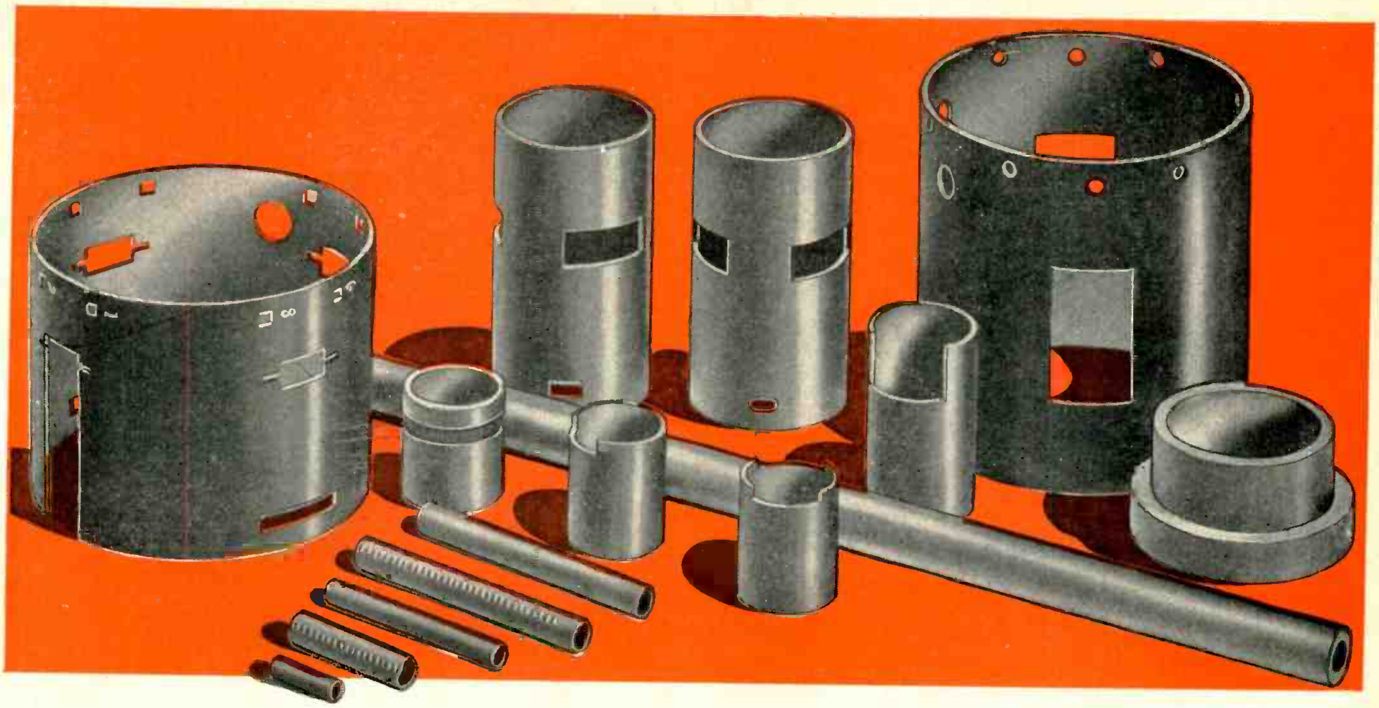
THE DU MONT TYPE 296

Oscillograph-record Camera

The Type 296 is an inexpensive oscillograph-record camera, greatly improved for general-purpose application with any standard 5-inch cathode-ray oscillograph. It incorporates a compact, all-metal, 35mm camera, calibrated shutter and a high-quality f/2.8, 75mm, coated lens which increases its capability 57% over the Type 271-A which it supersedes. Construction is rugged and durable; operation simple and foolproof. The Type 296 weighs only 4½ lbs.

PRICE . . . $149.50

ALLEN B. DU MONT LABORATORIES, INC., *INSTRUMENT DIVISION*, 1000 MAIN AVENUE, CLIFTON, NEW JERSEY



MANY MANUFACTURERS of ELECTRICAL EQUIPMENT are finding our CLEVELITE* and COSMALITE* . . . spirally laminated paper base phenolic tubing meets their most exacting requirements.

Available in diameters, wall thicknesses and lengths to meet endless adaptations.

What are your requirements?

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PHENOLIC TUBES

are the first choice of the Radio and Television Industries! For example, CLEVELITE* is the proper choice for Flyback and High Voltage Transformers.

It insures perfect satisfaction.

Furthermore, CLEVELITE* high dielectric strength . . . low moisture absorption . . . strength, low loss and good machineability meet widely varied requirements and give fine performance.

PROMPT DELIVERIES are available through our large production capacity.

Inquiries invited . . . Samples gladly sent.

The CLEVELAND CONTAINER Co.

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PLANTS AND SALES OFFICES at Plymouth, Wisc., Chicago, Detroit, Ogdensburg, N.Y., Jamesburg, N.J.
ABRASIVE DIVISION at Cleveland, Ohio
CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario

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Q. Why is "dag" Colloidal Graphite best for CRT Exterior Wall Coating?

A. It's cheaper
...Has better adhesion
...Requires no baking
...Resists scratching

BLEED STATIC FROM CABINETS!

Static charges built up in TV sets—particularly where metal CRT's are used—can be successfully bled off by coating the inside of cabinets with "dag" Dispersion #194. This reduces picture interference and also precludes shock. Easy to apply by spraying or brushing.

"dag" Exterior Coating is a lacquer-base dispersion of microscopically small graphite particles. It is easily applied to CRT surfaces by spraying, and dries very rapidly, enabling tubes to be handled in 2 or 3 minutes. Maximum adhesion is obtained by drying at room temperature for 24 hours, or by forced infra-red drying for ½ hour.

"dag" Exterior Coating forms a smooth, uniform, conductive black coating on any type glass. Its adhesive properties are so good that it will resist scratching by a thumb nail or soaking in water.

Prominent CRT manufacturers have found **"dag"** colloidal graphite dispersions satisfactory and usually cheaper for wall coatings . . . for other electronics work, too. Let Acheson Colloids engineers show YOU how these versatile dispersions can solve many and varied electronics problems. Send the coupon NOW for more information.

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Port Huron, Michigan

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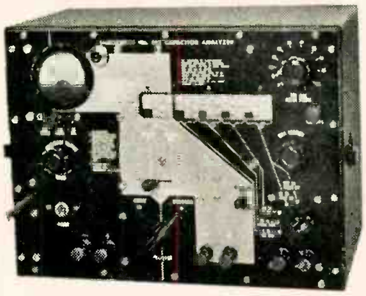
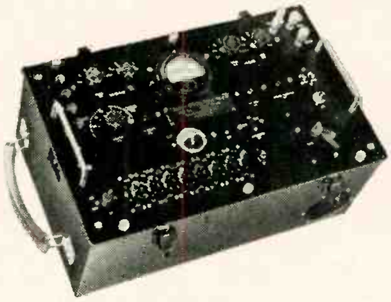
Something New



WIDE-RANGE, DIRECT-READING CAPACITOR ANALYZER

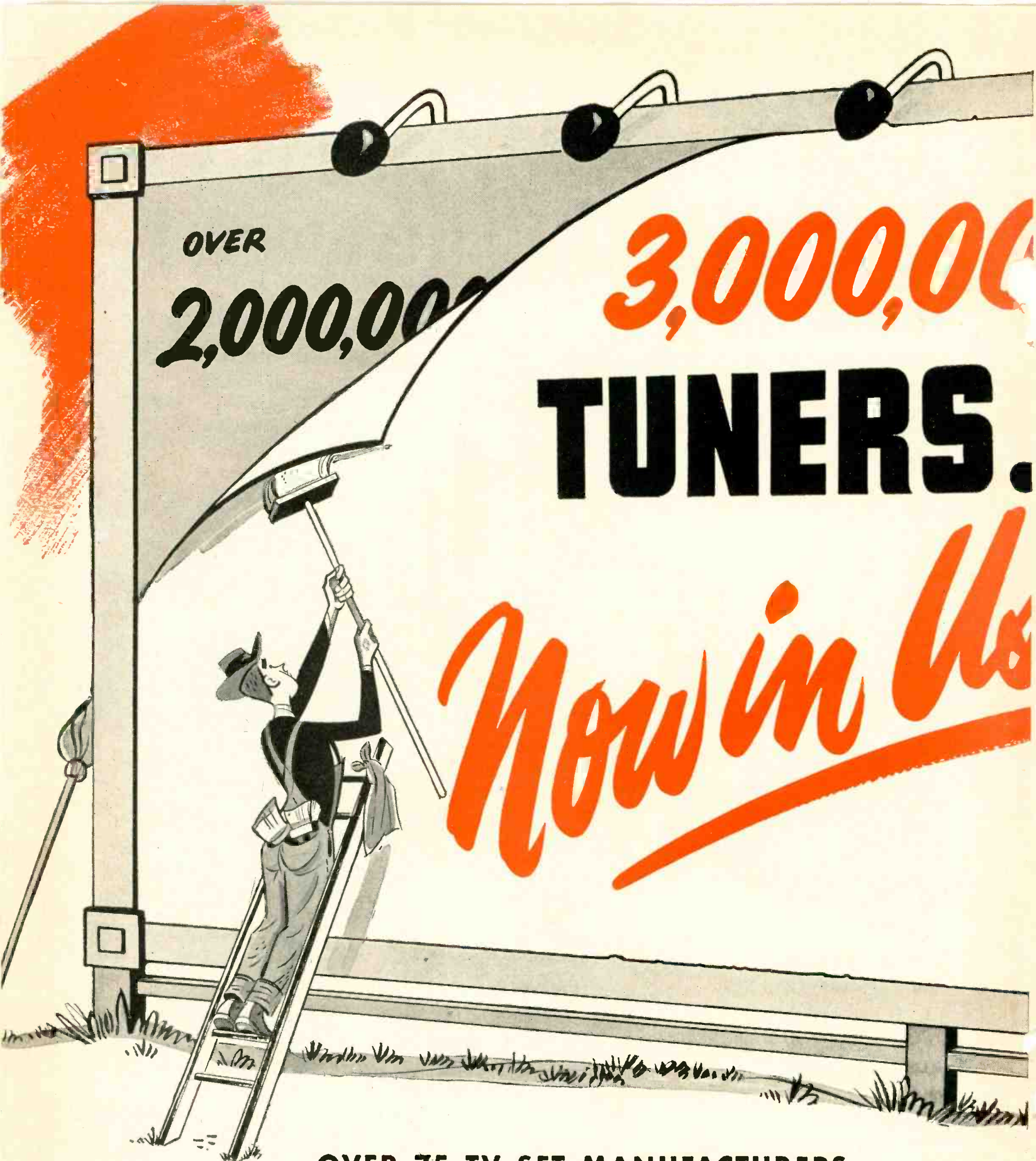
A laboratory-type Capacitor Analyzer meeting the need for a highly accurate, wide-range, direct-reading measuring instrument capable of determining the essential characteristics of capacitors has been announced by the Shallcross Manufacturing Co. This versatile instrument will determine capacitance values between 5mmf. and 12,000 mfd.; insulation resistance from 1.1 to 12,000 megohms; also leakage current, dielectric strength, and percentage power factor. A divided panel carrying an outline of the operating instructions makes it readily possible to use the instrument without reference to an instruction book. The Shallcross analyzer operates on 110 volt, 60-cycle alternating current. Literature giving full details will gladly be sent on request to the Shallcross Manufacturing Company, Collingdale, Pa.



MULTI-PURPOSE TRANSMISSION TEST SET

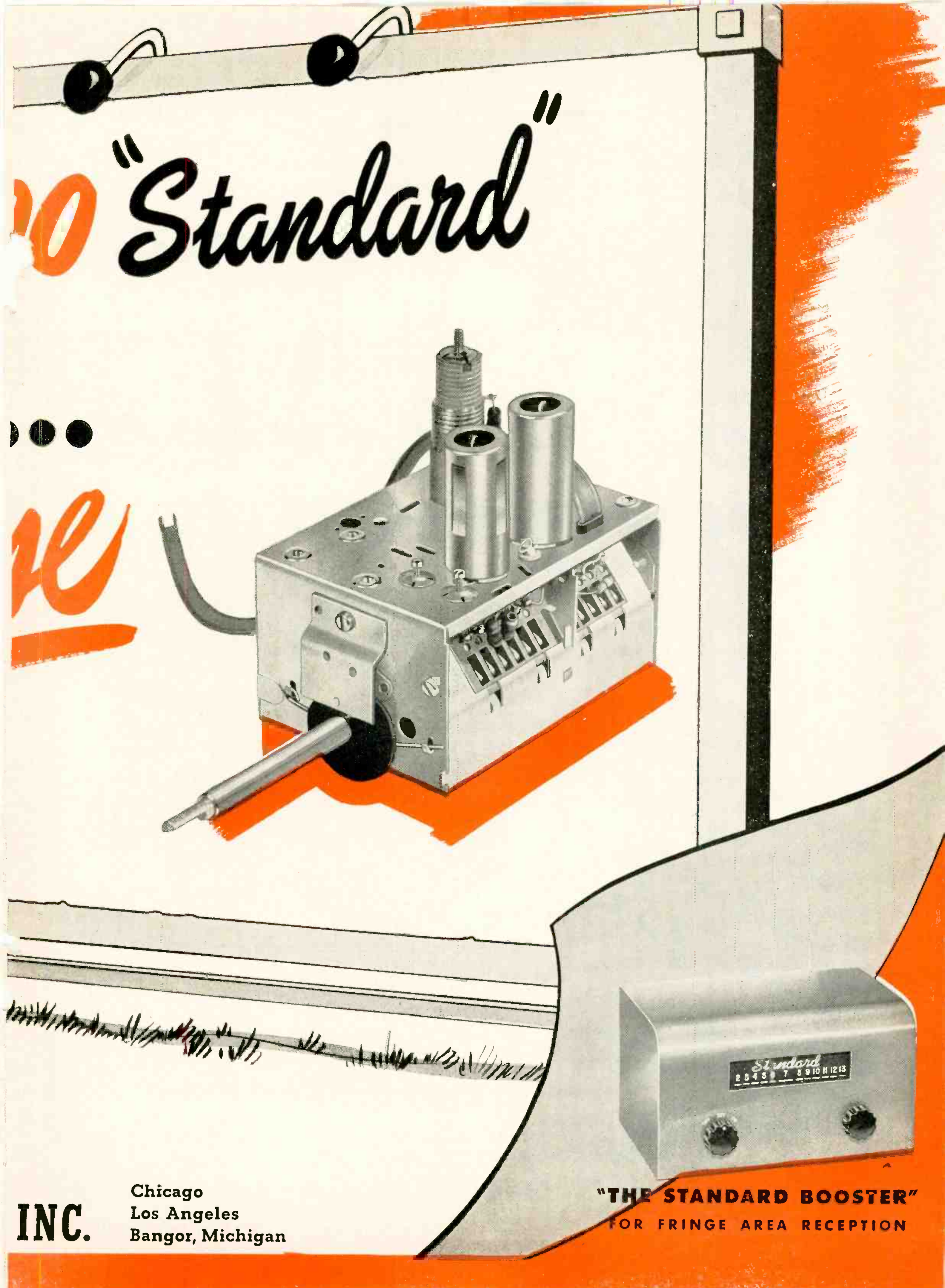
In addition to measuring the electrical characteristics of telephone lines and equipment the new Shallcross multi-purpose transmission test set may be used for efficiency tests on local and common battery telephone lines and sets, carbon microphones, receivers, and magnetic microphones. It also provides a fast, efficient means of testing capacitors, generators, ringers, insulation resistance, dials, and continuity. Key switches and dials are used to select and control the test circuits. The 693 Transmission Test Set is powered by external batteries. It features compact, substantial construction and is fully portable, thus making it ideal for either field or laboratory use. Details may be obtained from the Shallcross Manufacturing Company, Collingdale, Pennsylvania.

ADV.



OVER 75 TV SET MANUFACTURERS USE "THE STANDARD TUNER"

Standard COIL PRODUCTS CO.


"Standard"
INC.
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"THE STANDARD BOOSTER"
FOR FRINGE AREA RECEPTION

We repeat...

you can depend upon MITCHELL-RAND

TO PRODUCE WAXES AND COMPOUNDS AND SOLVE INSULATION PROBLEMS

The television industry had a serious insulation problem with fly-back transformers...all available waxes were tried and they just couldn't hold up. Mitchell-Rand undertook to develop an Impregnating and Dip Coating Wax which would stand the gaff and produced

R-4005 HIGH MELTING POINT WAX

FOR INSULATING AND MOISTURE PROOFING...AND THE PROBLEM WITH FLY-BACK TRANSFORMERS FOR TELEVISION USE IS NO MORE!

R-4005 • SPECIFICATIONS	
MELTING POINT (DRIP)	260/265 F
COLD FLOW (M-R)	255/260 F
PENETRATIONS	
32/200/60	10-12
77/100/5	19-21
115/50/5	28-32
COLOR	Tan
APPLICATION TEMPERATURE	285/350 F
SPECIFIC GRAVITY	0.91
FLASH POINT	490 F
SOFTENING POINT (B & R)	250/260 F
DIELECTRIC DISSIPATION AND POWER FACTOR	0.0054
DIELECTRIC CONSTANT	2.24

R-4005 for impregnating and dip coating coils, transformers, capacitors, etc., features high melting point, low impregnating viscosity, good electrical properties, resistance to low temperature crazing, good transparency and good adhesion. R-4005 is recommended for extreme high temperature applications on parts designed to operate up to 105-110°C, and its low temperature flexibility, coupled with its low degree of thermal shrinkage, make R-4005 well suited for units that must withstand extreme low temperatures down to minus 40°C. Its low electrical loss factor recommends R-4005 for impregnating special high quality coils. By altering wax bath temperatures and preheat cycles a wide latitude of single dip coating thicknesses can be obtained. The relatively transparent coatings are easily read through, and the surfaces obtained are semi-gloss and relatively non-blocking.

Write for your laboratory test samples . . . . . free upon request.

MITCHELL-RAND INSULATION CO. Inc.

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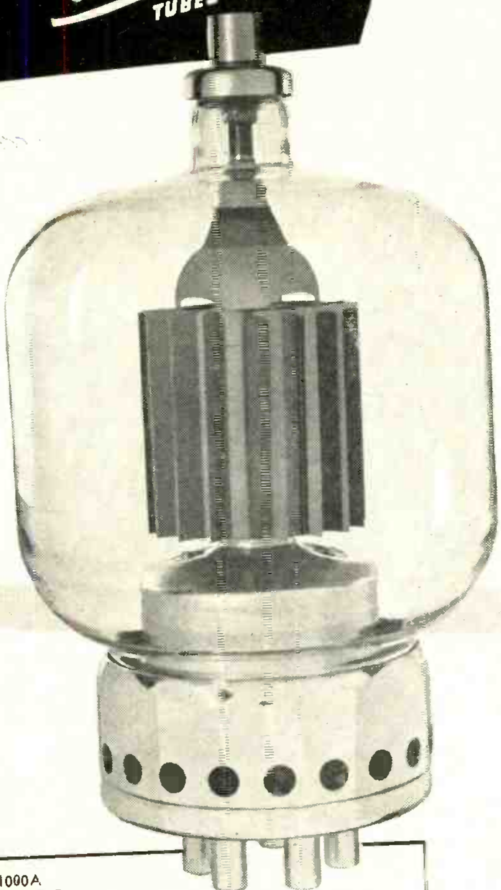
A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH • INSULATING PAPERS AND TWINES • CABLE FILLING AND POTHEAD COMPOUNDS • FRICTION TAPE AND SPLICE • TRANSFORMER COMPOUNDS • FIBERGLAS SATURATED SLEEVING • ASBESTOS SLEEVING AND TAPE • VARNISHED CAMBRIC CLOTH AND TAPE • MICA PLATE, TAPE, PAPER, CLOTH, TUBING • FIBERGLAS BRAIDED SLEEVING • COTTON TAPES, WEBBINGS AND SLEEVINGS • IMPREGNATED VARNISH TUBING • INSULATED VARNISHES OF ALL TYPES • EXTRUDED PLASTIC TUBING

Follow the Leaders to

Eimac TUBES



Eimac

4-1000A

POWER TETRODE

EIMAC 4-1000A POWER TETRODE	
General Characteristics	
ELECTRICAL	
Filament: Thoriated Tungsten	
Voltage	7.5 Volts
Current	21 Amperes
Grid-Screen Amplification Factor (avg.)	7
Direct Interelectrode Capacitances (avg.)	
Grid-Plate (without shielding, base grounded)	0.24 uufd
Input	27.2 uufd
Output	7.6 uufd
AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR	
TYPICAL OPERATION	
Class-AB, (Sinusoidal wave, two tubes)	
D-C Plate Voltage	5000 Volts
D-C Screen Voltage	1000 Volts
Max-Signal D-C Plate Current	1.00 Amps.
Effective Load, Plate-to-Plate	10,000 Ohms
Driving Power	0 Watts
Max-Signal Peak A-F Grid Voltage (per tube)	125 Volts
Max-Signal Plate Power Output	3100 Watts
PLATE MODULATED RADIO FREQUENCY AMPLIFIER	
Class-C Telephony—Carrier Conditions	
TYPICAL OPERATION	
(Freqencies below 30 Mc., one tube)	
D-C Plate Voltage	5500 Volts
D-C Screen Voltage	500 Volts
D-C Plate Current	600 Ma.
Driving Power	9 Watts
Plate Power Output	2630 Watts
RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR	
Class-C Telegraphy	
TYPICAL OPERATION, per tube	
(Frequencies below 30 Mc.)	
D-C Plate Voltage	6000 Volts
D-C Screen Voltage	500 Volts
D-C Plate Current	15 Watts
Driving Power (approx.)	.7 Amps.
Useful Power Output	3400 Watts

High-Power Amplifier Oscillator, Modulator

Eimac tetrode type 4-1000A is the electronic workhorse of modern communication systems. It is rated at 1000 watts of plate dissipation and is capable of efficient operation well into the vhf region. Like other Eimac tetrodes, the 4-1000A is readily 100% plate modulated.

At lower frequencies power gains of over 200 can be expected. Below 30 Mc. in normal operation 15 watts drive is sufficient to obtain output power in excess of 3000 watts per tube.

At 110 Mc. in FM broadcast service a pair of these heavy duty tubes will deliver over 5000 watts of useful power output.

In the adjacent column are highlighted typical operation data in more specific applications. Complete characteristics are compiled in a new data sheet . . . available by writing direct.

A 4-1000A is the economical vacuum-tube component for modern transmitters. Initial cost is low . . . tube life is long, consequently replacements are not only infrequent but also inexpensive. Consider it for your applications . . . Price $132.00.

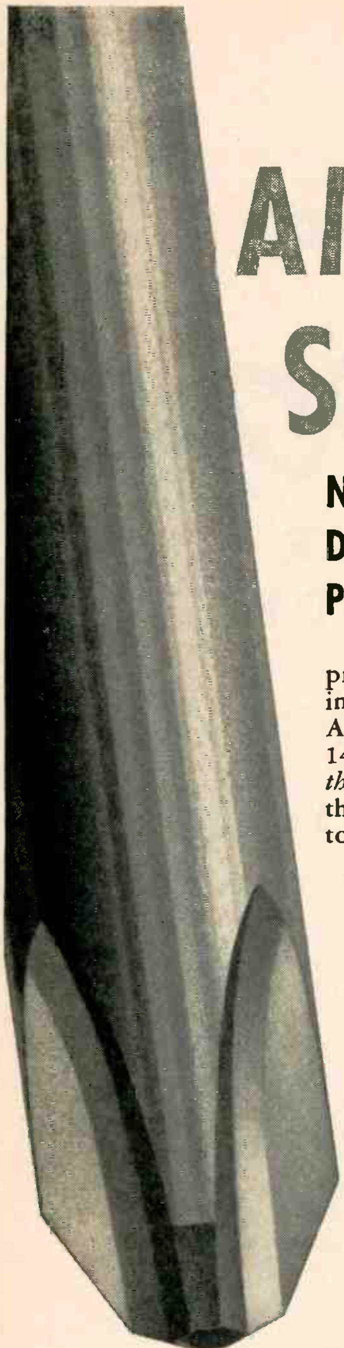
EITEL-McCULLOUGH, Inc.
San Bruno, California

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

271

Just off the press . . .

NEW, COMPLETE 4-1000A DATA...FREE



New Driving Power Behind AMERICAN PHILLIPS SCREWS!

New Campaign Goes Direct to Retail Buyers of Phillips-fastened products

Manufacturers of all types of products know the production-savings and sales-promotion power of American Phillips Screws. And now 14,000,000 prospective *buyers of those products* are being introduced, through the Saturday Evening Post, to the dependable "buy sign" of the Phillips Crossed Recess (the recess with the wide center opening for easy driving). They are being told that:

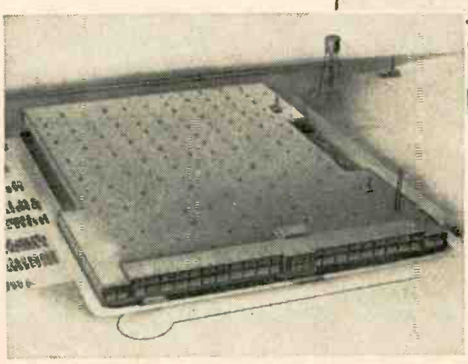
✖ is a *Known Quality*... a mark of *Top Quality* throughout the product

This campaign puts greater sales drive than ever behind American Phillips Screws... another good reason why it's good business to Phillips-fasten *your* products.

THE SATURDAY EVENING POST

4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS

PHILLIPS HEADquarters is this new and modern 5-acre plant at Willimantic, Conn., where American is in stronger position than ever to supply the growing demand for Phillips fasteners.



AMERICAN SCREW COMPANY

Plants at:
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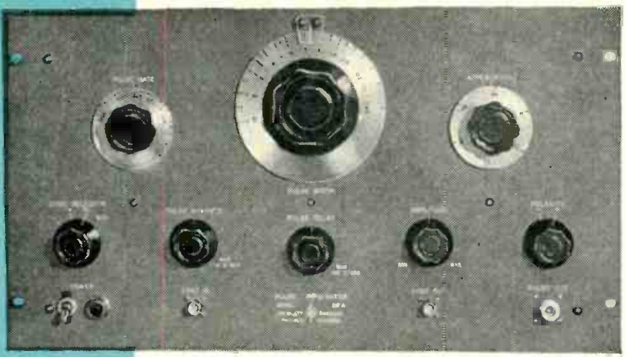
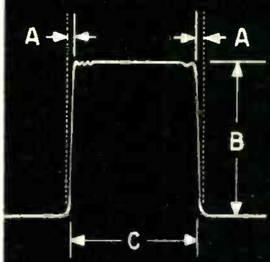
NEW -hp- GENERAL PURPOSE PULSE GENERATOR



-hp- MODEL 212A

TYPICAL 1 MICROSECOND
PULSE INTO 50-OHM LOAD



A. 0.02 μsec rise and decay time. Minimum overshoot.

B. 50 watt peak power. (50 v. to 50 Ω load.)

C. Pulse length variable 0.07 to 10 μsec.

SPECIFICATIONS

PULSE LENGTH:
Continuously variable, 0.07 to 10 μsec. Direct reading panel control.

PULSE AMPLITUDE:
50 v. into 50 Ω load. Pos. & neg. pulses. 100 v. open circuit.

AMPLITUDE CONTROL:
Continuous control throughout range. 50 db in 10 db steps. 10 db fine adjustment.

INTERNAL IMPEDANCE:
50 Ω or less.

PULSE SHAPE:
Rise and decay time approx. 0.02 μsec. (10% to 90% amplitude.)

REPETITION RATE:
50 pps to 5,000 pps. Internally or externally controlled.

SYNC IN:
May be triggered by pos. or neg. pulse of 5 v. at rates up to 5,000 pps.

SYNC OUT:
50 v. into 200 Ω load. Approx. 2 μsec long. Approx. 0.25 μsec rise time.

PULSE DELAY:
Main pulse delayable 0 to 100 μsec from sync output pulse.

PULSE ADVANCE:
Main pulse can be advanced 0 to 10 μsec from sync output pulse.

POWER SUPPLY:
110/220 v; 50/60 cps.

SIZE:
Panel 10½" high, 19" wide. Depth 12".

PRICE:
$550.00 f.o.b. Palo Alto.

Data Subject to Change Without Notice

CONTINUOUSLY VARIABLE, HIGH POWER PULSES OF SUPERIOR WAVE FORM!

THIS NEW -*hp*- 212A PULSE GENERATOR saves you time and work testing "fast" circuits as well as making everyday laboratory checks of other generators, rf circuits, peak-measuring equipment, etc. It is the first commercial pulse generator to successfully combine broad laboratory usefulness with the fast rise time, high power, variable pulsing and other features demanded in radar, television and nuclear work.

ACCURATE PULSES AT END OF LONG TRANSMISSION LINE

The pulse length is continuously variable from 0.07 μsec to 10 μsec, and is varied by a direct reading panel control. Extremely fast rise and decay time, together with freedom from ringing or overshoot provide a virtually distortion-free pulse. A low internal impedance (50 ohms or less) insures a pulse shape virtually independent of load. This low impedance also makes it possible to deliver accurate pulses at a distance from the instrument, if the transmission lines are correctly terminated.

The Model 212A's repetition rate is continuously variable from 50 to 5,000 pps. It can be controlled internally, or from an external synchronizing source. Synchronizing pulses are available from the instrument either in advance of or following the output pulse. An amplifier-attenuator output system gives a low source impedance, and makes possible continuously variable pulse amplitude, positive or negative.

Brief specifications of this new -hp- *instrument are shown in the adjoining column. For complete details... see your local* -hp- *representative... or write to the factory.*

HEWLETT-PACKARD COMPANY
2040A Page Mill Road • Palo Alto, California

Export: FRAZAR & HANSEN, Ltd., 301 Clay St., San Francisco, Calif., U. S. A. Offices: New York, N.Y. and Los Angeles, Calif.

2040

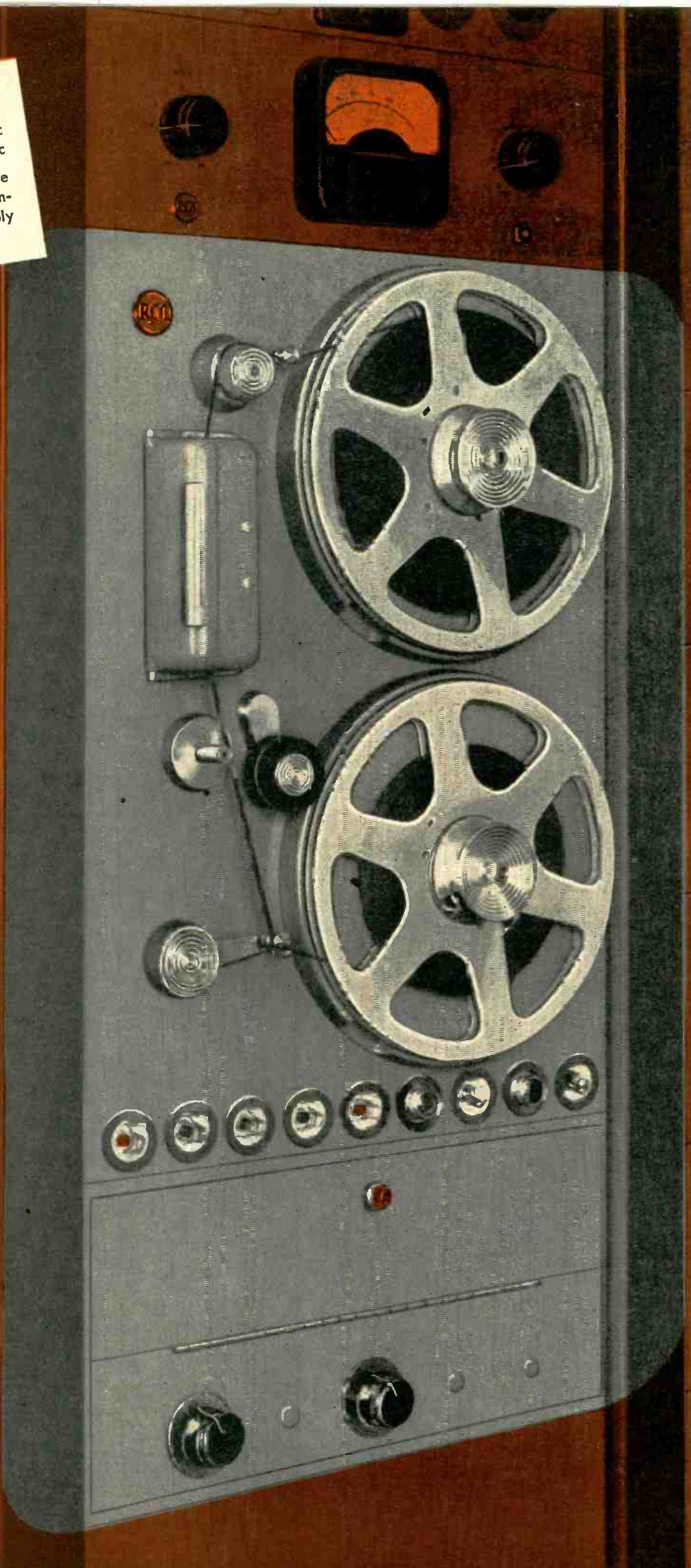
-hp- laboratory instruments
FOR SPEED AND ACCURACY

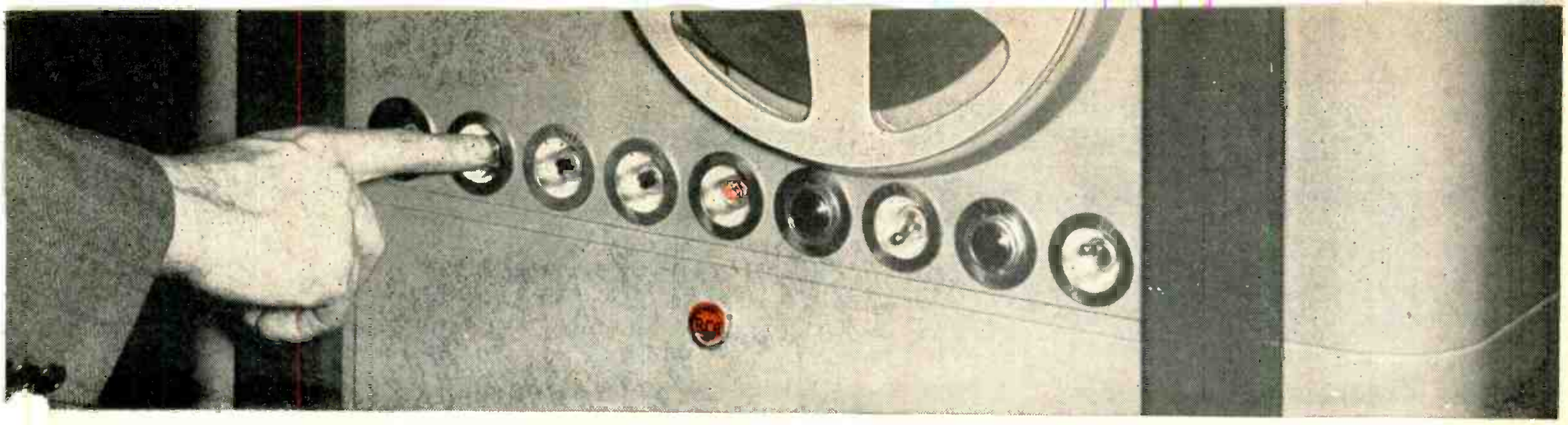
RCA TAPE RECORDER *Type RT-11A*

50 to 15,000 c.p.s. (±2 db) at 15 in/sec
50 to 7,500 c.p.s. (±2 db) at 7½ in/sec

COMPLETE—with motor board, plug-in type recording amplifier, plug-in playback amplifier, two standard NAB reels, power supply and panel and shelf.

- **Split-second start and stop**
- **Push-button operation**
- **Extremely accurate timing—with synchronous capstan**
- **Smooth tape runs—via sapphire guides**
- **Automatic tape lift for fast "forwards" and rewinds**
- **Microswitch "tape-break" control—no tape spills, snarls**
- **Remote control of all operations**
- **Rack or console mounting**
- **Plug-in amplifiers**
- **Interlock system for vital controls**
- **3 heads—Erase—Record—Playback**



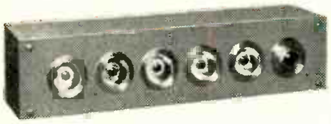


PUSH-BUTTON CONTROL puts tape recording facilities at your fingertips.

NEW—

High-Fidelity Tape Recorder

—the finest money can buy!



Remote Control Unit, MI-11948. Available extra.

This is the world's foremost professional tape recorder, the one recorder that has *everything*—accurate timing, low wow and flutter, plus quick starting. All operations are push-button controlled. All functions—including cueing—can be extended to remote positions.

Designed for applications where operating TIME and RELIABILITY are prime factors, the new Type RT-11A Recorder offers a number of exclusive features. For example, you can start or stop the tape in 0.1 second. You can jockey the tape back and forth for cueing without stopping. You can rewind a standard 10½-inch reel in one minute!

A synchronous capstan makes it practical to hold cording time to ±2½ seconds in a 30-minute run. And with synchronizing equipment . . . for which provision is made . . . *timing can be held to 0.3 second on any length program!*

Many more important features, too.

Self-centering "snap-on" hub adaptors assure perfect reel alignment with either RMA or NAB reels. A complete system of control interlocking virtually eliminates the possibility of accidentally erasing a program—makes it impossible to snarl or "spill" the tape. "Microswitch" control stops the machine if the tape is severed—applies reel brakes instantaneously. The tape automatically lifts *free and clear* of heads during fast forward runs or rewinds. Tape alignment over the heads is held precisely by a floating casting. Starting wow is reduced to the vanishing point.

BY ALL MEANS, *call your RCA Broadcast Sales Engineer for complete details. Or mail the coupon.*

RCA Engineering Products,
Department 36L,
Camden, New Jersey

Send me more information (including price and delivery) on your new De Luxe Tape Recorder, Type RT-11A.

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AUDIO BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

Specify Sorensen

AC VOLTAGE REGULATORS

Accuracy, with rugged construction, economical and trouble-free operation, reasonable cost — those are features that you expect, *and get,* when you specify Sorensen regulators!

ALL SORENSEN REGULATORS HAVE THESE ADVANTAGES:

- Wide Input Range
- Adjustable Output Voltage That Stays Set
- Regulation Accuracy of ± 0.1%
- Excellent Waveform
- Fast Recovery Time
- Insensitivity to Line Frequency Fluctuations.

MODEL NO. 500-S

STANDARD AC SPECIFICATIONS

VA capacity	150 500	250 1000	2000 3000	5000 10000 15000
Harmonic Distortion	3% max.	2% max.	3% max.	3% max.
Regulation accuracy	± 0.1% against line or load			
Input voltage	95-130 VAC; also available for 190-260 VAC single phase 50-60 cycles			
Output voltage	Adjustable between 110-120; 220-240 in 230 VAC models			
Load range	0 to full load			
P.F. range	Down to 0.7 P.F. All models temperature compensated			

NOTE: THREE PHASE AND 400 CYCLE REGULATORS ALSO AVAILABLE. ALL REGULATORS CAN BE HERMETICALLY SEALED.

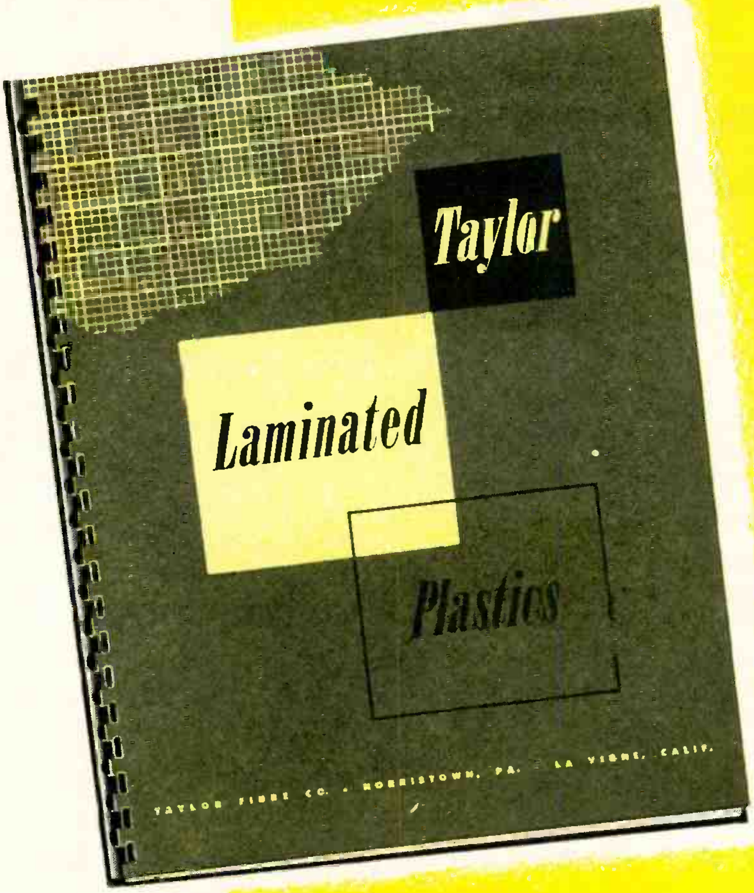
Write for Complete Literature

For regulated DC problems investigate Sorensen's line of Voltage Reference Standards, DC Supplys, and NOBATRONS

POWER controlled converted

Sorensen and company, inc.
375 FAIRFIELD AVE. • STAMFORD, CONN.

MANUFACTURERS OF AC LINE REGULATORS, 60 AND 400 CYCLES; REGULATED DC POWER SOURCES; ELECTRONIC INVERTERS; VOLTAGE REFERENCE STANDARDS; CUSTOM BUILT TRANSFORMERS; SATURABLE CORE REACTORS



HERE'S HELP

FOR THE PLASTICS USER

It's the new Taylor Catalog . . . 48 fact-filled pages of descriptive and engineering data on Vulcanized Fibre, Phenol Fibre and Special Laminates. If you are looking for new ways and means to improve your product, *and save money too*, here's an idea source guaranteed to spark the imagination and give you a hat full of hints, tips and suggestions.

In this new Taylor Catalog you will find all the details you need to know about electrical, physical and chemical properties of sheets, tubes and rods. It tells you how to design, plan, and buy for maximum economy. It offers valuable tips and suggestions on how to select the right Taylor material for the job. It shows you how to machine these versatile materials . . . gives you weights, suggested applications . . . specifications.

And that's not all! There's a lot more information as well . . . tables, diagrams and technical data that you'll find of constant value.

This new Taylor Laminated Plastics Catalog should be in your files. For your free copy, just fill in the coupon below . . . mail it *today* . . . we'll do the rest!

Taylor

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NORRISTOWN, PENNSYLVANIA
WEST COAST FACTORY: LA VERNE, CALIF.

TAYLOR FIBRE CO., Dept. E 11
Norristown, Pa.

Send me my free copy of the new Taylor Laminated Plastics Catalog

NAME ____________________

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NEW! FREQUENCY AND TIME MEASUREMENTS ACCURATELY . . . CONVENIENTLY

FREQUENCY RATIO MEASUREMENTS

DIRECT RPM READING TACHOMETER

SECONDARY FREQUENCY STANDARD

using $f = \frac{n}{t}$

ANY FACTOR MAY BE MEASURED FOR FIXED VALUE OF THE OTHER

FREQUENCY MEASUREMENTS

TIME INTERVAL MEASUREMENTS

TOTALIZING COUNTER

The Universal 6-IN-ONE MEGACYCLE FREQUENCY-TIME COUNTER by Potter

Now, the Potter Instrument Company offers all-in-one equipment, the features heretofore available only in separate counting systems. Two complete counting channels, a 100 kc crystal oscillator time base and unique gating circuits are combined to provide the new FREQUENCY-TIME COUNTER.

FREQUENCY MEASUREMENTS	0 to 1 mc range by counting cycles per pre-selected time or by measuring time per pre-selected count. Accuracy 0.001 % minimum.
TIME INTERVAL MEASUREMENTS	0 to 10 seconds ± 10 micro-seconds.
FREQUENCY RATIO MEASUREMENTS	Ratio of two external frequencies can be measured.
SECONDARY FREQUENCY STANDARD	100 kc crystal oscillator with divided frequencies available at 10, 1 kc and 100, 10, 1 cps.
TOTALIZING COUNTER	Six decades, pulses 0 to 1 mc, sine wave 10 cps to 1 mc.
DIRECT RPM READING TACHOMETER	Through the use of an external 60 count per revolution photoelectric disc generator an accuracy of ± 1 rpm is obtained.

FEATURES

WIDE FREQUENCY RANGE — Pulses 0 to 1 megacycle — sine waves from 10 cps to 1 mc.

EXTREMELY HIGH ACCURACY — 0.001% from 0 to 1 megacycle.

VERSATILITY — Frequency measurements, time intervals, frequency ratios, high speed counting, rpm measurements, and a secondary frequency standard — all in one instrument.

RAPID MEASUREMENT — No adjustments or interpolations — only a few seconds for a complete measurement.

DIRECT DECIMAL READING — Frequency or time displayed on six Potter Counter Decades using the 1-2-4-8 large neon glow lamp decimal indication. Readable even under high ambient illumination.

AUTOMATIC OR MANUAL RECYCLING — The counter will retain the measurement until reset or will automatically recycle after displaying the measurement for a selected time.

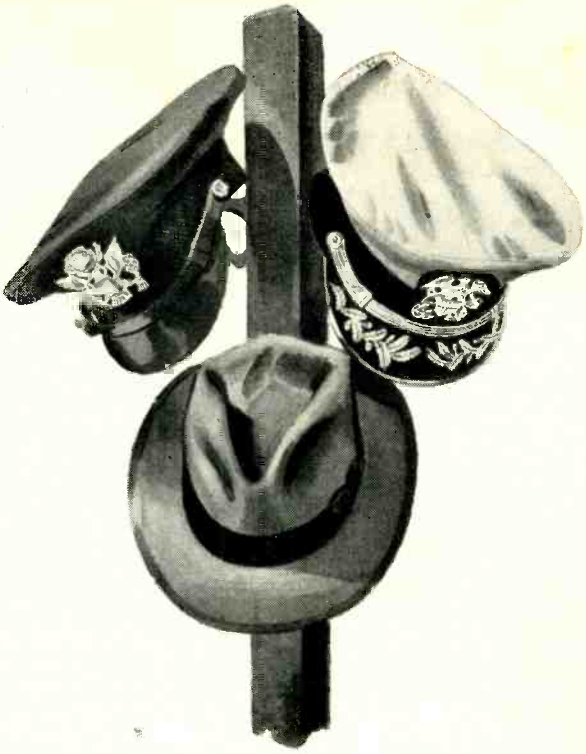
NO ADJUSTMENT — Stable decade counter frequency dividers, rather than multivibrators are used to establish the precise time base.

DEPENDABLE — The exclusive four-lamp Potter decades provide a direct on-off indication of the counter stages without the complexity and unreliability of a readout matrix. An associated glow lamp for each tube in the counting and dividing circuits simplifies tube servicing.

PERMANENT RECORD — Other versions of the Frequency Time Counter can be supplied with high speed recording devices.

INSTRUMENT Potter COMPANY

POTTER INSTRUMENT COMPANY
INCORPORATED
115 CUTTER MILL RD., GREAT NECK, NEW YORK



They're all in our reception room

How are your chances of getting an order of Karp-built cabinets or housings these days?

They're good — particularly if the work is part of a defense contract.

While both military and civilian customers are knocking at our door defense production must be given top priority.

Actually, most of the cabinets or enclosures we make are components of equipment equally useful in peace or war. Today a majority of our regular customers are simply ordering the same things they normally buy, but in greater volume.

To customers whose products are not related to defense needs, we pledge our utmost cooperation, serving them to the full extent of our ability . . . in the face of the shortages and restrictions that limit all of us.

KARP METAL PRODUCTS CO., INC.

215 63rd Street • Brooklyn 20, N. Y.

SPECIALISTS IN FABRICATING SHEET METAL FOR INDUSTRY

TWA buys Collins vhf transmitters

for its entire Martin 4-0-4 fleet

Collins shockmounted 17L-2 transmitter

Collins 314Y-1 remote control unit

By its purchase of 40 Martin 4-0-4's, which will begin to go into domestic service next spring, Trans World Airlines follows its traditionally vigorous course of progress.

Also reflecting TWA's policy of providing the most efficient air transportation that modern facilities permit, is the fact that the radio complement of every one of the new 4-0-4's will include a Collins 17L-2 vhf transmitter.

TWA engineers made a careful study of available vhf transmitting equipment. They knew that vhf communication is line-of-sight communication, noise-free within its range, but not applicable over great distances. They chose the 17L-2 largely because it had the best size-weight to power ratio.

The 17L-2, small enough to be housed in a standard ½ATR size case, weighs only 19 pounds. Yet it has a power output of eight watts or better into a 52-ohm load, thus assuring that transmissions will be received and acknowledged at the busiest air terminals.

In addition, it provides fingertip remote frequency control of all 180 channels reserved for aircraft communication in the vhf band. The 314Y-1 remote control unit can be located wherever it is most convenient.

All airline operations and communications people should be fully informed about this highly developed transmitter. A descriptive bulletin will be sent you on request.

IN RADIO COMMUNICATIONS, IT'S . . . COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 West 42nd Street, NEW YORK 18   27 West Olive Avenue, BURBANK

Now TWA Offers All-Cargo "Sky Merchant" Service Coast to Coast

Speed your electrical-product shipments direct at low cost between major U.S. cities

Practically anything you want to ship . . . and to almost anywhere you want to ship it . . . can now go faster, more economically and more easily via TWA's new fleet of giant, 4-engine *All-Cargo* planes . . . TWA "Sky Merchants."

TWA's "Sky Merchants" offer a new daily service to and from the principal commercial and industrial markets throughout the U.S. Direct flights, with connections serving more than 60 cities. Fast, daily service coast to coast . . . overnight between most points.

TWA's new *All-Cargo* "Sky Merchant" fleet greatly expands TWA's air freight service . . . already widely used by experienced shippers throughout the world. This dependable service with its increased facilities enables you to save transit time . . . save money . . . save work . . . beat competition . . . meet deadlines . . . increase turnover . . . increase sales.

Remember—it's good business today (and every day) to speed your large or small shipments via TWA. Phone nearest office for prompt pickup . . . rates . . . information. Write today for free Air Freight folder. Address: Cargo Sales Manager, TWA, 60 East 42nd Street, New York 17, N.Y.

TYPICAL LOW TWA AIR CARGO RATES	FROM	TO	COMMODITY	RATE PER 100 LBS. (MINIMUM WEIGHT)
	Philadelphia	Chicago	Radios and parts	$5.33
	Indianapolis	Pittsburgh	Television sets	4.46
	Philadelphia	Chicago	Electrical; Electronic merchandise	5.33
	Indianapolis	San Francisco	Recordings; Radio transcriptions	21.45
	New York (Newark)	Kansas City	Tel. & Tel. instruments; Parts; Supplies	10.38
	Chicago	Pittsburgh	Machines; Machine parts	4.24

TWA

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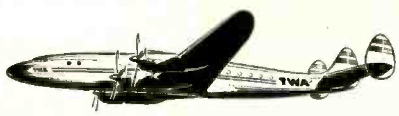


All TWA Flights carry Air Mail and Air Cargo

MINIATURE PARTS

to Precision Tolerances

METAL STAKING

Stays Tight!

That's Why

INSUROK T-725

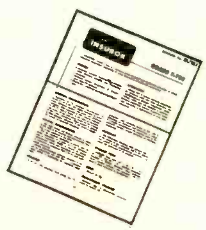
IS USED IN THIS HIGH-FREQUENCY FUNCTION SWITCH MADE BY GRIGSBY-ALLISON COMPANY

For this four-way function switch, which selects AM, FM, phono, or TV, Grigsby-Allison had to find an insulating material which would punch readily into intricate shapes. It had to possess high impact strength so that metal T-slugs, staked by a special method, would not loosen. Finally, because of the high frequencies involved, excellent electrical properties were needed in the material—even after sanding to close tolerances.

INSUROK T-725 has just the right combination of properties to meet these requirements. Equally important, Grigsby-Allison engineers can depend on these properties remaining uniform from shipment to shipment.

In hundreds of similar applications, laminated and molded INSUROK are solving difficult problems for industry. Investigate INSUROK for your product, today.

Write for Descriptive Data Sheet.



INSUROK*
Laminated and Molded Plastics

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The RICHARDSON COMPANY

FOUNDED 1858—LOCKLAND, OHIO

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SALES OFFICES: CLEVELAND • DETROIT • INDIANAPOLIS • LOCKLAND, OHIO • MILWAUKEE • NEW BRUNSWICK, N. J. • NEW YORK • PHILADELPHIA • ROCHESTER • ST. LOUIS

You Can Depend on DAVEN for *Accuracy* in Attenuators

*F*or many years Daven has been known for the quality of its attenuators. And, although Daven production has grown to include a wide variety of instruments for the electronics industry, the development of its attenuators has grown apace. Much of the testing equipment used by Daven to guide them in the manufacturing of attenuators has been developed by Daven's own engineering specialists. As a result, Daven attenuators have become the standard of the industry, by which all other similar equipment is measured. Shown and described here are two of the newest units that are typical of the vast Daven line of attenuators. Your inquiry for specific information to apply to your own particular problems is invited. Let Daven furnish you with completely detailed catalog data.

THE DAVEN CO.

191 CENTRAL AVENUE
NEWARK 4, N. J.

RF Attenuation Network

This equipment is an exclusive Daven development. It is a moderately priced attenuator incorporated in an RF Attenuation Box to insert accurate losses from D.C. to 225 MC. The unit has many applications where attenuation of UHF is desired, since it can be utilized as an all-purpose laboratory and test instrument.

SPECIFICATIONS:

ZERO INSERTION LOSS OVER ENTIRE FREQUENCY RANGE.
FREQUENCY RANGE: Zero to 225 MC.
IMPEDANCE ACCURACY: Within ±5% over frequency range.
ATTENUATION ACCURACY: ±5% over frequency range.
CONNECTORS: Receptacles are supplied. Cable plugs, if required, will be supplied at a slight additional cost. When ordering, specify which type connector is desired—either Series "BNC" (UG-185/U) or Series "N" (UG-58/U).
CIRCUIT: Constant input and output impedance (unbalanced). Zero initial loss.
RESISTOR ACCURACY: ±2% at D.C.

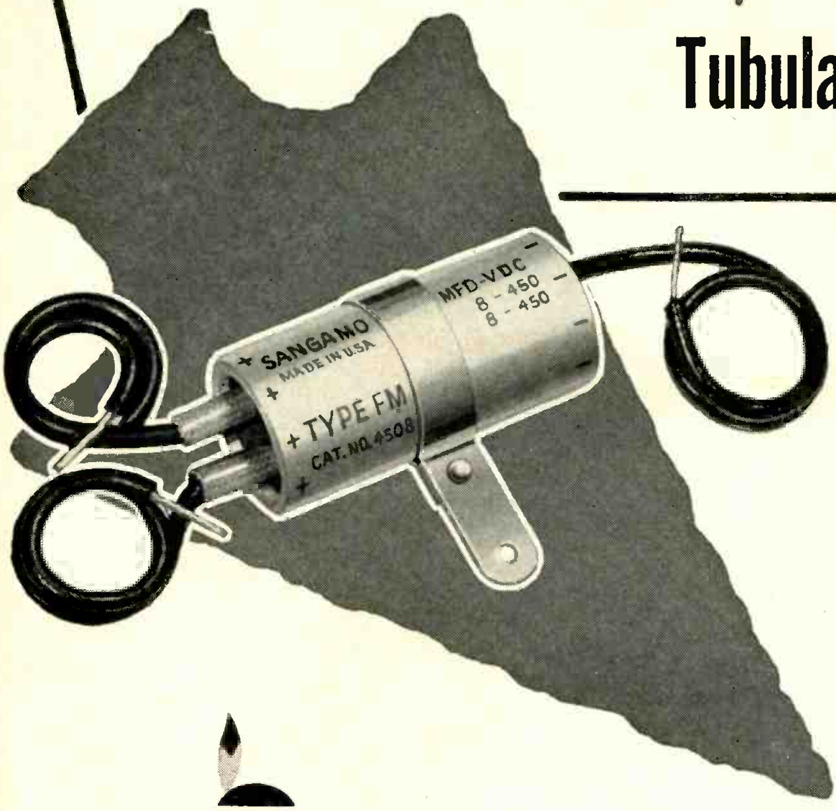
Carrier Frequency Decade Attenuator

This equipment is particularly applicable to extremely accurate measurements from D.C. to 200 kc. and can be used up to the lower radio frequencies. The Decade type switches make the box convenient to use. In addition, there are switch stops which prevent return from full to zero attenuation when making adjustments. A total of 110 Db. is available in 1.0 Db. steps, or 111 Db. is available in 0.1 Db. steps. Both of these types may be obtained in either a balanced H or an unbalanced T network.

SPECIFICATIONS:

ACCURACY: Each individual resistor is adjusted within ±0.25% of its correct value. The error in attenuation is less than ±1% of the indicated value, provided the output is matched by a pure resistance.
FREQUENCY ERROR: At frequencies below 200 kc., the total error in attenuation will not be greater than ±1% of the indicated value.

The New Sangamo *Arrowhead* Tubular Electrolytic



SMALLER THAN ANY OTHER DUAL TYPE

the Little Indian

THE LITTLE INDIAN SAYS: **"terrific for TV!"**

The new Sangamo Type FM "ARROWHEAD" tubular electrolytic capacitor is equipped with flexible, insulated wire leads and stud terminals to make installation easier by eliminating the problem of crossed wires and the need for insulating sleeves. Sangamo Arrowheads are much smaller than wax end filled types with insulated leads—*smaller than any other type with dual leads!*

These capacitors are housed in round aluminum containers which are encased in heavy insulating sleeves with mounting strap attached, and they are especially designed for the rugged television requirements where 85° C operating temperatures are encountered.

A trial of these new dry electrolytic capacitors will convince you. See your Jobber, or write for Catalog No. 800, which gives full information on the Arrowhead and the rest of the Sangamo Tribe.

Your Assurance of — The SANGAMO Tribe — *Dependable Performance*

PAPER · MICA · SILVER · ELECTROLYTIC CAPACITORS

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

SC50-10A

EXTRA RELIABILITY

GL-5686

G-E transmitting tubes have it! So . . . Mr. Manufacturer . . . specify General Electric, to design max dependability into your radio equipment!

HERE are tubes better-built by G.E. for better performance! Each has that something extra in design, in manufacture, which means real dependability when the chips are down and your equipment is working peak-load and full-time.

GL-5686 . . . It's a new nine-pin miniature that does the work of a 6AQ5 or 6AR5—does it consistently, because *every tube* gets 50 hours' service at the factory under Class A conditions, with frequent samples also being selected for full life tests. You can bank on the GL-5686!

GL-807 . . . The G-E grid construction is substantial and strong—will stand up under punishment. Moreover, special G-E development work in metals and other substances gives this tube premium quality from cap-terminal through to base-pins.

GL-813 . . . Superior G-E internal shielding, in the form of a large ground-plane barrier, gives ample protection against feedback—cuts down sharply on the need to neutralize. Improved design joins with precision G-E manufacture to offer you the leading beam power tube in its class.

Why not ensure your new transmitter's performance by choosing these and other G-E tubes your customers can count on, day-in and day-out? Just write for data sheets that give *all* ratings, in all classes of service. Or better, ask for the help of expert G-E tube engineers, who will be glad to consult with you personally on applications. Address *Electronics Department, General Electric Co., Schenectady 5, N.Y.*

GL-807

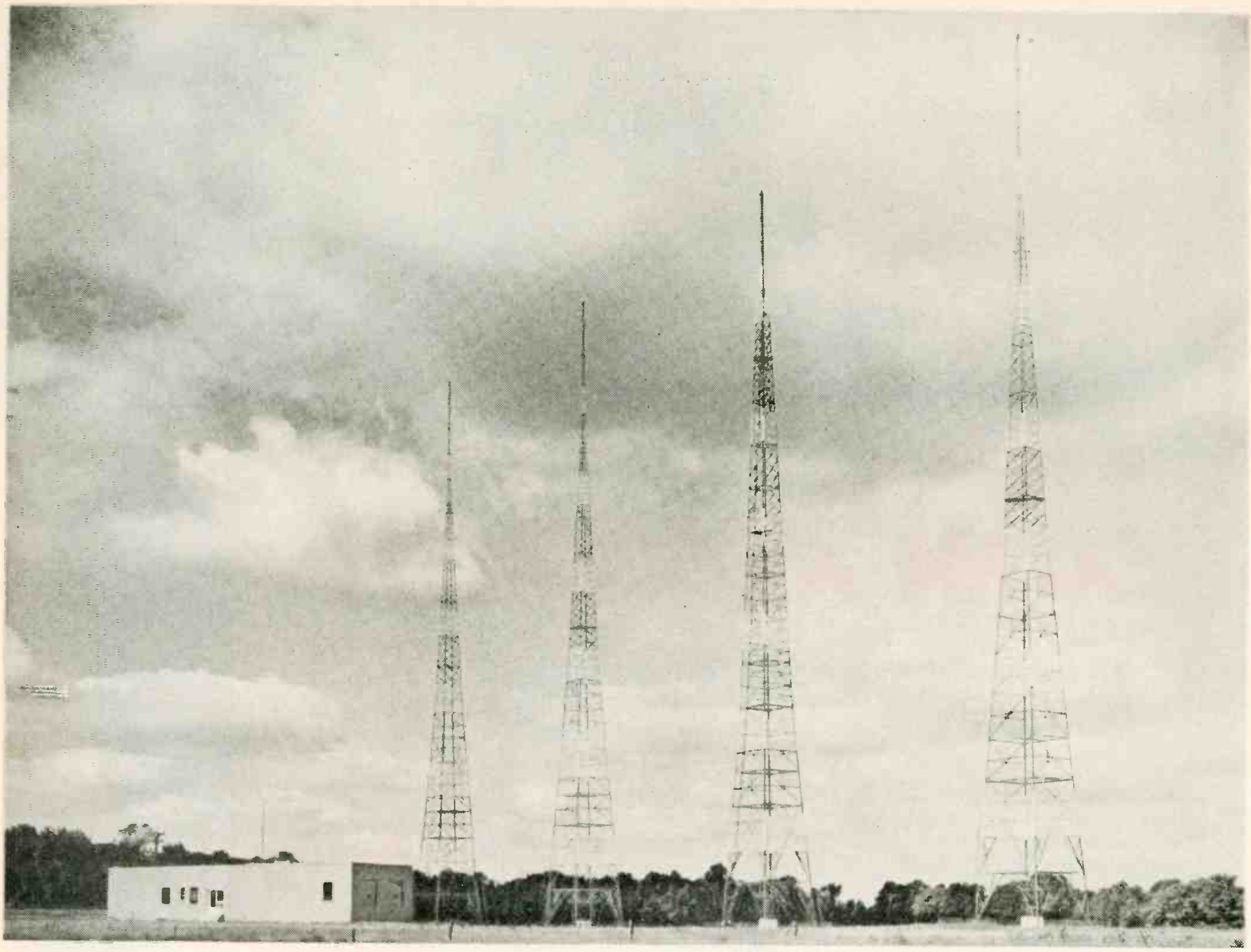
GL-813

TYPICAL OPERATION, CLASS C TELEGRAPHY

	GL-5686	GL-807	GL-813
Plate voltage	250 v	600 v	2,000 v
Plate current	40 ma	100 ma	180 ma
Driving power (approx)	0.15 w	0.2 w	1.9 w
Power output (approx)	6.5 w	40 w	275 w
Max plate dissipation	7.5 w	25 w	100 w
Freq. at max ratings	160 mc	60 mc	30 mc

GENERAL ELECTRIC

180-J7



WERE WAS "THERE"

—when they specified Blaw-Knox Towers for their powerful new AM, FM, TV station!

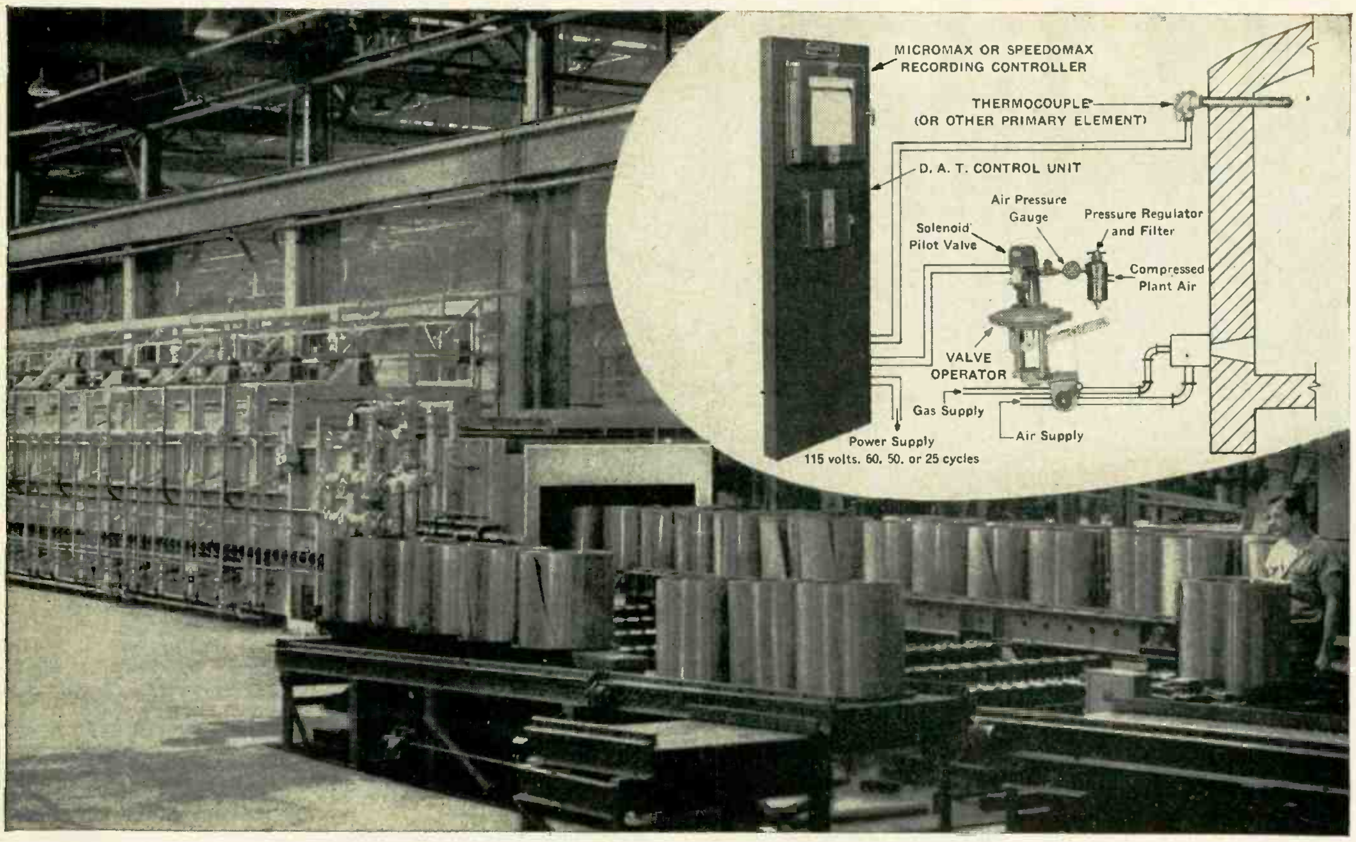
WERE's technicians couldn't actually *see* Blaw-Knox engineering or point to Blaw-Knox long experience in tower-building, or show off the inherent strength and efficiency of these towers—*but they knew they were all there!* Hence their choice.

. . . A quotation will prove that there's no premium on Blaw-Knox quality.

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
2077 Farmers Bank Building, Pittsburgh, Pa.

Distributed by GraybaR
OFFICES IN 100 PRINCIPAL CITIES

BLAW-KNOX *ANTENNA* TOWERS



One of four 119-foot annealing furnaces built by Surface Combustion Co., and The Electric Furnace Co., for Scovill Manufacturing Company's new $10 million continuous strip mill. Crediting L&N D.A.T. pyrometric control on all these furnaces, Scovill says: "D.A.T. is taking a big part in helping us turn out the most uniform, high-quality brass we've ever made." Sheet is annealed in 2,000-lb coils; capacity is 32,500 lbs. per hour per furnace.

THIS "PACKAGE" OF CONTROL FITS ITSELF TO FURNACE NEEDS

And Only L&N Can Supply All Its Features!

SCOVILL'S latest success in controlling temperatures in brass strip-annealing furnaces is doubly interesting because it shows what can be done with other thousands of industrial furnaces. Small units may need only one instrument, instead of Scovill's five per furnace, but the principle's the same. Any furnace which can be controlled by turning fuel "on" at a predetermined low temperature, and turning it "off" at a predetermined high, will get its best possible regulation by D.A.T. Control.

D.A.T. excels for two reasons. First, it takes the "predetermined" out of the on-off action. Second, it adds full proportioning action. Instead of operating at predetermined temperatures, D.A.T. acts earlier or later, depending on change in heat demand. Only D.A.T. supplies all these features.

Increased production resulting from unusual uniformity is the great advantage of D.A.T. but other points are worth remembering: (1) Fuel can often be saved because less heat is lost up the stack. (2) Valve and burner sizes are not particularly critical. (3) D.A.T. can often modernize an old furnace, because it's so easy to install.

D.A.T. is just one of several L&N Controls. Call us for service or information in selecting equipment for any temperature-control problem. Address nearest office or 4979 Stenton Ave., Philadelphia 44, Pa.

TYPICAL RESULTS

D.A.T. exactly adapts its action to the upsets, load changes and lags of the furnace. This means it holds temperature in line for all normal changes in furnace charge, ambient temperature, temperature control point, etc.

D.A.T. offsets many inherent lags or delays in "sensing" temperature changes, such as that due to thermocouple protecting tubes.

D.A.T. operates equally well on furnaces of full-muffle, semi-muffle, open firing and conventional radiant-tube design.

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

LN LEEDS & NORTHRUP CO.

Jrl. Ad. N-33A-626(6)

Here's the motor that "couldn't be built"!

It's the Holtzer-Cabot quiet-running capacitor motor — the motor that powers the Nesbitt schoolroom ventilating unit.

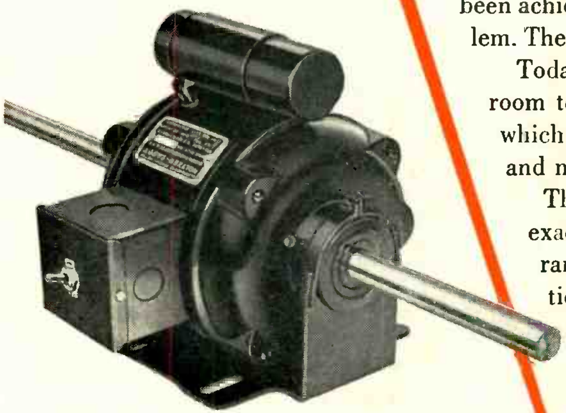
Previously, the hum of A.C. motors powering these units had proved so distracting as to be impractical. Hence, when alternating current only was available, motor-generator sets were required to convert to D.C.; but this arrangement was not too satisfactory because of the excessive additional cost.

Quite a problem!

The obvious solution was a really quiet A.C. motor — something that had never been achieved up to that time. Holtzer-Cabot engineers went to work on the problem. The result was an A.C. motor that performed perfectly . . . *and silently!*

Today, schools from coast to coast are using Nesbitt ventilator units in each room to furnish a continuing supply of fresh sweet air. These units, many of which are powered by Holtzer-Cabot motors, operate efficiently and quietly, and make possible full concentration in the classroom.

This is just another example of Holtzer-Cabot's ability to meet the most exacting specifications in small-motor applications. Holtzer-Cabot motors range from 1/2000 up through 1½ H.P., from 24,000 RPM to 1 revolution per day!



The Holtzer-Cabot RWC-6417, an improved version of the first silent A.C. motor developed to Nesbitt Co. specifications. Single phase, 1/12 H.P. single value capacitor type, with totally enclosed wool-packed sleeve bearing and a resilient base mounting. Shaft is 43" overall, ¾" in diameter, adjustable variable speed. Gives trouble-free performance.

HOLTZER-CABOT

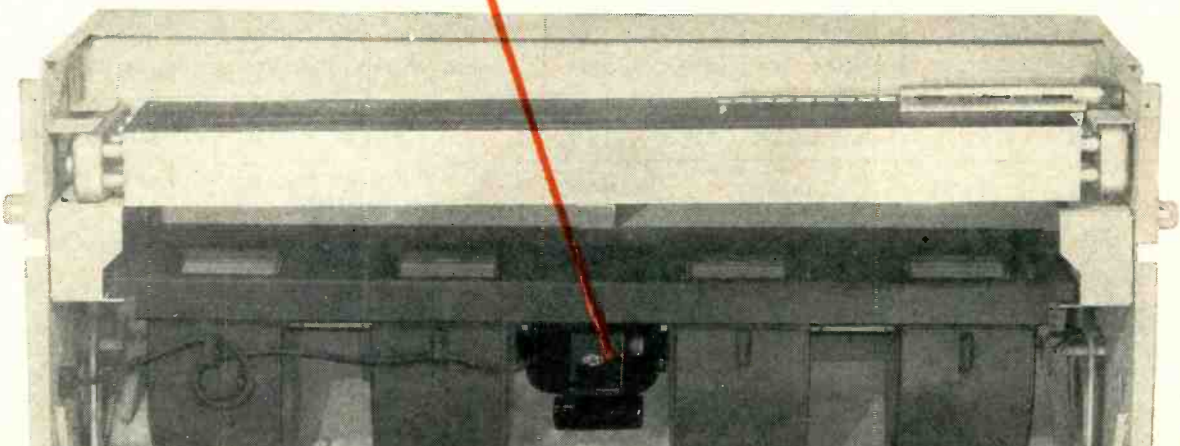
HOLTZER-CABOT ESTABLISHED 1875

DIVISION OF NATIONAL PNEUMATIC CO., INC.

BOSTON 19, MASSACHUSETTS

"Manufacturers of fine electrical apparatus since 1875"

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



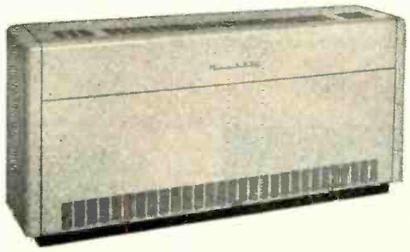
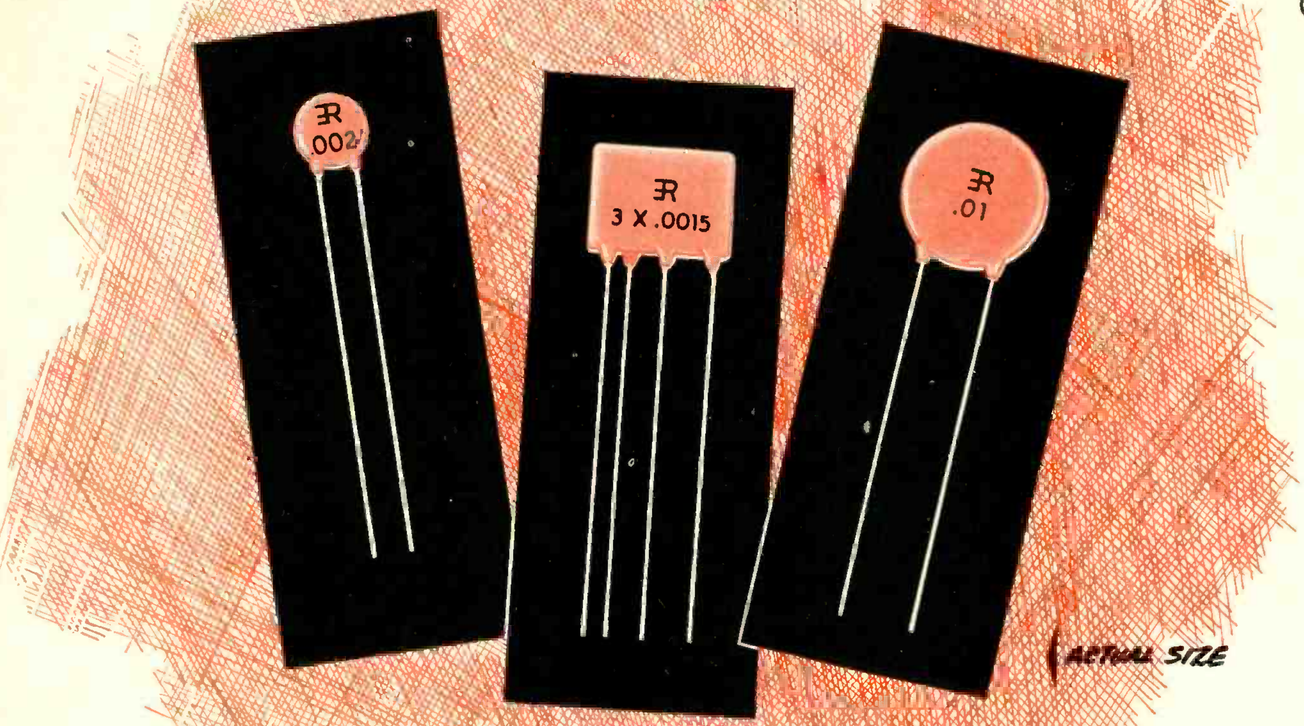


photo courtesy of John J. Nesbitt Co., Inc.

Erie DISC AND PLATE Ceramicons®



for by-passing and coupling applications

High capacity in extremely compact size is the distinguishing feature of Erie Disc and Plate Ceramicons. Illustrations are exact size, and their shape as well as their compactness make them amazingly easy to install in small spaces. They simplify soldering and wiring operations and speed up the assembly line.

Erie Disc and Plate Ceramicons consist of a flat ceramic dielectric with silver plates fired onto the dielectric. Lead wires of 24 gauge tinned copper wire are firmly soldered to the silver electrodes and the unit is given a protective coating of phenolic.

Such simplicity of construction results in low series inductance and unusual efficiency in high frequency by-passing.

For complete information and samples to meet your particular needs, write us today.

STANDARD AVAILABLE CAPACITIES

ERIE STYLE	SIZE	CAPACITY	STAMPING
831	5/16" Max. Dia.	800 MMF	ER 800
801	3/8" Max. Dia.	.001 MFD	ER .001
		.0015 MFD	ER .0015
		.002 MFD	ER .002
811	19/32" Max. Dia.	.005 MFD	ER .005
821	3/4" Max. Dia.	.01 MFD	ER .01
812	19/32" Max. Dia.	Dual .001 MFD	ER 2 x .001
		Dual .0015 MFD	ER 2 x .0015
		Dual .002 MFD	ER 2 x .002
822	3/4" Max. Dia.	Dual .003 MFD	ER 2 x .003
		Dual .004 MFD	ER 2 x .004
883	9/16" x 3/4" Max.	Triple .0015 MFD	ER 3 x .0015

SPECIFICATIONS

Voltage: Units are rated at 500 VDC. Dielectric strength test: 1,500 VDC.

Power Factor: 2.5% max. at 1 K.C. at not more than 5 volts RMS.

Insulation Resistance: 7,500 meg. Ω min.

Capacity: Capacity measurements are made at room temperature (25° C) at 1 K.C. and at not more than 5 Volts RMS. Standard tolerance is +100%, —0%.

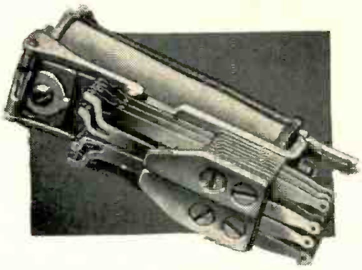
Temperature Characteristics:
Capacitance shall not decrease more than 50%, nor increase more than 25% from its value at room temperature (25° C), as the temperature is varied from +10° C to +75° C.

Electronics Division
ERIE RESISTOR CORP., ERIE, PA.
LONDON, ENGLAND . . . TORONTO, CANADA

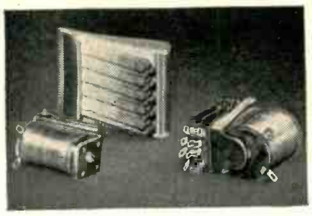
Ask for this 88-page technical guide to the use of relays and switches

Catalog No. 4071-F

relays

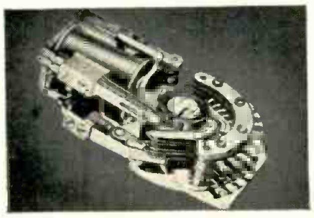


Class "B" Relays—For extremely high speed operation and for time delays on either "operate" or "release" strokes. Available for either d-c or a-c operation.

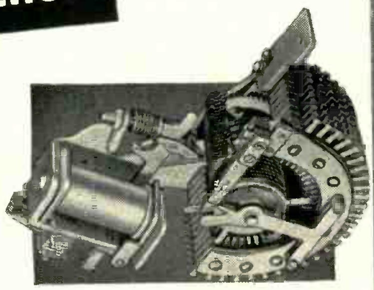


Class "S" Relays—Astonishing power in a small, light weight relay. Hermetically sealed if desired. Unaffected by vibration, temperature, humidity. Coils up to 10,000 ohms or more.

switches



Type 44 Stepping Switch—For d-c operation, tiny, light weight. Accommodates up to 6 bank levels with 10 points plus "home." Adaptable to 10-, 20- or 30-point operation.



Type 45 Stepping Switch—For d-c operation, or supplied with built-in rectifier for a-c operation. Accommodates up to 10 or more bank levels. Adaptable to 25- or 50-point selection.

AUTOMATIC ELECTRIC
CHICAGO

For any product — for any purpose where you need relays or stepping switches—there is an Automatic Electric unit that's exactly RIGHT. Only a few are shown at the left, but all are illustrated and described in our big new catalog 4071-F.

Here are complete specifications and performance and mounting data on the wide range of components manufactured by Automatic Electric Company for communication, signaling, and industrial electrical control service. Here you'll find units for *your* jobs—including hermetically sealed and low-capacitance relays, and the most compact stepping switch on the market! Write for your copy of this new catalog. Address: AUTOMATIC ELECTRIC SALES CORPORATION, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric (Canada) Ltd., Toronto. *Offices in Principal Cities.*

Automatic Electric Sales Corporation
1033 West Van Buren Street
Chicago 7, Illinois

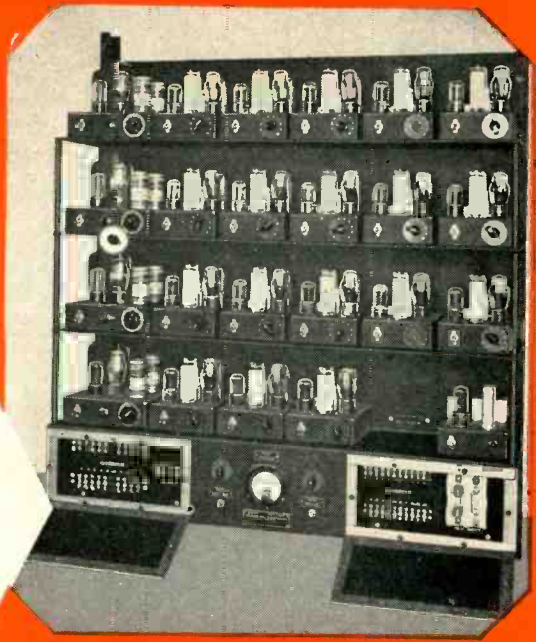
Gentlemen:
Please send me a copy of Catalog No. 4071-F. I am attaching my business letterhead and address.

Name ______________________
Title ______________________
Company ______________________

NEW

DRIVER-HARRIS ELECTRONIC TESTING

Obsoletes Previous Methods of Testing Enameled Wire Insulation



This revolutionary Dielectric Continuity Tester at Driver-Harris checks the quality of coating on 19 strands of wire simultaneously—as the wire leaves enameling furnaces. Tap switches on the test units are calibrated in impulses per minute required to operate an alarm. With the speed of the wire known, and also the maximum number of faults per 100 feet permitted by specification, each test unit is readily set to operate in conformance with the terms of the test imposed.

In order to guarantee the quality of a spool of enameled wire, every inch of the wire should be checked for dielectric faults, not just a few feet. In general practice, however, only a short sample of wire is examined. This is passed through a mercury cup held at a fixed potential, and shorts through the insulation are indicated on a voltmeter. If faults do not exceed a specified maximum for a given length of wire, insulation throughout the *entire* spool is assumed to be satisfactory.

This inefficient, compromise method has two important disadvantages: (1) the small portion of wire tested may not truly represent the condition of insulation throughout the spool; (2) insulation failures are not discovered until long after the enameling process is completed.

By checking insulation *continuously,* as wire leaves the enameling furnaces—the only 100% dependable way—Driver-Harris' new test equipment obsoletes such ineffectual and wasteful procedure.

So long as specifications are met, the new Driver-Harris electronic tester permits the enameling process to continue uninterrupted. When the *rate* at which faults occur approaches the maximum number of faults permitted by specifications, the test mechanism sounds an alarm and a record is made on a moving chart.

In this way, enamel coating is not only tested for continuity throughout the entire length of spooled wire, but sub-standard enameling is detected—and can be corrected—as soon as it occurs.

Thus makers of wire-wound resistors—particularly in finer sized wire, where shorts are more likely to occur—are enabled to eliminate time-waste and material-waste in their production, and obtain superior, more dependable products.

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

Driver-Harris Company

HARRISON, NEW JERSEY

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

Manufactured and sold in Canada by

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

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

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

VHF

IMPEDANCE MEASUREMENTS

UHF

SPEED AND CONVENIENCE

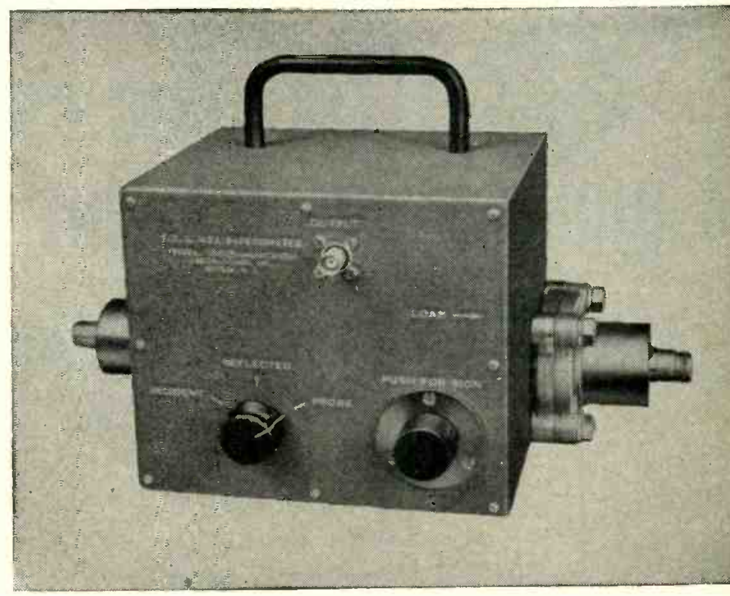
Rapid, accurate measurement of impedance, reflection coefficient and standing wave ratio. Small size, convenient for field use.

50 to 500 Mc.

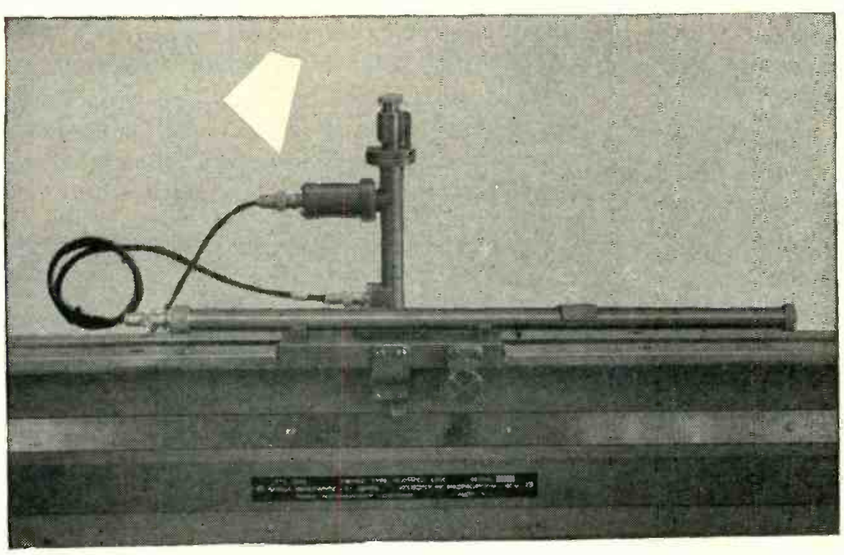
Can be inserted in various sizes of solid coaxial line or flexible cables.

Make three readings, plot diagram and read off impedance to ± 5%.

$400.00.



FTL-42A IMPEDOMETER



FTL-30A SLOTTED LINE

PRECISION

Precise impedance measurements in the range of 60 to 1000 megacycles per second. Accuracy ± 2%.

1000 to 2000 Mc range covered with slightly reduced accuracy.

Coaxial line 250 centimeters long having a surge impedance of 51.0 ohms ± 0.5 ohms.

$2,495.00.

Write for FTL-30A and FTL-42A brochures

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ELECTRONICS

Designers

ELECTRONIC COMPONENTS

A HIGHEST QUALITY LINE

—constantly improved and added to—

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- Reactors
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- Glass bushings
- Thermistors
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ELECTRONICS DEPARTMENT

- Tubes
- Television components
- Phono pickups
- Speakers
- Quartz crystal units
- Germanium diodes

When you're building any of thousands of complex industrial and military electronic devices, reliable components are a must.

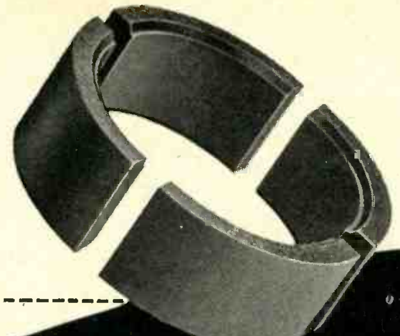
To give you, the designers of these devices, the utmost in reliability, General Electric is constantly at work improving and redesigning in its ever growing line of electronic components.

The list at left only partially covers the thousands of parts in the complete G-E line. We'll tell you about as many of them as space will permit in these pages from month to month. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

667-8

SEGMENTED DEFLECTION YOKE CORES



This popular 4-segment design is highly efficient. It is easy to handle in TV production work and assures a minimum of breakage. 2-segment types are also available.

STACKPOLE

Ceramag® ... THE CERAMIC CORES THAT SET THE QUALITY STANDARDS

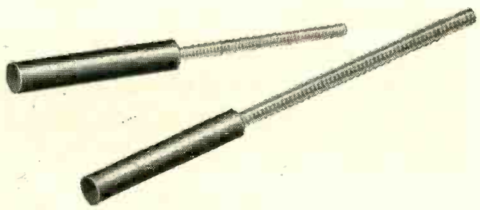
The tremendous advance in the use of metallic oxide (non-metallic) cores has been due in large part to Stackpole powder molding experience which paved the way to fully dependable units in production quantities. Stackpole Ceramag Cores assure lower losses with higher operating efficiency, lower operating temperatures, lighter weight, smaller sizes, maximum permeability, less corona effect and minimum cost. Ceramag cores are made in two grades for high and low flux densities.

"U" and "E" CORES FOR FLYBACK TRANSFORMERS

Permeability of these Stackpole Ceramag Cores is of the order of 10 to 1 by comparison with conventional iron cores. They are materially smaller, have higher resistance and operate much cooler due to the absence of eddy current losses. Many special types are regularly produced.

TELEVISION IMAGE W-I-D-T-H CONTROL TYPES

These Stackpole Ceramag Cores assure remarkably higher standards of efficiency for TV horizontal image deflection circuits. In areas where there is a low line voltage, they give ratios of from 1 to 8 or more compared with 1-5 for previous high permeability types.



Electronic Components Division

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

HPB-617

Jensen presents... G-610 TRIAXIAL

a NEW loudspeaker which for the *first time* spans the full frequency range of the ear!

A new, skillfully integrated combination of three independently-driven units . . . two compression driver and horn combinations, plus heavy-duty direct radiator . . . with 3-channel electrical crossover and control network . . . achieving the widest frequency range and finest reproduction ever attained!

Write for Data Sheets 160 and 152 which describe the G-610 and other Genuine Jensen Wide Range Speakers.

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HERMETIC SEALING COMPONENTS

NEO-SIL CORPORATION

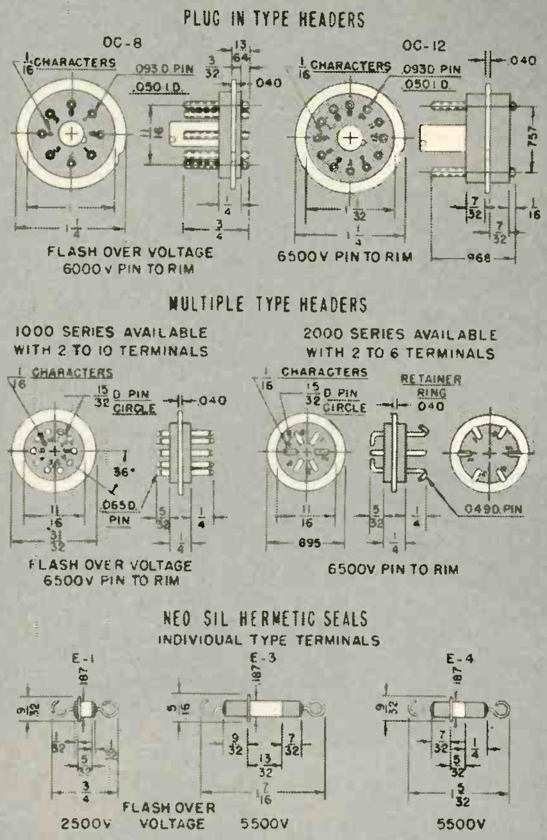
Welcomes Exacting Demands

NEO-SIL is the result of ten years of engineering research and development. Its application to our hermetic sealing components has been proven under severe and exacting tests in both our own and our customers laboratories. NEO-SIL components will help reduce your rejects resulting from breakage, strain, cracks, physical shock, etc.

NEO-SIL components will pass the grade one, class A requirements for Army, Navy and aircraft military equipment.

It costs no more to use these hermetic sealing components and their use will save you money.

For performance, quality and economy—specify NEO-SIL hermetic sealing components. Manufactured by NEO-SIL Corporation—to meet the most exacting performance demands.



SPECIALTY PRODUCTS

1. Molded Cables With Plugs Attached
2. Female 4 Pin Panel Connector
3. Meter Hermetic Seal Gasket
4. Panel Type Hermetic Seal Fuse Holder
5. 5 Pin Female Panel Connector
6. Rotary Hermetically Sealing Panel Bushing

The above items are all pressure checked at 25 pounds per square inch.

The materials and processes used in the manufacture of all sealed components are made to conform to the most rigid JAN specifications.

Your special problems are solicited.

NEO-SIL TECHNICAL DATA

NEO-SIL is a synthetic compound, which was developed expressly for the purpose of providing a suitable insulating material, which could be satisfactorily bonded to various metals, under a wide range of temperatures, be impervious to most acids and alkalies, provide a comparatively non-wetting surface, have a high insulation resistance, and meet the exacting requirements of the Janization program of the Armed Services. These compounds, in their various forms, produce component parts which are able to meet these exacting requirements.

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 *Megohm-inches*	R.H. 30 percent *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 CORPORATION

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

for COMPLETE r-f *COVERAGE*.

— from VHF to EHF

it's PRD

If you are in need of accurate test equipment why not consult with PRD? You'll no doubt find we have just the item you require. Consider, for example, the versatile new instruments illustrated on this page which embody the carefully thought out design features characteristic of all of PRD's precision test equipment. These and many other new instruments are now being offered to fulfill your VHF, UHF, and microwave requirements.

TYPE 650 UNIVERSAL POWER BRIDGE — This direct-reading bridge may be used with either positive or negative temperature co-efficient bolometers for the accurate determination of r-f power. Full scale ranges of 0.1, 1.0, 10, and 100 milliwatts permit measurement over a wide range of power levels.

TYPE 904 VHF-UHF NOISE GENERATOR — This calibrated broadband noise source permits direct measurement of noise factors as high as 20 db for r-f amplifiers and receivers operating in the range from 10 to 1000 mc/sec.

TYPES 902 and 903 BROADBAND MICROWAVE SIGNAL GENERATORS — These new instruments furnish c-w, pulsed, or frequency modulated r-f signals for the 3650-7300 and 6800-10,900 mc/sec. bands. Direct reading frequency dials and automatic mode tracking are employed, together with a 0-120 db cutoff attenuator calibrated directly in —dbm.

For complete information and a copy of our latest catalog, write to Department E-10.

Polytechnic RESEARCH & DEVELOPMENT COMPANY, Inc.

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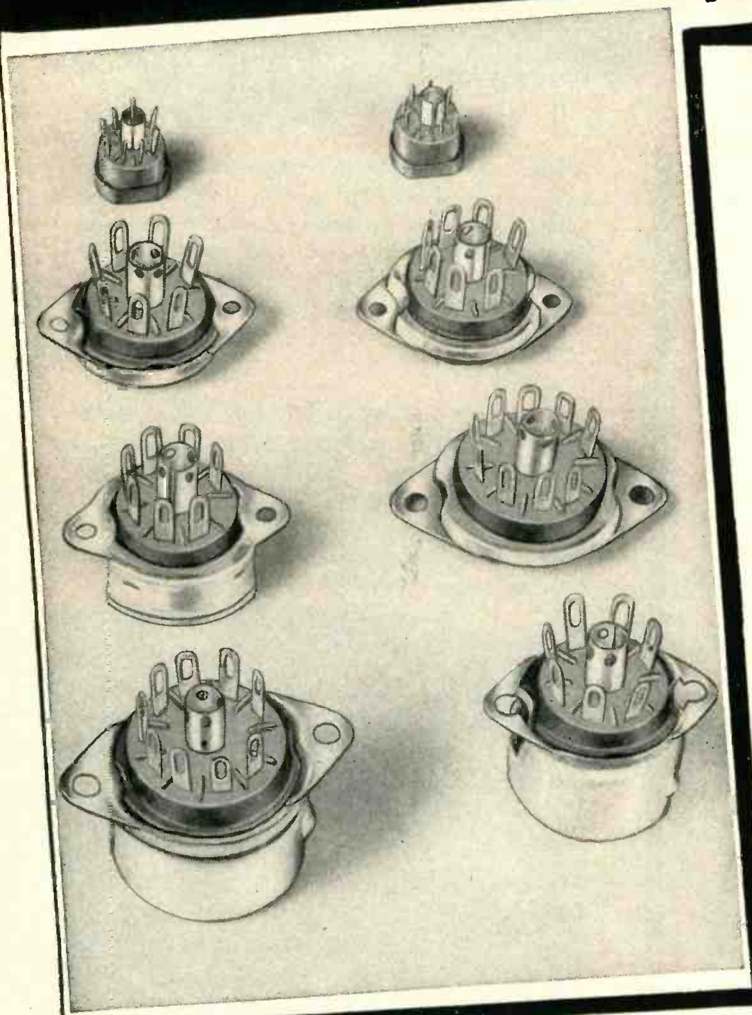
P R D

MYCALEX

MINIATURE TUBE SOCKETS

7-PIN and 9-PIN . . . and SUBMINIATURES

PREMIUM INSULATION PRICED COMPETITIVELY



Now MYCALEX offers both 7-pin and 9-pin miniature tube sockets . . . with superior low loss insulating properties, at prices that offer ceramic quality for the cost of phenolics.

MYCALEX miniature tube sockets are injection moulded with precision that affords uniformity and extremely close tolerances. MYCALEX insulation has high dielectric strength, very low dielectric loss, high arc resistance and great dimensional stability.

Produced in two grades: MYCALEX 410 conforms to Grade L4 specifications, having a loss factor of only .015 at 1 MC. It is priced comparably with mica filled phenolics.

MYCALEX 410X is for applications where low cost of parts is vital. It has a loss factor only one-fourth that of "everyday" quality insulating materials, and a cost no greater.

Prices gladly quoted on your specific requirements. Samples and data sheets by return mail. Our engineers will cooperate in solving your problems of design and cost.

Mycalex Tube Socket Corporation
"Under Exclusive License of Mycalex Corporation of America"
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—by the top specialists in the ceramic field

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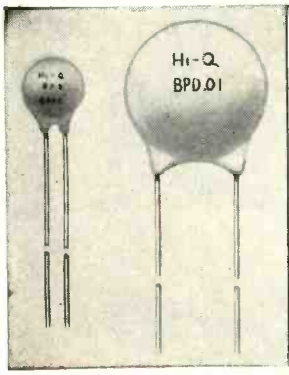
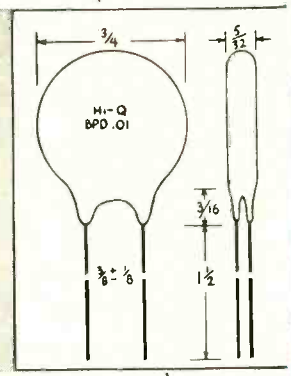
CERAMIC DISK CAPACITORS

Hi-Q Ceramic Disk Capacitors for by-passing, blocking, or coupling are being used by the millions by television receiver manufacturers who demand the utmost in performance.

Unit cost, time and labor may be saved by using several of the multiple capacity **Hi-Q** Disks where applicable in your television circuit. Multiple capacities having a common ground are available in standard units as shown in the chart below. **Hi-Q** Disks are coated with a non-hydroscopic phenolic to insure protection against moisture and high humidities. **Hi-Q** Disks like all other **Hi-Q** components assure you of the highest quality workmanship at the lowest possible cost.

Our Engineers are ready and willing to discuss the application of these highly efficient, dependable capacitors in your circuits. Write today for your FREE copy of the new **Hi-Q** Datalog.





Type	A Diameter	B Lead Width	C Thickness
B.P.D. .00047	5/16″ max.	3/16″ ± 1/16″	5/32″ max.
B.P.D. .0008	5/16″ max.	3/16″ ± 1/16″	5/32″ max.
B.P.D. .001	3/8″ max.	1/4″ ± 1/16″	5/32″ max.
B.P.D. .0015	3/8″ max.	1/4″ ± 1/16″	5/32″ max.
B.P.D. .002	7/16″ max.	1/4″ + 1/8″ − 0	5/32″ max.
B.P.D. .004	19/32″ max.	1/4″ + 1/8″ − 0	5/32″ max.
B.P.D. .005	19/32″ max.	1/4″ + 1/8″ − 0	5/32″ max.
B.P.D. .01	3/4″ max.	3/8″ ± 1/8″	5/32″ max.
B.P.D. 2x.001	19/32″ max.	3/8″ ± 1/8″	5/32″ max.
B.P.D. 2x.0015	19/32″ max.	3/8″ ± 1/8″	5/32″ max.
B.P.D. 2x.002	19/32″ max.	3/8″ ± 1/8″	5/32″ max.
B.P.D. 2x.003	3/4″ max.	3/8″ ± 1/8″	5/32″ max.
B.P.D. 2x.004	3/4″ max.	3/8″ ± 1/8″	5/32″ max.
B.P.D. 3x.0015	3/4″ max.	3/8″ ± 1/8″	5/32″ max.
B.P.D. 3x.002	3/4″ max.	3/8″ ± 1/8″	5/32″ max.

Insulation: Durez and Wax impregnated.
Leads: 22 gauge pure tinned dead soft copper.
Capacity: Guaranteed mininum as stamped.
All capacitance measurements made at 25°C at 1 KC at a test voltage not over 5 volts RMS.

Insulation Resistance: 7500 megohms min.
Power Factor: Max. 2.5% at 1 KC at not over 5 volts RMS.
Test Voltage: 1500 volts D. C.

Hi-Q COMPONENTS

Capacitors
Trimmers • Choke Coils
Wire Wound Resistors

BETTER 4 WAYS

✔ UNIFORMITY ✔ DEPENDABILITY
✔ PRECISION ✔ MINIATURIZATION

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Hi-Q

Electrical Reactance Corp.

OLEAN, N. Y.

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

PLANTS: Olean, N. Y., Franklinville, N. Y.
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Potter & Brumfield's *MT Relay*

the SMALLEST, MOST VERSATILE, telephone relay available

Rugged, compact (Miniature Telephone) Assembly saves over one-third chassis mounting space, guarantees trouble-free operation. Supplied open or hermetically sealed.

FOUR MODELS FOR EVERY APPLICATION

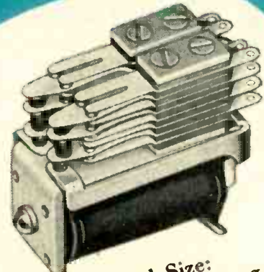
1. **MT—** for DC voltage operation
2. **MTA—** for 60 cycle AC voltage
3. **MTL—** for sensitive DC current

AND...

4. **the NEW MTM with MICROSWITCHES—AC or DC** —for snap-action performance under severe conditions.

- Up to 16 contact springs—6 movable poles.
- Bifurcated palladium or single silver contacts up to 5 amperes.
- Maximum winding 22,000 ohms.
- Maximum sensitivity 50 MW per movable pole.
- Maximum coil dissipation 5 watts.
- Hum free on 60 cycles.
- 10 G with low coil wattage.

SHOCK and VIBRATION to BETTER THAN 50 G



Actual Size: 11/16″ wide x 1 1/2″ long

Actual Size—2 microswitches 11/16″ x 1 3/8″ x 1 1/2″ high

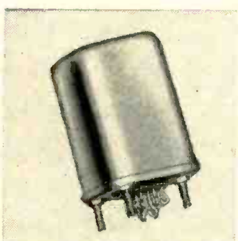
MTM is equipped with from one to four 1SM1 micro-switches. Provides smallest size for highest shock and contact load.

- Silver contacts rated 5 amperes.
- One to four switches—4 form C.
- Wide Temperature range.
- Open or hermetically sealed.

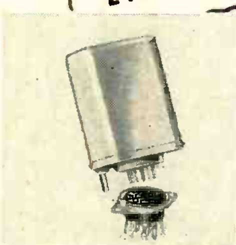
Actual Size—4 microswitches 11/16″ x 1 7/8″ x 1 1/2″ high

ENCLOSURES

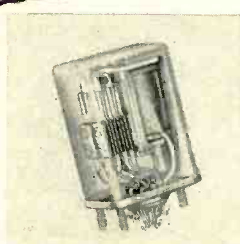
Potter & Brumfield is equipped to hermetically seal or enclose in dust cover any of the above relays.



Model M1
Chassis space 1″ x 1 11/16″
Height 2 5/32″
Up to 18 solder terminals



Model M2
Chassis space 1″ x 1 11/16″
Height 2 5/32″
7, 9 or 14 pin plug in



Model K1
Chassis space 1 5/8″ x 1 13/32″
Height 2 1/16″
Up to 18 solder terminals

Model K2
Chassis space 1 5/8″ x 1 13/32″
Height 2 1/16″
Octal Plug

Model P2—Clear polystyrene
Chassis space 1 3/8″ x 1 3/8″
Height 2″
Octal Plug

Complete information on these assemblies as well as Potter & Brumfield's full line of standard and special relays, timers, shaded pole motors, and electro-mechanical assemblies is available in new comprehensive catalog No. 109. Write today for your free copy.

P & B engineers are always ready to help solve your particular relay problem. Forward specifications for samples and quotations.

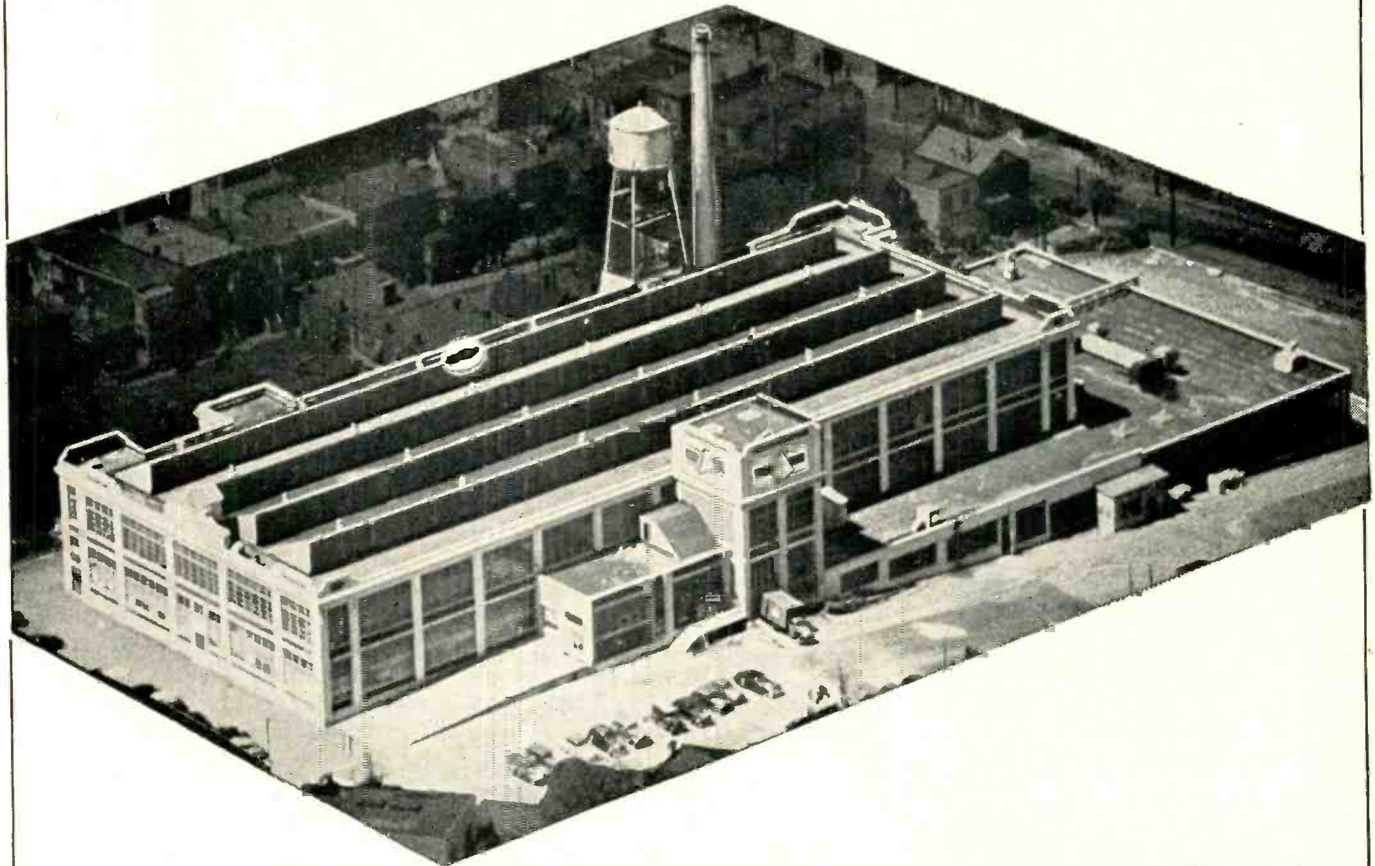
Standard P & B relays are available at your local electronics parts distributor.

Potter & Brumfield
213 N. Main Street • Princeton, Indiana
Export 2020 Engineering Building, Chicago 6, Ill., U.S.A.

THE **NEW HOME** OF

PYRAMID CAPACITORS

will be in full operation by **FEBRUARY 1, 1951**



LOCATION	**1445 HUDSON BOULEVARD, NORTH BERGEN, N. J.**
SIZE	**137,000 SQUARE FEET**
PRODUCTS	**ELECTROLYTIC CAPACITORS** **PAPER CAPACITORS** **RF INTERFERENCE FILTERS**

Your inquiries are invited

PYRAMID ELECTRIC COMPANY

BUSINESS BRIEFS

By W. W. MacDONALD

Color Television has, for the moment, swept mobilization planning from the front page. Talk with anyone in our business about anything at all for more than a few minutes and it comes up. FCC-CBS ears must ring.

Parable for which we are indebted to Charlie Hirsch of Hazeltine:

"It seems the FCC wanted to adopt a child and found a year-old infant having desirable characteristics. But the child could not feed itself. Assured by psychologists that the child would surely be able to feed itself in another year and would steadily improve in other respects, the Commissioners nevertheless professed disbelief and looked elsewhere.

At the zoo they found a monkey. It was about the same size as a year-old child and had been feeding itself for the last ten years. So the FCC adopted the monkey."

SMPTE Conventioneers at Lake Placid listened to 43 technical papers. Of these, 14 were about television.

Quoting DuMont's Goldsmith: "Color films are not plentiful. Even if they were, no one has yet built teletranscription equipment capable of putting them on the air under the new FCC color television standards. Stations planning to transmit in color may have to operate quite a while using live talent, without benefit of films."

Magnetic Recording is rapidly becoming standard practice in Hollywood for original sound takes. Paramount, for example, recorded the sound for its last 21 movies that way, using 10 million feet of 17½-mm oxide-coated film rather than tape for the purpose. The sound was later re-recorded on the edge of 35-mm picture film for playback by conventional photoelectric methods.

At least two companies are understood to be developing magnetic tape which can be transferred to picture film without re-recording. That this can be done has been demonstrated experimentally. Widely sought is some method by which simultaneous recording of pictures photographically and sound magnetically can be accomplished on the same piece of film. Among the problems currently encountered is the tendency of oxides to run into picture area during development. Binders which hold the oxide in place appear to reduce the amplitude or quality of sound playback.

Trend toward red-oxide tape and oxide-in wind, among manufacturers of magnetic recorders is noted by C. J. LeBel of Audio Devices. Only 7 percent of the machines made today call for black oxide, while the others use either black or red. Over 75 percent of all new machines use oxide-in wind.

Scanning Ads searching for electronic engineers, we note that a high percentage of those at present appearing are placed by aircraft manufacturers, or by firms primarily serving aircraft makers, or by government agencies.

Shipments of electronic apparatus in six categories to the U. S. government by RTMA members totalled $33,393,093 in the second quarter of 1950 as against $30,640,943 in the first quarter. The breakdown was as follows:

Radar	$27,676,595
Comm. equip.	4,218,508
Sonar	866,543
Nav. aids	405,501
Test. equip.	214,933
Quartz crystals	11,013

Orders received from the government during the second quarter totalled $61,701,467 compared with $41,305,390 in the first quarter.

Touring GE's new $18,000,000 research laboratory in Schenectady during the recent NAS meeting, we heard about a method of measuring films down to one millionth of an inch in thickness.

"How," we asked, "do you obtain

Now 6

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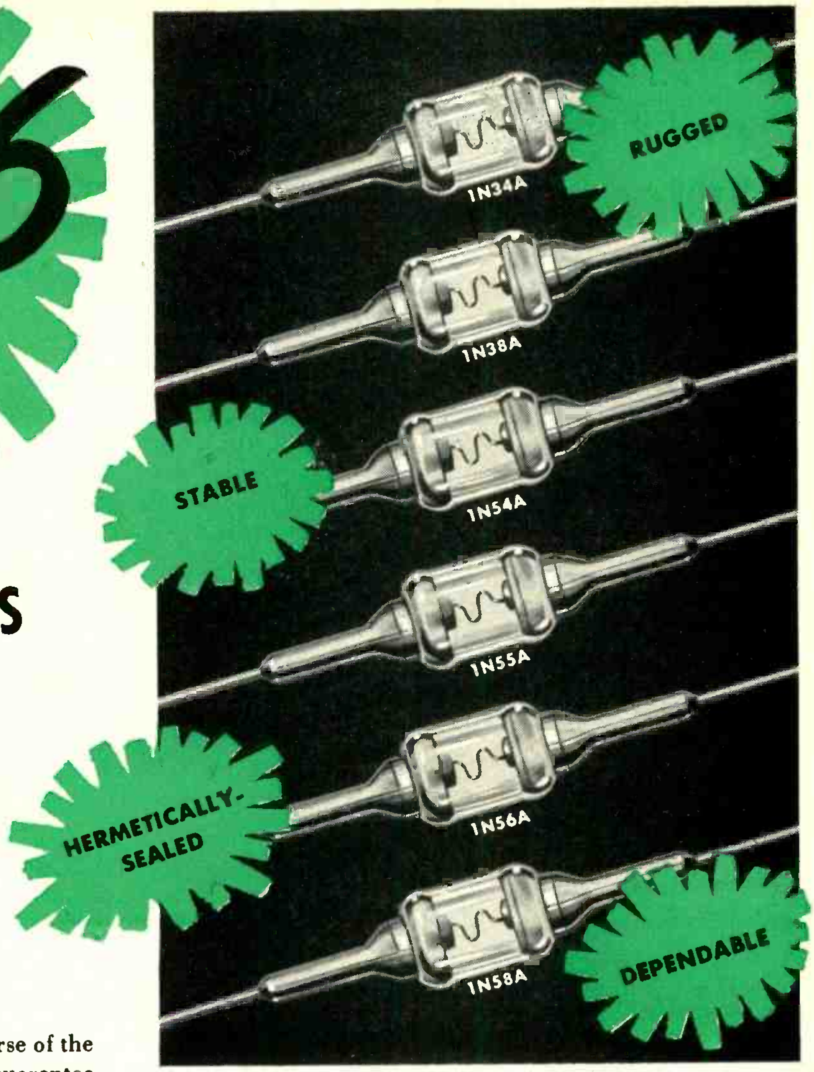

1N34A—General Purpose Diode. The workhorse of the Sylvania line. *New* higher quality standards guarantee back resistance higher than ⅓ megohm at −10 volts.

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Try these new, finer-quality Sylvania "Sealed-in-Glass" Germanium Diodes. You'll find them ideal for scores of applications calling for low power rectification at frequencies up to several hundred megacycles.

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ELECTRONIC DEVICES; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

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films that thin for calibration?" and were told, in all seriousness, that it is merely a matter of putting ten coatings on top of each other, each coating being one ten-millionth of an inch thick. Actually, that's just what's done. The deposited layers are one molecule thick, and a molecule just happens to be one ten-millionth of an inch.

We are reminded, somehow, of a dimly-remembered method of determining the number of cows in a field by counting something or other and dividing the result by four.

Receiver Sales by licensees during the first six months of 1950 totalled 9,016,645 units, worth $618,907,976. Here's the way the total broke down:

Type	Units	Dollars
Electric		
Table (under $12.50 billing price)	1,320,645	$13,605,829
Table (over $12.50 billing price)		
A-M	982,205	17,952,722
A-M/F-M	179,814	5,514,594
F-M (including converters)	7,785	157,600
Consoles		
A-M	3,732	226,144
A-M/F-M	2,960	290,623
Table-Radio-Phonos		
A-M	168,052	6,755,785
A-M/F-M	6,317	247,442
Console-Radio-Phonos		
A-M	28,494	2,267,068
A-M/F-M	222,078	25,599,159
Battery		
Portable A-C/D-C	874,149	15,418,449
Table	54,942	860,008
Consoles	9	683
Auto	2,147,544	55,576,098
Television		
Converters	4,060	482,171
Radio Table Models	1,265,915	172,699,420
Radio Consoles		
Direct viewing	1,198,775	221,785,958
Projection	6,979	1,780,042
Radio Phonos		
Direct viewing	265,992	69,724,082
Projection	29	15,246
Phonographs		
Phono only	223,496	3,866,708
With radio attachment	8,388	232,114
Without Cabinets		
A-M	5,074	145,266
A-M/F-M	9,086	354,658
Television	30,125	3,350,107

Mercury-Arc Rectifiers are big money makers in the industrial electronics business, according to an AIEE survey. Total d-c output power provided by all presently installed units is $5\frac{1}{4}$-million kw, divided among users as follows:

Electrochemical	3,974,000 kw
Railway	864,000
Mining, steel and general industrial	407,000

In electrochemical service over 99 percent are continuously pumped. In the third category only 33 percent are continuously pumped. Among all users the trend is toward completely sealed types.

Average yearly outage time is 50 hours, or about 0.8 percent in electrochemical service. Average life of sealed types in 24-hour-a-day electrochemical service is 3.8 years.

Abstract of a paper entitled "Null Polygons", delivered before a meeting of the National Academy of Sciences:

> By a null polygon we mean a plane polygon each of whose sides is of length zero. So we have n corners, $P_1, P_2 \ldots P_n$ and n *sides* $P_1P_3 = 0, \ldots P_nP_1 = 0$. We study the set of all diagonals. They are not zero. What is the theory of the diagonals? That is the problem of this paper.

We can see how it *would* be.

Conclusions of a study of the effects of television on sports attendance, by Jerry Jordan (for a degree in psychology at Princeton and a master's at the University of Pennsylvania), are as follows:

"The length of time a person has owned a television set directly influences his and his family's attendance at sports events.

"When he first buys a set, attendance goes down temporarily. Later—after one season in most sports—attendance returns to normal.

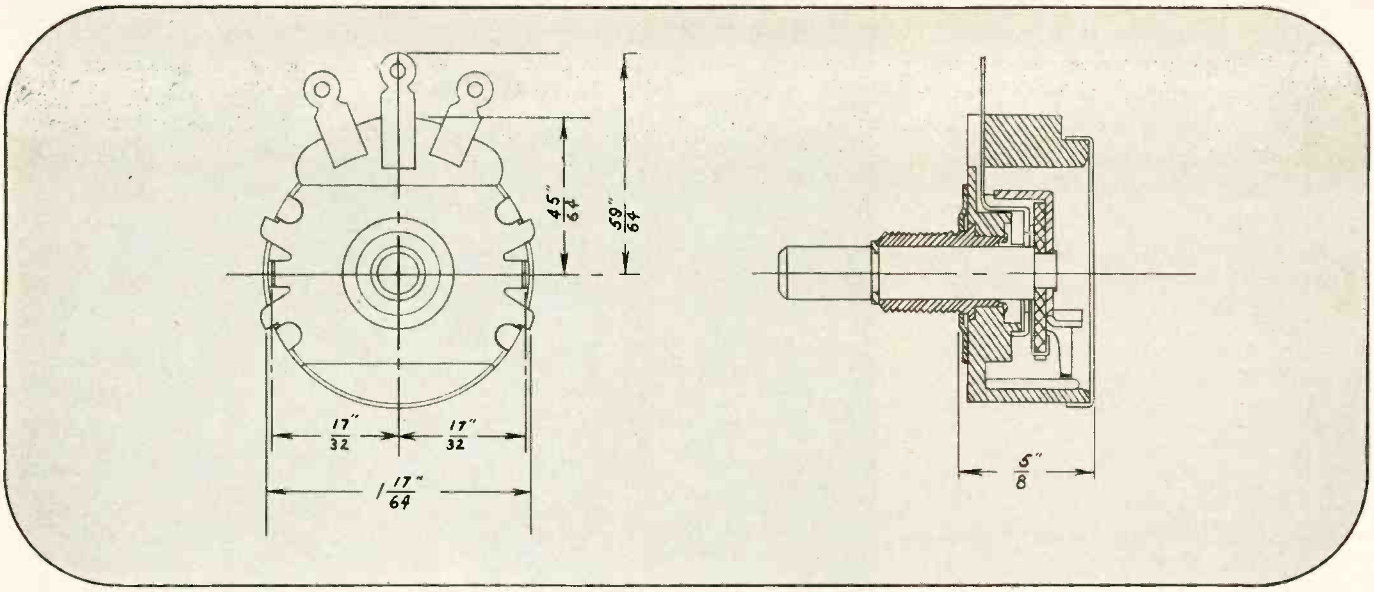
"After one or two years of ownership, the tv owner's attendance rate is higher than that of non-members. . . . .

"TV owners take other members of their family out to games more frequently than non-owners.

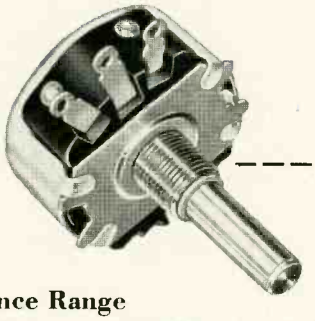
"The long-range effect of television, as it is today, therefore, will not harm attendance at sports events, and may help to increase it."

Radio-Equipped Taxicabs now total 46,000, and are operated by 3,000 companies in 1,500 cities, according to Stanley C. Ross, president of the American Taxicab Association.

We've Just Met a Navy radioman trained to take pictures from the air. His present assignment involves taking them under water. Every time he dives he draws flight pay.



Now...from Mallory...



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Can be supplied with knurled and slotted shaft for push-on knob, standard screwdriver slot, or milled flats for set screw or push-on knobs.

To the Mallory line of variable resistors there has now been added a 2-watt wire wound control with features deserving the attention of design engineers.

Precision winding, durable contacts, and sturdy design all contribute to the long life, superior performance and dependable uniformity for which all Mallory components are known.

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CROSS TALK

▶**MIXED** . . . The cover of this issue demonstrates the validity of the mixed-highs principle of color television transmission, (see also p 122 of this issue). It demonstrates that, using mixed highs, image quality can be obtained with a video band of 4.2 mc which is remarkably like the quality obtainable with a 12-mc band when mixed highs are not used. Unfortunately the mixed-highs technique cannot be used in the field-sequential (CBS) color system; it can be used in quasi-simultaneous systems like the dot-sequential (RCA) system. In deciding in favor of the CBS system, therefore, the FCC passed up a tremendously important principle of spectrum conservation. There were, of course, extenuating circumstances which weighed against the adoption of a system using mixed highs. But the members of the FCC *ignored* the principle of mixed-highs; they did not *balance* it against the advantages of the field-sequential system. According to the FCC "first color report", the advantages of mixed highs are mere "claims", and loss of horizontal resolution (!) was attributed to the use of mixed highs. Commissioner Jones, in his separate opinion, stated that "the principle of mixed highs is a matter of complete theory, unsupported by any scientific data other than barefaced statements . . . ". Yet Commissioner Jones saw the very pictures which appear on our cover on April 27, 1950, several months before he wrote his opinion. He evidently did not know what he was looking at: explicit scientific proof of the efficiency of mixed highs. Or, if he did understand it, he preferred to ignore the evidence before his eyes.

The FCC, having expressed disbelief in the engineering testimony of a large segment of the industry (it will have little to do with the N.T.S.C., for example), continues to make similar errors of technical judgment. The very transmission standards adopted on October 11 for the field-sequential color system are a case in point. Nowhere in the standards is there any specification of the relative amplitude of antenna voltage on successive fields. This omission is a technical mistake which must be rectified before any equipment can be designed for the system. In the meantime, the industry is proceeding on the assumption that the missing standard, when ordered by the Commission, will follow the CBS recommendation that equal signal voltages on successive fields will produce a standard white equal to "illuminant C" ($x = 0.310$, $y = 0.316$). Perhaps the FCC staff has a better or different idea. Whatever it is, it must be stated as a standard, and quickly.

In another part of its report, the FCC says "The Commission is aware that of necessity it must rely to a great extent upon industry experts for data and expert opinion in arriving at decisions in the field of standards; our own facilities are too limited to gather much of the data." Truer words were never said.

▶**ANTI-RAIN** . . . Comes now the story of Dr. G. A. Sykes, whose picture appears on p 134 of this issue. Dr. Sykes had a contract with the Palisade Amusement Park, on the cliffs opposite 125th Street, Manhattan, to the following wit: He uses a fearsome collection of surplus radio gear, including an X-band paraboloid with wires attached, to irradiate the clouds over the amusement park. His object: to dissipate the clouds in favor of good amusement-park weather, thereby putting himself in direct competition with Harvard's Dr. Howell, who had a contract with the New York Board of Estimate to make rain.

Dr. Howell makes Dr. Sykes look like a piker when it comes to take-home pay. Herr Sykes, it says here, gets $500 for each clear day, forfeits $1,000 for each rainy day. Just to see what kind of a horse-race this is, we called up the New York Weather Bureau and found that records based on 75 years, covering the months June through September, indicate an average of 41 rainy days, against 73 clear and cloudy days, the remainder being indifferent combinations of rain, clear and cloudy. So, playing the matter strictly on form, the Doctor stands to pay out $41,000 and take in $36,500, for a net loss of $4,500 per season, unless the management gives him half credit for the indifferent days, in which case he takes in another $2,000, cutting the loss to $2,500.

Anyway you look at it, we want no piece of that contract. Except for one thing. Dr. Sykes is using electronic devices to shade the average in his favor. Might be something in it at that!

HIGH-RELIABILITY

Tube failure during the first 1,000 hours has been reduced from 30 percent to 3.2 percent in airborne communication and navigation equipment under the program for improvements in construction and manufacturing techniques sponsored by ARINC

AT THE CLOSE of the recent war, the commercial airlines were faced with the full impact of the problem of tube reliability.

Electronic tubes must necessarily be employed for the satisfactory operation of the complex gear associated with modern aircraft. However, factors such as excessive on-off cycling of the equipment, constant vibration, and wide variations in operating voltages impose requirements which are difficult for the tubes to meet.

Under the severity of the application, the failure rates of conventional receiving tubes employed reached alarming heights. With safety of airline operations endangered and the cost of the associated maintenance excessive, the need for more reliable tubes was manifest.

To combat the situation, Aeronautical Radio Inc. presented to the tube industry a progressive program to adapt the quality of the receiving tubes employed to the requirements of the applications. This organization, commonly known as ARINC, is a non-profit technical agency maintained by the airlines to coordinate the development of electronic equipment for their use. The immediate objective of the ARINC program was the improvement of existing constructions and manufacturing techniques to the point where the highest degree of reliability could be expected from each tube. To enable the design, manufacture, and test effort to be directed effectively to the basic goal of maximum reliability, cost considerations were necessarily relegated to a position of secondary importance.

The scope of the ARINC program was intentionally limited to a relatively small number of types. By concentrating the engineering effort on a minimum number of types, the goal of quality was felt to be enhanced.

ARINC, after consulting the manufacturers of aircraft electronic equipment, chose initially 10 tube types to be included in the program. The equipment manufacturers agreed that these 10 types would fill the majority of their needs for airborne communication and navigation equipment and that they would attempt to design new equipment around these types to the exclusion of other conventional types.

Performance Checks

The program was to be dynamic. Records were to be kept of each tube in service, and each inoperative tube was to be returned to the manufacturer for engineering analysis. Based on the condition of the returned tubes and on the associated performance data, the design was to be continually modified to achieve additional reliability. Also, whatever savings were realized from improved manufacturing methods or increased production were to be reinvested in another aspect of quality such as the tightening of the control limits. The result of the dynamic aspects of the program was the production of a tube whose quality improves steadily with time.

A word should probably be said to explain the use of the word "reliable." The airlines, typical of industrial users of electronic tubes, desired relatively long life of the tubes; however, the predominant factor was satisfactory performance between predetermined replacement periods. If the tubes could be depended upon to operate for a fixed period, relatively inexpensive preventive maintenance methods could be employed; unscheduled failures which adversely affect the safety level, increase down-time of the aircraft, and increase maintenance expenses could be eliminated. Thus, the actual number of hours of tube life is less important than the fact that no failures occur during the established service time.

The objective of the ARINC program was the realization of tubes with special attention given to construction so that a very high percentage would realize a certain life. Such a tube can properly be called a high-reliability tube. The airlines clearly recognized the fact that high-reliability tubes, and not necessarily long-life tubes, were required for their applications.

No single feature distinguishes a reliable tube from a standard commercial type. Reliability is a characteristic that is built into tubes as the integrated result of special design considerations, advanced manufacturing techniques, and rigorous testing procedures.

Special Techniques

The design of the ARINC tubes must assure that the tubes have the capabilities of reliable operation. In addition to incorporating the requirements for excellent electrical performance, the high-reliability types incorporate a heater construction designed to withstand excessive heater-cathode cycling. The design also satisfies the requirements for mechanical sturdiness. To withstand shock and vibration, the lengths of the internal elements are kept to a minimum, and all parts are securely fixed in position to avoid potential short circuits.

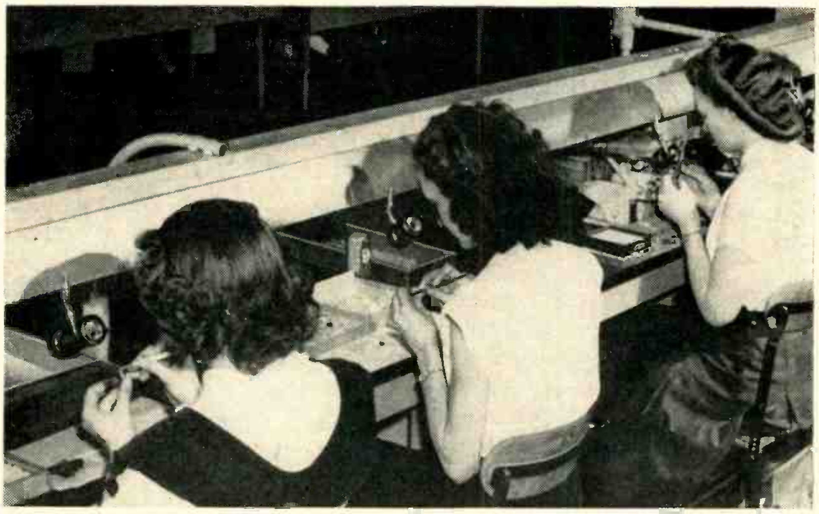
To assure the ultimate in quality, the actual assembly of the high-re-

MINIATURE TUBES

By GEORGE GAGE
Engineer
General Electric Co.
Owensboro, Kentucky

liability types is separated from the assembly of the conventional receiving types. The operators are specially selected and are paid high hourly rates.

The operators are carefully instructed that quality of workmanship is the primary consideration. During the entire manufacturing procedure, extreme care is exercised. Questionable materials or parts are discarded. No attempt is made to reduce costs in any way that could conceivably impair the quality of the finished product.



On the production line where mounts for the tubes are assembled, magnifying glasses are used for inspection

Heater Construction

Because the reliability characteristic of the final tube depends on the quality of each component part, extreme care and exhaustive inspections are incorporated in every stage of production. As an example of the special manufacturing techniques employed, consider the processing of the heaters.

The heater wire is first coated with insulating material, and the diameter of the coated wire is measured with micrometers to assure uniformity of coating. The heater wire is then bent to the desired form, and the ends are clipped to the proper size. The formed heater is then checked for length and bends. The size of the bend is carefully controlled. The bend can not be excessively sharp or brittleness and mechanical weakness result. On the other hand, an excessively large bend will not fit properly in the cathode sleeve.

Because, in the process of forming, the insulation is cracked at the bends, additional coating is deposited on all bends, to eliminate the possibility of heater-cathode shorts, by a process known as cataphoresis. After cataphoresis, the heaters are 100-percent inspected under binocular microscopes for uniformity and bend coating. The heaters are then fired to bake the insulating coating. Following firing, uniformity of bend size is checked, and samples are subjected to rigorous brittleness tests. The heaters are then inserted in small individual glass tubes to avoid possible damage in handling.

After the heaters are in the glass tubes, a 100-percent binocular-microscope inspection is incorporated to check for chips, dryness, and other imperfections of the insulation as well as crooked heater legs and dark insulation which can result from impurities in the heater wire. The acceptable heaters are then transported to the mounting section in the glass tubes.

Before being inserted in the cathode sleeve, each heater is visually inspected by the mounting operator. After mounting, the heater is again 100-percent checked under binocular microscopes for defective insulation and defective heater welds. Thus, by exhaustive inspection technique every effort is expended to avoid defective heater units and possible heater-cathode shorts.

Comparable precautionary measures control the production and processing of all other component parts. Numerous inspections regulate the quality of the mica insulators, plates and shields, cathode tabs, sprayed cathodes, stems, and grids. Although each component is completely inspected before being sent to the mounting group, each part is reinspected by the mounting operator under a magnifying glass before being used.

As a final check, the completed assembly is 100-percent inspected under binocular microscopes. The final inspection covers a minimum of 16 items and includes, for example, checks for the grid turns (loose, tight, or distorted), heater welds (burned, cold, splashed, or poorly bedded), mica insulators (broken or defective), and cathodes (bowed, distorted, or defective). Here, as in every other inspection, any item which is of questionable quality is discarded.

Burning-In Check

After the tubes are exhausted and aged, each tube is tested for shorts, gas, and a major characteristic such as cutoff. All tubes are then given a burning-in period of 48 hours under normal operating conditions. The burning-in period has been found, after exhaustive tests, to reduce drastically the number of early-life failures. The burning-in period also serves to stabilize the electrical characteristics.

On an exacting, statistical sampling basis, the tubes are subjected to severe test conditions. In addition to the standard electrical tests, the tubes must pass the requirements for vibration, shock, glass strain, grid emission, electrode insulation, and heater-cathode leakage.

Two life tests are incorporated. The first is similar to the standard intermittent life test. To be acceptable in this case, the tubes tested must have a 95-percent realization of possible operating time. The second life test is the heater-cycling life test. In this case, 7.5 volts is applied to the heater and 100 volts d-c is applied between the heater and cathode. The voltages are applied for one minute and then removed for one minute. The tubes are tested for 2,000 cycles under these conditions.

Because of the destructive nature of the heater-cycling life test, the tubes tested are discarded. An adequate sample is tested to assure that a minimum of 99 percent of the entire product will not fail or develop an appreciable heater-cathode leakage current while operating under the conditions of the test. If the sample fails the heater-cycling life test, the entire production lot is scrapped.

Results of Program

Before the program was initiated, the commercial airlines were experiencing as high as 30 percent failures on the type 6AK5 during the first thousand hours. The failure rate, after three years of continual improvement on the 5654 (high-reliability sharp-cutoff pentode which has superseded the 6AK5 in aircraft equipment), has been reduced to 3.2 percent in the first thousand hours.

It is expected that, even without drastic changes in design and manufacturing techniques, the failure rate will be brought down to less than one percent as a result of the dynamic nature of the program. Other types on which sufficient life test data are available show equally impressive improvements.

Many of the original complaints such as heater failure due to cycling have been reduced to the vanishing point. The majority of failures currently being experienced by the airlines are emission failures as contrasted to such common causes of failures as shorted elements and open heaters. In many applications, emission failures can be considered as safe failures.

It is estimated by ARINC that in 1949 the net saving to the airlines by using the two reliable types available at that time was over a quarter of a million dollars. The saving was achieved despite the fact that each tube is approximately three to five times more expensive than a similar conventional receiving type. The increased reliability of the electronic gear has also resulted in increased safety of the airline operation and a reduction in the number of delayed flights.

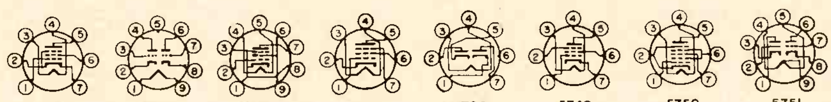
Nine of the original ten types are available, and the tenth is in the process of design. The characteristics are tabulated on the attached summary chart. Included in the available types are three twin-triodes, three radio-frequency pentodes, a power-amplifier pentode, a twin diode, and a pentagrid converter. All are of miniature construction.

The ARINC program was initiated to develop the quality tubes required for aircraft applications. The immediate goal of fewer than 2.5 percent failures during the first thousand hours has essentially been reached, and new goals of even lower failure rates are being set. The result of the program—the production of high-reliability electronic tubes—is therefore now available to other industrial applications.

Essential Characteristics of the ARINC Tubes

Tube Type	Description	Heater Volts	Heater Amperes	Maximum Ratings E_b	Maximum Ratings E_{c2}	Maximum Ratings P_d	Service	Characteristics
GL-5654	Sharp-cutoff r-f pentode	6.3	0.175	180	140	1.7	Class A amplifier	$E_b=120$, $E_{c2}=120$, $R_k=200$, $G_m=5,000$, $I_b=7.5$, $I_{c2}=2.5$
GL-5670	High-frequency twin-triode	6.3	0.35	300	...	1.5	Class A amplifier	$E_b=150$, $R_k=240$, $G_m=5,500$, $\mu=35$, $I_b=8.2$
GL-5686	Power-amplifier pentode	6.3	0.35	250	250	7.5	Class A amplifier Class C r-f amplifier	$E_b=250$, $E_{c2}=250$, $E_{c1}=-12.5$, $R_L=9,000$, $P_O=2.7$ $E_B=250$, $E_{c2}=250$, $E_{c1}=-50$, $P_G=0.15$, $P_O=6.5$
GL-5725	Dual-control r-f pentode	6.3	0.175	180	140	1.7	Class A amplifier	$E_b=120$, $E_{c3}=0$, * $E_{c1}=-2$, $I_b=5.2$, $G_m=3,200$
GL-5726	Twin-diode	6.3	0.30	Peak inverse voltage=330, Peak current=54 ma d-c output current=9 ma				
GL-5749	Remote-cutoff r-f pentode	6.3	0.30	300	125	3.0	Class A amplifier	$E_b=250$, $E_{c2}=100$, $R_k=68$, $G_m=4,400$, $I_b=11$
GL-5750	Pentagrid converter	6.3	0.30	300	100	1.0	Converter service	$E_b=250$, $G_c=475$, $I_b=2.6$
GL-5751	High-mu twin-triode	6.3/12.6	0.350/ 0.175	300	...	1.0	Class A amplifier	$E_b=250$, $E_{c1}=-3$, $\mu=70$ $G_m=1,200$, $\mu=70$, $I_b=1.1$
GL-5814	Medium-mu twin-triode	6.3/12.6	0.350/ 0.175	300	...	2.75	Class A amplifier	$E_b=250$, $E_{c1}=-8.5$, $\mu=17$, $G_m=2,200$, $I_b=10.5$

The ratings and characteristics of all twin-section types are given for each section.
* The control and suppressor grids of the 5725 may be used as independent control elements.



5654 5670 5686 5725 5726 5749 5750 5751 5814

STORAGE DEVICES for Communications

Improved communications systems are predicted upon devices in which the time scale is expanded and compressed as well as upon delay types. Equipment for attaining these conditions, including electrostatic storage tubes, delay lines and flip-flop circuits, is described

By A. J. LEPHAKIS

Research Laboratory of Electronics
Massachusetts Institute of Technology
Cambridge, Mass.

STORAGE OF information takes place, in some form or other, in all communications systems, and is evidenced by the fact that the output of a system is a weighted response to the past of the input. It is known that the output of a system does not depend alone on the present value of the input, but is also influenced, to varying degrees, by the previous behavior of the input.

In general, the storage and weighting functions of a system are combined, and the storage is not clear-cut. It is not usually possible to point to a part of the system and say that it contains, in recoverable form, all input events that have occurred in an interval T extending from the present into the past. Rather, the storage is distributed throughout the system, and the identity of individual input events is lost.

Recently, the need has developed for systems whose sole function is storage—systems that will retain all input events occurring in a particular interval, and from which the events can be individually recovered. Advances in the theory of communications have shown that an insight into many communications problems may be obtained through the use of such systems

This work was supported, in part, by the Signal Corps, Air Materiel Command and ONR.

Much has been published during the last few years on the subject of new communications theory. Although it is theoretically true that systems can be designed to enhance signal-to-noise ratio or to conserve bandwidths in our diminishing radio channels, we have not yet attained the ultimate in equipment for the purpose.

Particularly to the non-communications type of reader this article will serve for orientation. Although the electronic circuitry of devices now a-building is not detailed, the gross outlines of the building blocks are described. —The Editors

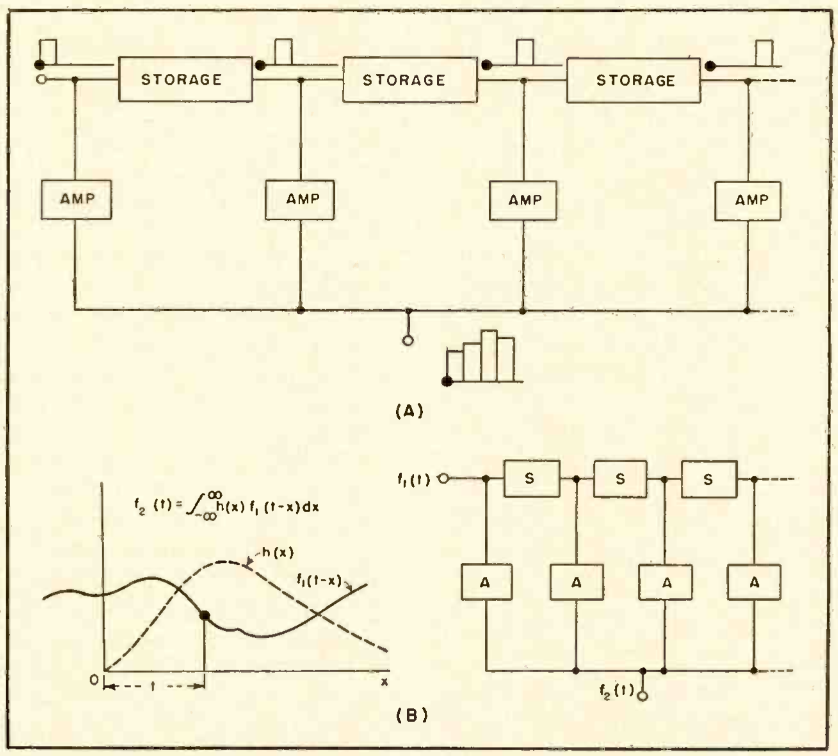


FIG. 1—A generalized linear network is adjusted as shown at (A) and operates in the manner indicated in (B)

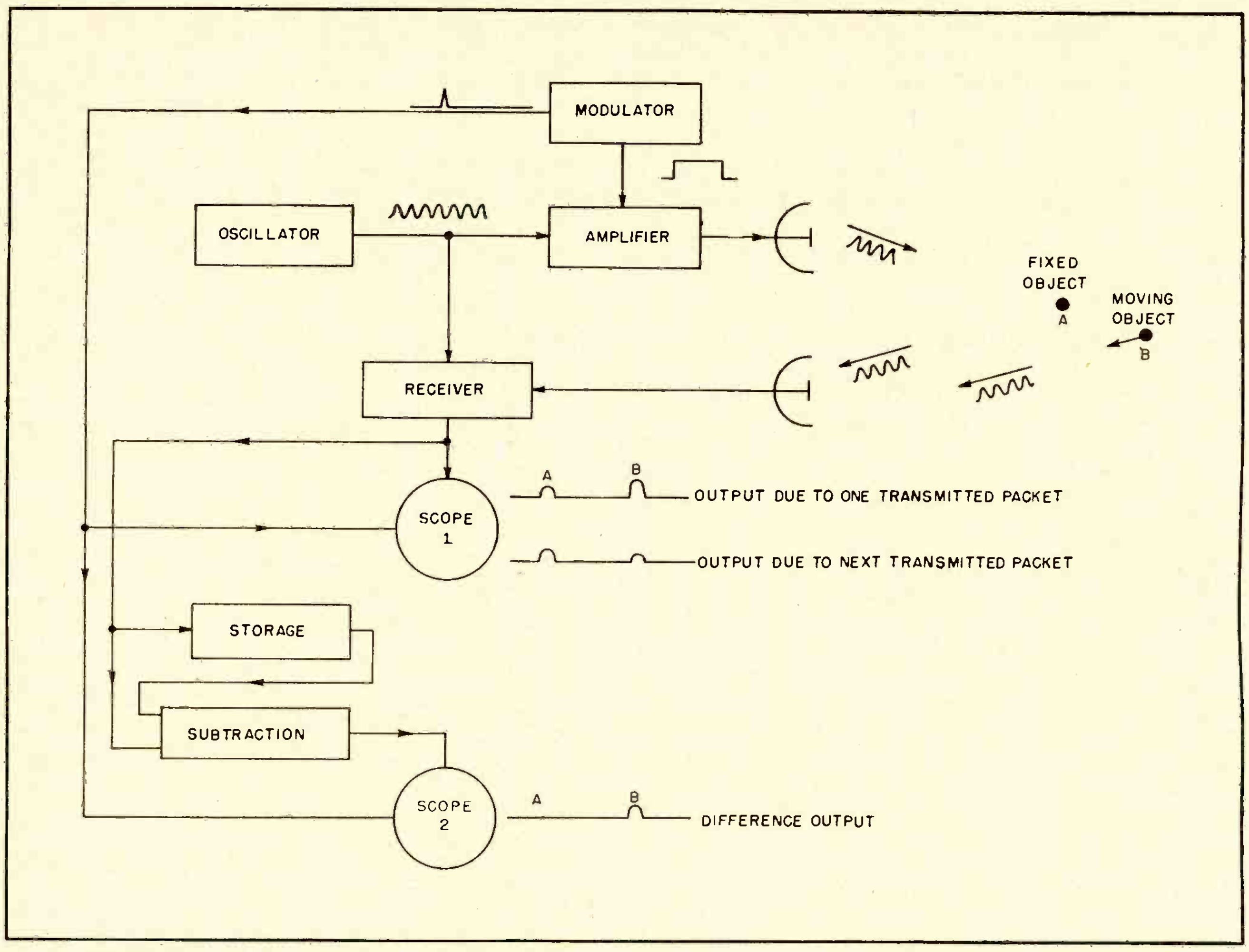


FIG. 2—Representative mti radar system. Scope 1 shows all targets while only moving targets are shown in scope 2

as these. The following examples will make evident the types of storage that are required in communications applications.

Networks

In connection with a current investigation of optimum linear filters[1], there has been developed a generalized network that can be used to synthesize linear transfer characteristics experimentally. The network, based on the Wiener-Lee canonical form, is shown in Fig. 1A.

A transfer characteristic is synthesized, in the time domain, by adjusting the network to approximate the corresponding response to a unit impulse. The adjustment is performed by applying a narrow pulse to the input and setting the amplifiers to give the desired response. The first amplifier passes the input pulse, and hence affects the amplitude of only the first output pulse. The second amplifier passes the pulse emerging from the first storage unit, and affects the amplitude of the second output pulse only. Similarly, each of the succeeding amplifiers is used to control the amplitude of an output pulse.

Once adjusted, the network responds to an input $f_1(t)$ by a process that is analogous to the graphical evaluation of the convolution integral. This analogy is illustrated in Fig. 1B. In the network, the variable x of the integral may be thought of as representing distance toward the right. The weighting function $h(x)$, which is the response to a unit impulse, is contained in the amplifiers by virtue of the initial adjustments. The scanning function $f_1(t-x)$ is contained in the storage units; it may be visualized as a space plot of the voltage distribution along these units. Each amplifier multiplies corresponding points on the weighting and scanning functions, and the mixed amplifier outputs represent the value of the integral at the particular time t.

This network is an example of a system in which the storage and weighting functions are separated. Furthermore, it demonstrates the necessity for a component whose only function is storage. The requirements that the storage component must satisfy are, in this case, particularly simple. Each storage unit is required only to deliver, at a later time, a replica of its input. The simplest storage device possessing this property is a delay line. Consequently, a tapped delay line will serve as the storage component of the network.

Another interesting application of delay-type storage is found in recent work that has been done on nonlinear systems[2]. A method has been formulated for characterizing nonlinear transducers, and a canonical form developed for a large class of such transducers that comprises a finite number of resistors, capacitors, inductors, and rectifiers. In the canonical form, the storage function of the transducer is placed in evidence as a tapped artificial delay line; weighting alone is accomplished in the remainder of the network.

Radar Applications

In a moving-target-indication (mti) radar system, a display is presented in which moving objects show up but stationary ones do not[3]. Such a display is obviously desirable when moving objects must be detected in a background of fixed objects. Storage components are essential elements of all mti systems.

The operation of such a system is illustrated by the simplified diagram of Fig. 2. The radar set sends out a pulsed oscillation that is reflected by various objects in its path. Received wave packets and the oscillator signal are mixed and detected, and an output is obtained that depends on the relative phase between the oscillator signal and each received packet. The phase relationships are functions of the distances between the radar set and the objects. The output due to a single transmitted packet is shown by the upper trace at scope 1; the first pulse is caused by object *A* and the second, by object *B*.

The output obtained when the next packet is transmitted is shown by the lower trace at scope 1. The pulse due to a fixed object such as *A* will be the same as before because the phase relationship between the oscillator signal and the reflected packet will not change. However, the pulse due to a moving object such as *B* will be different, since the change in the distance between it and the radar set will cause a change in the phase of the received packet with respect to that of the transmitted packet.

It is evident that response to fixed objects may be eliminated by subtracting the outputs due to two successive transmitted packets. In the subtraction process, the constant outputs corresponding to fixed objects will cancel, while the varying outputs corresponding to moving objects will not. The cancellation obviously cannot be accomplished without the use of storage, since the output due to each transmitted wave packet must be preserved for a time equal to the interval between successive packets.

Packets are transmitted periodically. Consequently, a delay line having a delay time equal to the packet period will serve as the storage device. If delay-line storage is used, the receiver output and the delay-line output are combined in a subtraction circuit, which gives the difference output corresponding to two successive transmitted packets. This output is shown at scope 2.

In place of a delay line and subtraction circuit, a suitable electrostatic storage tube can be used. When a spot on the target of such a tube is bombarded by the electron beam the spot is charged to a certain potential and stays at this potential for a short time. An output signal is obtained from the tube only when an uncharged spot is being charged. If a storage tube is substituted for the oscilloscope tube at scope 1, the mti difference output will be obtained directly. There will be no output corresponding to object *A* because any two successive traces on the storage-tube target will coincide everywhere except in the interval corresponding to a moving object.

Recoding Messages

Possibly the most important communications application of storage is found in the problem of obtaining more efficient utilization of communication facilities. Although little work has been done on this problem in the past, an intelligent attack can now be made using information theory as a tool.

Quantitatively, the amount of information conveyed by an event depends on the logarithm of the reciprocal of the probability of the event. An event that is quite likely to happen conveys very little information when it does happen, whereas one that is unlikely to happen conveys considerable information when it happens.

In most communication processes, information is generated at a variable rate. The communication channels, however, are presently designed to transmit the information at the maximum rate at which it is generated. Consequently, the channels are not used in the most efficient manner. Reduction of the necessary bandwidth, or reduction of the average power required, or improvement of the signal-to-noise ratio, can be obtained by requiring the channels to transmit information at the average rate of generation, rather than at the maximum rate. These benefits cannot be obtained without the use of storage systems.

The basic method of smoothing the flow of information may be illustrated by a simple example. Suppose that the message to be transmitted is represented by a combination of two basic symbols, 0 and 1, which are generated at a uniform rate of *S* symbols per second. Suppose, further, that the

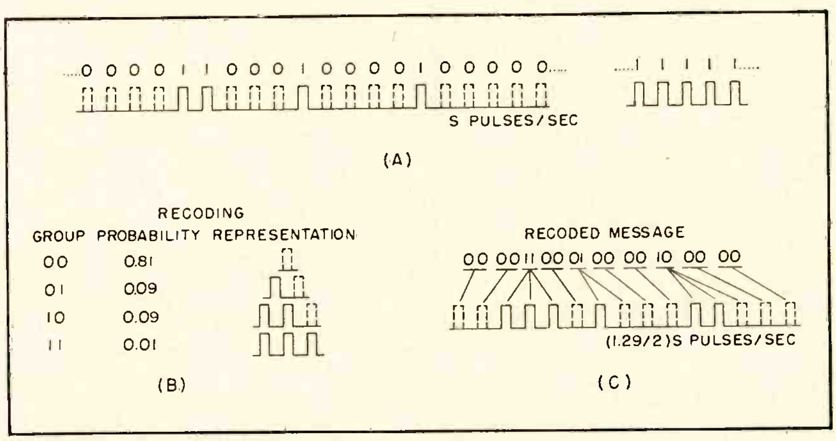


FIG. 3—Message consists of sequence of basic symbols 0 and 1. Symbols are generated at a constant rate *S* per second. Symbols are independent. Value of $p(0)$ is 0.9 and $p(1)$ is 0.1. Bandwidth of recoded message at (C) is less than original at (A)

symbols are independent, and that on the average 0 occurs nine-tenths of the time and 1 occurs one-tenth of the time. Such a message is shown in Fig. 3A.

The message may be represented electrically by a train of pulses that occur at a rate S per second, and which have two distinct states, corresponding to the two symbols. As shown in Fig. 3A, the symbol 1 may be represented by a positive pulse and the symbol 0 by absence of the pulse that would normally occur at that time. Knowledge of the pulse repetition rate and indication of the symbol 1 are sufficient to specify the message, since it is known that the symbols occur at that rate and each must be 1 or 0.

The required bandwidth of the transmission channel will be determined by the maximum number of pulses per second which it must carry. If the representation of Fig. 3A is used, the channel must be capable of carrying pulses at the rate of S per second, because it is possible, although very unlikely, that a sequence of 1's will appear somewhere in the message.

Now, suppose that instead of a pulse position being assigned to each symbol, a group of pulse positions is assigned to a group of symbols. If, for example, the symbols are taken in groups of two, as shown in Fig. 3B, four different group combinations will exist. The frequencies with which the groups occur will be different, because the symbol 0 occurs in the message more often than the symbol 1. To each group is assigned a different electrical representation. These representations are chosen in a systematic way that takes into account the relative frequencies of the groups. Representations of the more probable groups contain fewer pulse positions than those of the less probable groups[4].

The recoded message is shown in Fig. 3C. The pulses representing this message are also transmitted periodically. However, the repetition rate of these pulses is made less than S per second because on the average, the recoded message will contain fewer than S pulses per second. The latter fact can be seen by considering the group probabilities and representations of Fig. 3B. On the average, group 00 occurs 0.81 of the time, and occupies one pulse position; group 01 occurs 0.09 of the time, and occupies two pulse positions; and so forth. A simple calculation shows that an average of 1.29 pulse positions per group are required. In the original representation (Fig. 3A), however, two pulse positions per group were required. Consequently, the recoded message can be transmitted at a rate of $1.29S/2$ pulses per second. With this lower rate, a proportionate saving in channel bandwidth can be obtained. The use of longer groups, instead of just two-symbol groups, will generally result in a greater rate reduction.

It is seen that the flow of the information contained in the message has been smoothed out by the recoding. The more probable groups, which convey small amounts of information when they occur, are transmitted in shorter time intervals than the less probable groups, which represent larger amounts of information. This smoothing process is evidenced as an accordion-like compression and expansion of the time scale of the original representation. Recoding cannot be accomplished unless storage units are used. Without storage units, the necessary alterations in the time scale of the original message cannot be obtained.

The recoding may be carried out as shown in Fig. 4. The original message is routed to a small temporary storage unit, which has a capacity of two pulses. This unit may comprise either flip-flops or a tapped delay line. As soon as two pulses have been stored, the coder is actuated and generates the corresponding group representation, which is placed in the main storage unit. Pulses are removed from the main storage unit at a uniform rate and are transmitted.

Pulses enter the main storage unit at a variable rate, but are removed at a constant rate. On the average, the unit will be half full, since the output rate equals the average input rate. From time to time, however, the number of pulses stored will vary. Suppose, for instance, that the unit is half full, and that a long sequence of 0's occurs in the message. Under this condition, stored pulses will be removed faster than new pulses enter. If the sequence of 0's is long enough, the storage unit will be emptied and the transmission system will temporarily fail. Alternatively, suppose that the unit is half full and that a long sequence of 1's occurs in the message. In this case, new pulses will enter the unit faster than stored pulses are removed, and if the sequence is sufficiently long, the unit will be completely filled. On the basis of the group probabilities, the capacity of the storage unit can be found such that the probability of failure of the transmission system has a specified value. This probability of failure can be made smaller by increasing the capacity of the storage unit, but it can never be reduced to zero as long as only a finite amount of storage is available. In practice the probability of failure due to overloading of the storage unit need not be made zero. It is sufficient to make this probability comparable to the probability of failure due to other causes.

At the receiving end of the transmission system, the inverse process of decoding the groups must be carried out in order to obtain the

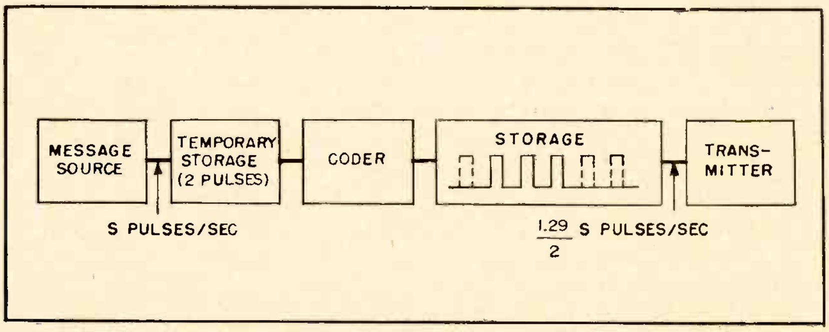


FIG. 4—Method of accomplishing recoding of Fig. 3

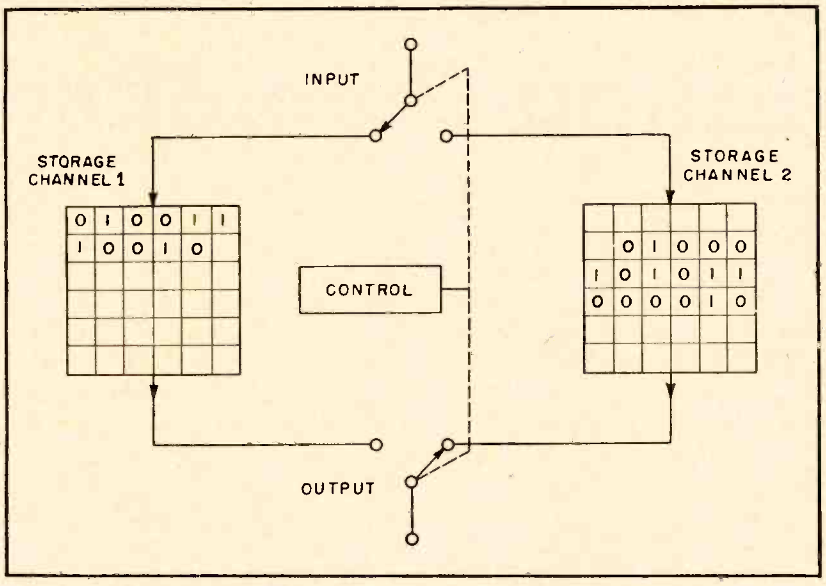


FIG. 5—Representation of a practical flexible storage system

original message. Storage units that function in essentially the same way as at the transmitting end are necessary, since again the time scale must be altered.

The statistical structure of most practical messages is much more complicated than that of the simple message in the preceding example. Practical messages are made up of more than two basic symbols. Also, the state of any particular symbol is affected by one or more preceding symbols. In a written message, for instance, it cannot be assumed that the occurrence of a certain letter is independent of all other letters. Rather, the fact must be considered that certain letters are more likely to occur when preceded by other particular letters, as in the combinations TH and ES. In speech, similar relations exist among the vowel and consonant sounds. In a television image, the light intensity of a particular spot is related to the intensities of other spots, both in the same and in preceding frames. The advantages of recoding can be realized in these more complicated cases. The detailed method of accomplishing the recoding will, of course, be quite complex. But, the fact remains that if recoding is to be carried out, alterations of the time scale are necessary. Highly flexible storage systems must be used at both the sending and receiving ends of the transmission system.

Most existing storage devices are capable of storing only binary pulses—pulses that can have only two states, and which can represent the binary digits of 1 and 0. This condition is not a drawback as far as the communications applications of storage are concerned. Information can be represented to any desired degree of accuracy by a sequence of binary numbers, and can therefore be electrically represented by binary pulses.

Suitable Systems

A symbolic representation of a practical storage system sufficiently flexible to be used in communications applications is shown in Fig. 5. It is assumed that the information to be stored has been put in binary form.

If alteration of the time scale of the input is to be obtained, use of delay-line-type storage devices is not practical. A storage device should be used that preserves the state and order, but not the time relationship, of stored pulses. Such a storage device might be visualized as a box partitioned into a number of compartments. Incoming symbols are dropped into successive compartments, where they remain until removed by an external device; the rate at which this device operates determines the time relationship of the output symbols. In a practical storage system, it is preferable to have two storage channels of this type, which are arranged as shown in Fig. 5. Incoming pulses are routed to one of the two channels, while pulses that were previously stored are being removed from the other. A control component automatically switches both the input and output connections when the channel from which pulses are being recovered is empty. It is seen that a continuous flow of information will be maintained through the system, but the operations of storage and recovery will never take place simultaneously in one channel. Circuit complexity is reduced because of the latter condition.

Two existing storage devices are suitable for use in a storage system of this general type—flip-flops and electrostatic storage tubes. Economically, the tubes are preferable because several hundred of the compartments shown on the diagram can be provided by one tube; a high-capacity flip-flop storage system is not practical because one flip-flop is required for each storage compartment. From the speed standpoint, flip-flops are better; electrostatic tubes now available cannot be operated as fast as flip-flops.

At this laboratory, construction of a two-channel electrostatic-tube storage system has recently been completed[5]. Each channel comprises one tube, and at present has a capacity of 256 pulses. For reliable operation, the required minimum time intervals between adjacent pulses are 30 microseconds when pulses are stored, and 15 microseconds when stored pulses are recovered.

The writer gratefully acknowledges the suggestions of R. M. Fano, J. B. Wiesner, H. E. Singleton, and C. A. Stutt.

REFERENCES

(1) C. A. Stutt, private communication, Research Laboratory of Electronics, MIT, Cambridge, Mass.

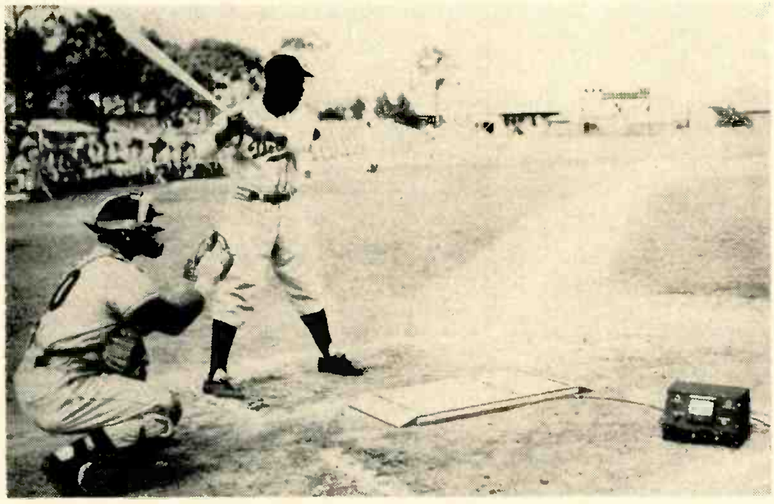
(2) H. E. Singleton, Theory of Nonlinear Transducers, Technical Report No. 160, Research Laboratory of Electronics, MIT, Cambridge, Mass., May 25, 1950.

(3) L. N. Ridenour, "Radar System Engineering," McGraw-Hill Book Co., New York, 1947.

(4) R. M. Fano, The Transmission of Information, Technical Report No. 65, Research Laboratory of Electronics, MIT, Cambridge, Mass., March 17, 1949.

(5) A. J. Lephakis, An Electrostatic-Tube Storage System, Technical Report No. 154, Research Laboratory of Electronics, MIT, Cambridge, Mass., March 27, 1950.

Thyratron-Controlled



Jackie Robinson and Bruce Edwards, of the Brooklyn Dodgers, are shown at Vero Beach, Florida, using the electronic umpire during a practice session

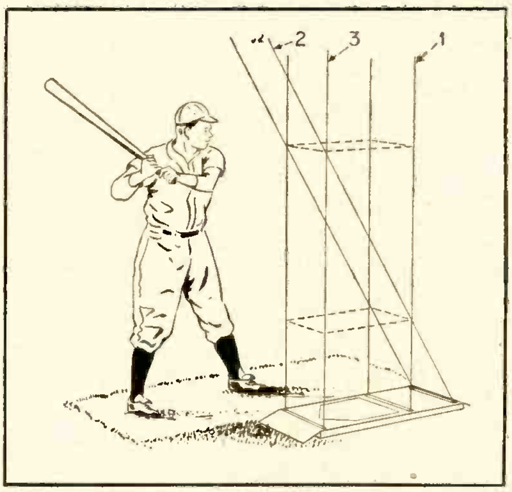


FIG. 1—The ball must pass through the three intersecting planes in 1-2-3 order to record a strike

THE ELECTRONIC UMPIRE arose out of a need for a device to assist pitchers and batters in learning control and judgement. Other devices were in use or had been tried out for such purposes, but they either interfered with a batter's swing or were bulky and not easily transportable. In addition to being able to call strikes, it was thought desirable to add speed measurement to the device, thus permitting a reasonably accurate appraisal of a pitcher's ability in terms of speed and control.

The electronic umpire is a portable two-unit device which can be set up in a matter of minutes wherever there is an a-c supply available. One unit is placed on the ground and carries a simulation of the home plate. Alternatively, it may be set flush with the surface of the ground. The other unit may be located anywhere within a radius of twenty-five feet from the ground unit. It provides an indication when a ball has passed through the strike zone and an indication of its speed. No lights or other equipment than the two units described above are required. The strike zone is adjustable to suit batters ranging in height from 5 ft 1 in. to 6 ft 5 in. Speed in excess of 50 ft per second may be measured to an accuracy of 5 percent.

The device may also be connected to a tape recorder to make a permanent record of each pitcher's ability and improvement. The equipment is intended primarily for training purposes.

Theory of Operation

Figure 1 illustrates the basic theory of operation. The ground unit contains three sets of phototubes and associated optical equipment, so arranged that each set of phototubes looks at a very restricted portion of the sky as, in effect, a beam. Two of these beams are vertical and one inclined. The ball, in its passage across the plate, will interrupt these beams in a certain sequence, depending upon height. If the inclined beam is made to intersect the first vertical beam at the proper knee level and the second vertical beam at the proper arm-pit level, a ball passing through the strike zone will interrupt these beams in a 1, 2, 3 sequence. The sequence for a low ball will be 2, 1, 3, and for a high ball 1, 3, 2. Of course, any ball which is wide of the plate will fail to interrupt all three beams.

To make the system responsive to interruption of the beams in only the 1, 2, 3 sequence, thyratrons in the control box are triggered by pulses produced by passage of the ball through the appropriate beam. The thyratrons are connected in series so that the first must fire to supply voltage to the second, which, in turn, must fire to supply voltage to the third. Such a system will be unresponsive to any other sequence of firing.

If the firing sequence has been correctly followed, a relay is energized and a strike indicator lamp is lighted. In addition, the pulses from the two vertical beams are used to trigger a flip-flop which controls a charging and metering

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

Photoelectric Umpire

Automatic device detects passage of baseball through an adjustable strike zone and indicates speed of ball as it crosses plate. Interconnected thyratrons prevent false operation by bat swinging through strike area. Tests indicate the electronic umpire will be as accurate as live umpires and less vulnerable to flying pop bottles

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circuit that provides a measure of time interval, and hence speed of the ball.

The device also incorporates reset circuits which serve to reset the thyratrons in a relatively short time if only one or two are fired, as by a low or high pitch. If a strike is recorded, the reset circuits will hold off for a longer period, sufficient to read the speed meter, before resetting.

Block Diagram

Figure 2 shows a block diagram of the system. Each phototube pair (two are used for each slot) has an associated preamplifier which amplifies the pulse derived from passage of the ball and applies it to the grid of the corresponding thyratron. Thyratrons 1 and 2 actuate the reset circuit, if fired. Thyratron 3 also actuates the reset circuit if a strike is called, but in such manner as to increase the reset time as described in a later section. The signals from thyratrons 1 and 3 are applied to the timing circuit, which applies a voltage to the metering circuit proportional to the interval. The meter reading is inversely proportional to speed. The reset circuit temporarily removes the plate voltage from the thyratrons and sets the timing and metering circuits back at their initial conditions, ready for another pitch.

Figure 3 shows the circuit of one set of phototubes and the associated amplifier. The phototubes are located in the ground unit, two to each slot. The slots are 19 inches long, and are protected against direct sunlight by rubber guard strips. In the case below the slots are located sectors of plastic lenses and mirrors which focus the sky light at a point inside the box. An aperture at this focal point prevents stray light from energizing the phototube, which is located behind it. By this means, the phototube is made responsive to the ambient sky light emanating from a very small, sharply defined sector of the sky. A ball passing through this beam will cast a shadow on the phototube and produce a unidirectional pulse which is amplified and passed along to the control unit over a 25-foot shielded cable.

The mirrors of the two vertical beams are fixed at 45 degrees; however, the mirror for the inclined beam is displaced from directly be-

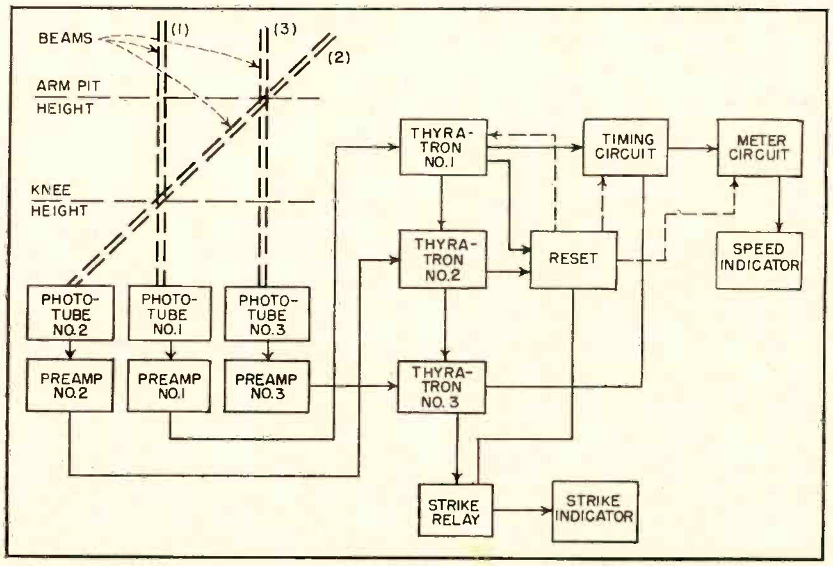

FIG. 2—Speed of pitch is determined by measuring interval required for ball to pass between plane 1 and plane 3

low the slot and is rotatable by means of a calibrated knob through an angle of 51 degrees to 58 degrees, thus varying the intersection of this inclined beam with the two vertical beams to correspond to the knee and arm-pit heights of different batters.

Thyratron Circuits

Figure 4 shows the details of the thyratron circuits. One thyratron is used for the first vertical beam, but two are used for each of the other two. This is done to insure firing of the thyratrons as the ball enters the beam. If this method were not employed, it would be possible to fire the thyratron V_2 as the ball was passing out of the slant beam, the firing occurring on the declining portion of its grid pulse instead of in the rising portion. This would result in extension of the strike zone downward and upward from that indicated by intersection of the beams.

Consider the sequence when a strike is thrown. The ball passes through beam 1 first, which causes V_1 to fire. This applies plate voltage to V_{2B} and V_{3A}. Next, the ball passes through slant beam 2 and fires V_{2A}. The pulse obtained from its cathode is differentiated and applied to V_{2B}. This now fires and applies plate voltage to V_{3B}. Lastly, the ball passes through beam 3 and fires V_{3A}, and the differentiated pulse from V_{3A} fires V_{3B}, whereupon the strike relay is closed. A green indicator is lighted on the panel of the control box. It is also possible to record the word "strike" on a tape recorder which is actuated by this relay.

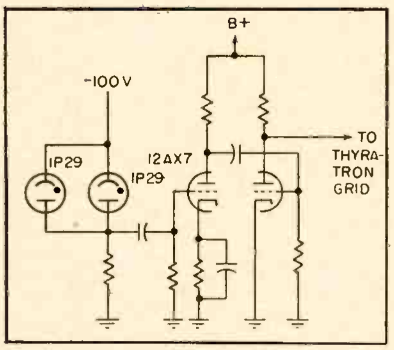

FIG. 3—Phototubes and 12AX7 preamplifiers are located in ground-level plate unit

The timing circuit, to be described later, is actuated by the voltage appearing at the junction of the resistors R_1 and R_2 and turned off again by the voltage appearing at the cathode of V_{3B} after the strike has been thrown.

The voltage on the above divider and voltage appearing on the cathode of V_{2A} are applied to the reset circuit. Thus, if only one or two thyratrons were fired, the reset circuit would be energized and would quickly restore the thyratrons to their unfired condition. In the case of a strike the strike relay operates to delay this reset operation.

Timing and Metering

Figure 5 shows this portion of the equipment. A 12AT7 is used as a conventional flip-flop, turned on by the No. 1 pulse and off by the No. 3 pulse. During the time it is on, it supplies a signal to the grid of the 6AU6 which is normally biased to cutoff. Plate current flows and charges a capacitor to a voltage proportional to the time the flip-flop has been on. This voltage is measured by a balanced d-c vacuum-tube voltmeter.

The voltmeter has two ranges, obtained by shunting the meter. One range corresponds to a minimum speed of 50 feet per second, the other 100 feet per second. The high range is adjusted by means of a variable resistor which varies the charging rate, the other range by the shunt across the meter.

The reset circuit, when actuated, opens the cathode of the first half of the flip-flop, returning it to its stand-by condition, and removes any charge from the capacitor.

Reset Circuit

The reset circuit, as illustrated in Fig. 6, employs another 2D21 thyratron in conjunction with the strike relay and the reset relay to accomplish the objectives described above.

The operation is as follows: normally, this thyratron is cut off by the −27 volt bias applied through resistors R_4 and R_5. Actually about half this voltage is effectively on the grid, due to the voltage divider action of the resistor going back to the thyratrons. Capacitor C_3 is charged to approximately −13 volts, C_2 to −27 volts. If now either thyratron V_1 or V_{2A} (or both) is fired, a large positive voltage will be applied through the reset time potentiometer and will discharge

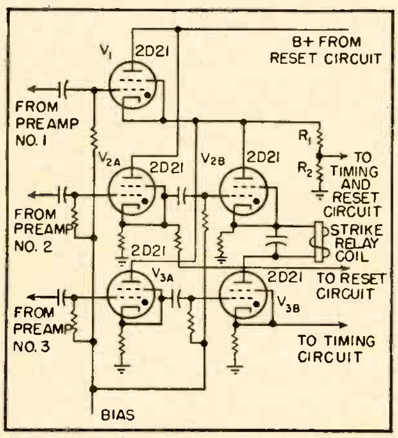

FIG. 4—Interconnected thyratron control circuit prevents false operation

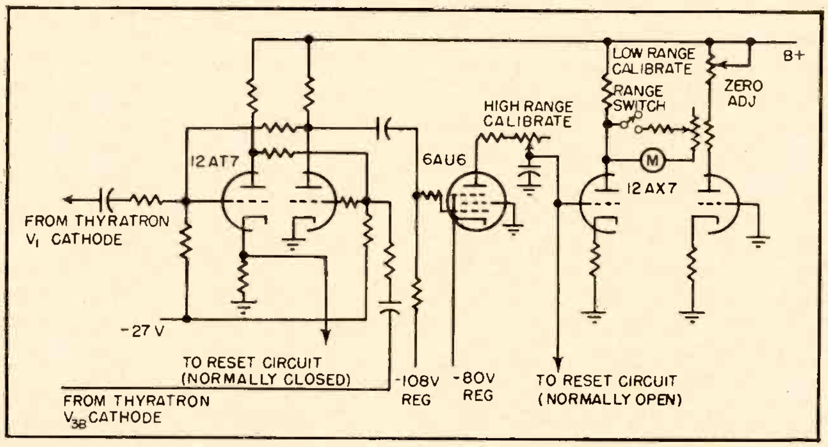

FIG 5—Two speed ranges are available—50 and 100 feet per second—each having its own calibration adjustment

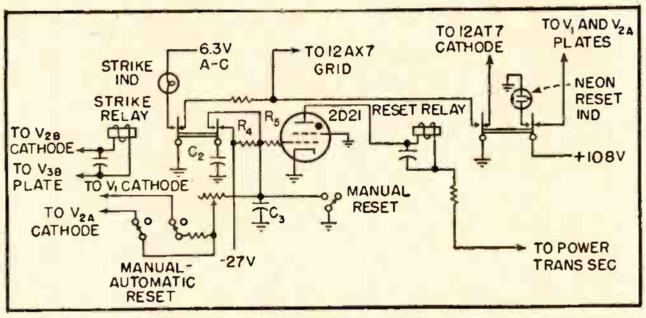

FIG. 6—Reset may be accomplished either automatically or manually

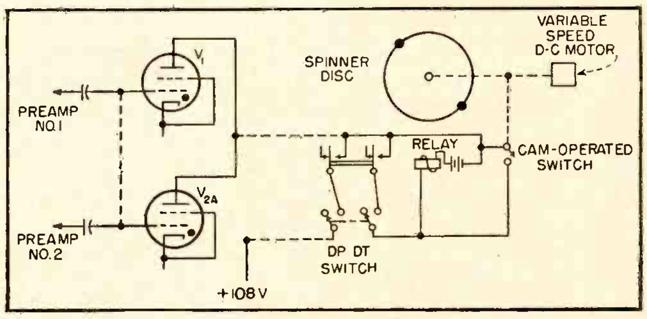

FIG. 7—Electronic umpire is calibrated by a spinner disc that simulates balls traveling at different speeds

capacitor C_3. When the voltage on this capacitor drops to the proper level, the 2D21 will fire and will energize the reset relay. One set of contacts resets the flip-flop and metering circuits as described above, while another set momentarily removes B+ from the thyratrons until the 2D21 is again cut off and the relay released. It also applies this B+ to a neon indicator which gives a momentary indication of resetting. The above reset time is normally set for less than 0.1 second.

If, on the other hand, the ball passes through beam 3 before this cycle has elapsed and the strike relay becomes energized, a somewhat different cycle occurs. Capacitor C_2, which was charged to -27 volts, is now connected to the junction of resistors R_4 and R_5, with the result that a considerably longer period, of the order of 5 seconds, is required for the voltage on the 2D21 grid to decay to the firing level. This provides ample time to read the meter.

A momentary contact switch provides means of manually resetting the device by grounding the 2D21 grid. A double-pole switch also makes it possible to disconnect the reset circuit to hold a reading for longer periods or fire the thyratrons individually in testing.

Calibration

The electronic umpire is equipped with jacks whereby calibrating devices may be connected to it. Figure 7 shows the method used. A large 3-ft diameter spinner disc of $\frac{3}{16}$ inch Plexiglass is mounted on a variable-speed d-c motor, capable of rotating the disc at speeds up to 1,200 rpm. Two opaque areas on the rim of this disc simulate a baseball. The disc is placed so that it rotates over the ground unit, with the opaque areas alternately interrupting beams 1 and 3. Thyratrons V_1 and V_{2A} are now connected in tandem so that both will fire simultaneously.

Associated with the shaft of the motor is a cam-operated switch which energizes a relay once each revolution. This relay has two sets of contacts, connected in series with a double-pole double-throw switch. When this switch is closed, the next time the cam-operated switch is closed, the relay will lock in and will hold down until the switch is opened. This will also apply plate voltage to the thyratrons. When the spinner disc interrupts the beams, the thyratrons will fire and indicate a strike in the same manner as for a pitched ball. The equipment designed as above ensures that the thyratrons are always activated at the correct time. It also permits adjustment to avoid the possibility of firing while the ball is passing through or out of the beams.

By knowing the rotational speed of the disc and the distance between slots, the equivalent linear ball speed may be calculated and the meter set at the correct reading by means of the two range adjustments.

Operational Tests

In actual tests at the Brooklyn Dodger training camp in Vero Beach, Florida, the electronic umpire demonstrated that it could call as reliably, if not more so, than a regular umpire. Extensive tests were made using a pitching machine, as well as members of the Dodgers team, and it was found that the definition of the strike zone is satisfactorily sharp on all four sides. In addition, since there are no interfering parts above the ground, a batter can take his stance over the device and swing the bat through the beams. As long as the bat is swung in the usual manner, it will interrupt the beams in the wrong sequence, and the umpire will reset before the pitch is delivered.

One compromise was necessary in the design of the device in order to accommodate curves as well as straight pitches. The No. 1 slot was made 18 inches wide and the 2 and 3 slots were made 18½ inches wide, whereas the plate is 17 inches wide. The two vertical beams are just before and after the plate. It is conceivable that a very fast breaking curve may cut one corner of the plate and miss one or two of the beams yet still be legitimately a strike. However, if the beams are widened to accommodate this possibility, it then becomes possible to call a strike on a straight ball off the side of the plate. The above compromise is apparently reasonably satisfactory from both standpoints, on the basis of tests made to date.

The author wishes to acknowledge the work of R. Spencer, D. W. Cottle, C. E. Metcalf and C. E. Theall, all of the Electronics Department, General Electric Company, who contributed most of the work on this project, and to Branch Rickey and the members of the staff of the Brooklyn Dodgers whose cooperation made the above tests possible.

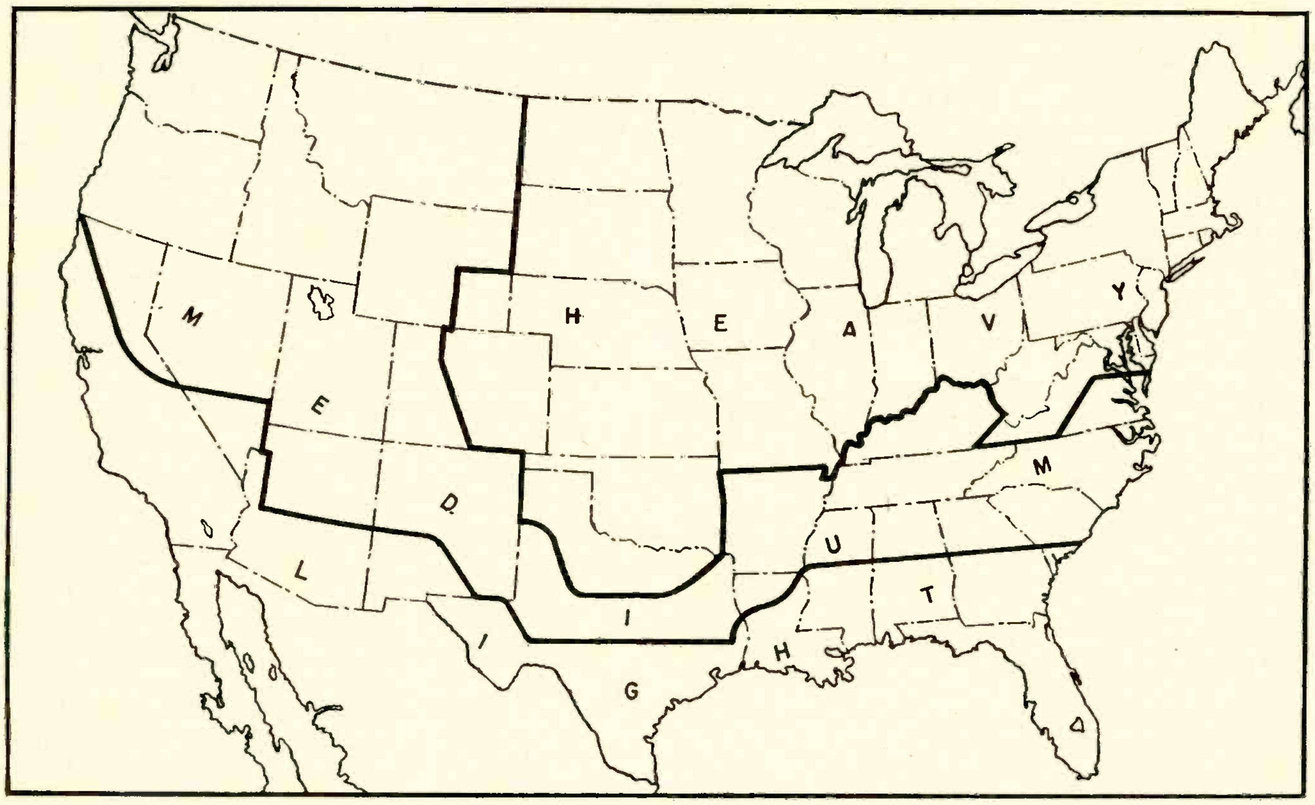

FIG. 1—Wind and ice loading zones in the United States

How to Select ANTENNA TOWERS

A knowledge of mechanical design principles is essential. This article summarizes general practice with respect to self-supported and guyed structures, materials, mounts and footings. Erection and maintenance, factors which affect the choice, are also covered

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ELECTRONIC ENGINEERS are frequently called upon to select structural supports for antennas. Special design is occasionally necessary but in most instances standardized supports are indicated. In either case, selection is facilitated if the engineer has a general knowledge of mechanical design principles, installation and maintenance problems. It is such knowledge that this paper is intended to summarize.

The maximum strain on most antenna supports is imposed in a horizontal direction by wind; ice coatings create additional gravity loads but their greatest imposition of stress is caused by the increment of area they add to the surface the structure presents to the wind.

The wind pressure on a structure varies with the square of the wind velocity; calculations based on wind-tunnel data are given below:

Wind Velocity (mph)	*Pressure (lb per sq ft)* Flat Surface	Round Surface
60	13.3	8.9
70	18.2	12.1
80	23.7	15.8
90	30.0	20.0
100	37.0	24.6
110	44.8	29.8
125	57.9	38.6

The profile or projected area is used for calculations of wind load.

Meteorological records and re-

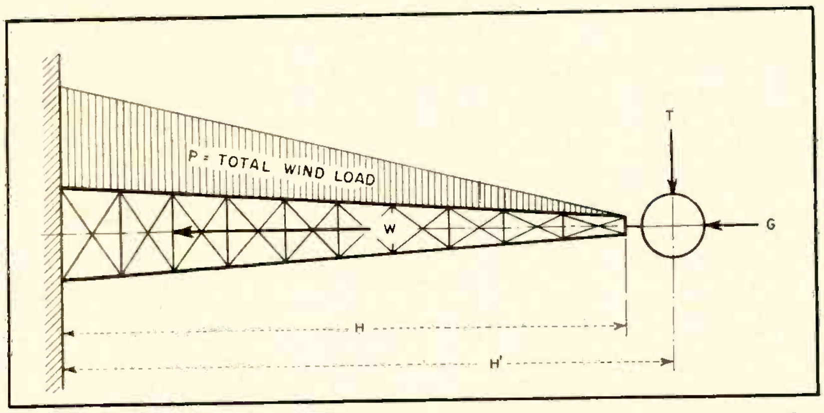

FIG. 2—Loading on a tapered, self-supporting tower, turned on its side in the drawing for better visualization of forces involved

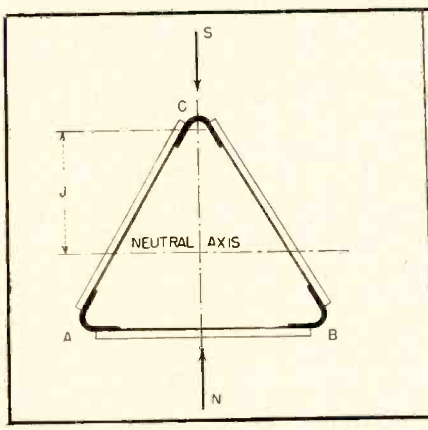

FIG. 3—Cross section of triangular tower

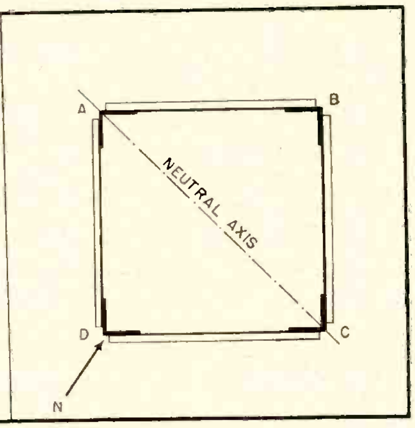

FIG. 4—Cross section of square tower

and MASTS

search have established maximum wind and ice conditions normally to be expected in various parts of the United States. Figure 1 delineates the various wind and ice loading zones. Conservative design practice anticipates the following loadings:

	Ice-Coating (in.)	*Wind-Velocity (mph)*
Light	0	60
Medium	0.25	70
Heavy	0.50	90

Ice loadings are expressed as radial thicknesses to be added to the projected area of members.

The loading map does not take into account unusual local conditions which may suggest design to a higher or lower wind velocity. In areas subject to hurricanes it is usually best to select towers rated at 90 miles per hour. Hurricanes involve winds having speeds of over 125 miles per hour, but only near the eye or center of the storm; velocities in the periphery are usually below 90 miles per hour. It is therefore sometimes cheaper to replace a damaged structure with a similar structure than to replace with one which would resist the rarely encountered forces which destroyed the original.

Masts and towers are generally rated in terms of pounds of horizontal top load at a given wind velocity, or wind velocity plus a given ice load. An additional figure is often given for the gravity load which may accompany the maximum horizontal load. Thus a tower with a capacity of 200 pounds at 90 mph can be loaded with $6\frac{2}{3}$ square feet of flat surface, 10 square feet of round members, or any combination totaling 200 pounds of wind resistance.

Self-Supporting Structures

Stress analysis of a self-supporting structure is complicated by the fact that it is loaded as a beam and as a column at the same time. Figure 2 shows the loading on a tapered tower; it is turned on its side for better visualization of forces. Shaded area P shows the total wind load on the support structure, usually expressed in pounds per square foot and here represented as increasing toward the base because of longer bracing members and heavier corner posts at the base. The letter T denotes wind load on the antenna, and G and W are the gravity loads of the antenna and tower structures respectively, plus the weight of any ice coating.

Assuming a tower of triangular cross section, the maximum compression load imposed on member C in Fig. 3 occurs when the wind is from direction N. A line parallel to AB and one third up from the base will be the gravity or neutral axis of the section; this line has no theoretical stress. With the wind from N, C is in compression and A and B in tension.

The corner post C is a column; its tensile strength is its net area multiplied by the allowable stress of the material, but its compression strength is always something less than this. Since the wind from direction N imposes a tensile load divided between A and B, while an equal compression load is placed on C alone, and considering that the corner post in effect is stronger in tension than in compression, it becomes obvious that the compressive strength of the corner posts is the critical design factor in a self-supporting tower.

Gravity loads of all kinds are equally divided among the corner posts but unfortunately they add to the compression load on C while subtracting from the tensile load on A and B. Referring to Fig. 2, G is constant except for the additional weight of any ice and its weight is transmitted throughout the length of the tower, while W is additive owing to the tower taper; some towers have heavier corner posts toward the base in consideration of this latter fact.

In the case of square towers P is uniform from top to base of the structure and W increases uniformly instead of geometrically. Maximum stresses occur in a section when the wind is from N as in Fig. 4. The neutral axis is a diagonal, B is in compression, D in tension, and A and C have very little stress.

Guyed Structures

The guyed structure is subject to a different set of stresses, as shown in Fig. 5. The strain taken by each guy is resolved into its horizontal and vertical components for purpose of stress analysis. The horizontal components H_a, H_b, and H_c are equal to the horizontal wind load on half of the sections adjacent to each guy point. The horizontal load on the antenna itself, I, is taken by H_c, and H, the bottom horizontal reaction, is merely half the wind load on the bottom section.

Referring to Fig. 6, $V = H \tan \phi$, and the greater ϕ becomes, corresponding to anchoring the guys closer to the base of the tower, the greater V will become for a given wind load reaction H. In effect, failure of a guyed structure results from wind load stressing the guys to the point where they pull the tower down. Good practice usually has the guys anchored from 70 to 100 percent of their height from the tower base, but some tubular masts, taking advantage of the lower wind resistance of round members, are designed to take the downward pull of guys anchored closer. Since it is most economical to have all guys in a set anchored at one point, ϕ is usually small for the lower guys.

The summation of all vertical forces at the bottom of the tower, ΣV as in Fig. 5, is the accumulation of gravity loads of the antenna, structure and ice, plus the vertical components V_a, V_b and V_c of all the guy strains. The maximum column load on the corner posts occurs at the bottom of the structure. Since a substantial increment is added at each guy point, many large guyed towers make a change to heavier corner post sections at the guy points. The fact that a structure does not add corner-post material at each guy point, however, does not necessarily mean that it is poorly designed. Changes in corner-post section complicate section splices in some designs and there are economies in keeping the number of different sections to a minimum. Heavier material is often used higher up the tower than stress analysis alone demands.

The wind direction for maximum stress in a guyed tower is different than for a self-supporting one, and is S rather than N in Fig. 3 for a triangular section. Corner-post C again gets the greatest load, in compression, and A and B share an equal tensile load between them. A wind from N will throw the full tensile load on C alone, but the corner post is stronger in tension than in compression.

For the square tower, Fig. 4, corner-post B was in compression in the self-supporting structure; if guys are added D takes the compression load when the wind is from N and B is in tension. The guys at A and C are slack. A wind normal to any face of a guyed triangular or square tower will not impose stresses as heavy as those just described, because the compressive loads are then divided between two corner posts.

Figure 7 shows how wind pressure on a triangular section between guys stresses it as a simple beam with a uniformly distributed load. With the wind coming from direction N, this results in a compression stress in A. Thus there are three compression loads on A, the beam stress just mentioned, the vertical component of guy strain, and the gravity loads of the antenna and the structure itself plus the weight of any ice. These constitute the maximum loads of any member of the tower, and reach their highest values at the bottom.

Cross-Bracing

The cross-bracing of towers is subject to infinite variation, depending upon decisions of the individual designer. Many combinations of horizontals and diagonals can result in a sound structure, and some successful lighter designs omit either horizontal or diagonal bracing entirely.

In general, and where a structure has both, the horizontals are compression members while the diagonals distribute tensile loads among the corner posts. The corner post is a column unsupported between bracing; the greater the length of a bay the heavier the corner post must be, and the bracing must also be heavier. The designer arrives at a compromise between putting his material into corner

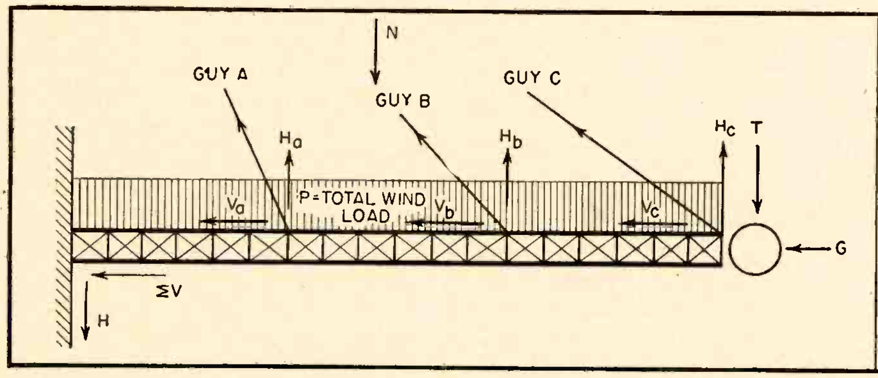

FIG. 5—Loading on a guyed tower, showing vertical and horizontal components

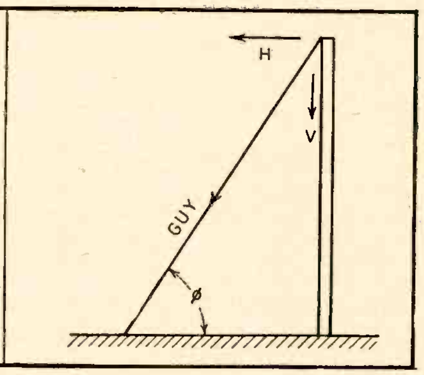

FIG. 6—Guy-angle geometry

posts or bracing and tries to get a combination which will expose a minimum of area to the wind.

A few successful designs have used wire cable for diagonal bracing, despite the fact that end connections are expensive and cable is subject to stretching.

End connections of rigid bracing usually require that the material be two to three times the diameter of the bolt or rivet in width; this often determines the minimum section which can be used for bracing. Because of corrosion, traditional structural practice has in the past prohibited the use of any section less than ⅛ inch thick, but the tower industry, doing careful stress analysis and using corrosion-resisting materials and coatings, has in many instances safely disregarded this arbitrary minimum. The more massive structures are usually built entirely of standard channels and angles, but lighter towers often use specially formed sections stamped from sheet or extruded in the light metals. Round tubing is an excellent shape for corner posts as well as bracing, since it is equally strong in all directions.

Fastenings

Towers other than the most massive designs are usually factory assembled into sections which are bolted together at erection. Where rod and tubing are used, factory assembly is generally done by welding; this is highly satisfactory if the welds are sound and are carefully cleaned before galvanizing or painting. The most dangerous type of corrosion starts at improperly cleaned welds.

Factory-driven rivets give little trouble except where they have not been thoroughly descaled before finishing the structure. Bolts and nuts are usually hot-dip galvanized; the nuts are usually retapped slightly oversize after galvanizing to permit easy assembly. Electro-zinc and cadmium plating of bolts and nuts permits their manufacture with closer fits than hot-dip galvanizing, but the difficulty of maintaining quality control, especially in barrel plating, has in some instances in the past made them less uniformly corrosion-resistant. However, electro-zinc and cadmium plate are excellent paint bases; even if the structure itself is not galvanized, plated fastenings are well worth their slight additional cost.

Both self-supporting and guyed towers are subject to substantial vibration in gusty winds. Investment in locknuts or lockwashers of any standard type, plated like the nuts and bolts, is well worth the cost of additional material and erection labor.

Mounts and Footings

Guyed and self-supporting structures are mounted on different types of footings. The self-supporting tower must be anchored so that each leg footing can resist a tensile pull of high magnitude. Referring to Fig. 2 and 3, this is:

Tensile Pull $= PH/3 \div J + TH' \div J - (G + W) \div$ No. of corner posts. For a given top load capacity and height, a tower with a greater spread at the base will cost more than others but, where soft ground conditions require extensively spread footings, a more economical installation will result from the fact that the tensile forces the base must resist will be less, since the denominator J shown in Fig. 3 is greater. Where a self-supporting tower is used as a vertical radiator, push-pull insulators are usually employed for the legs; Fig. 8 shows how such insulators translate tensile pull on the leg into a compression strain on the porcelain.

The base of a guyed structure is less elaborate, since there are no upward components of force, but the footing, usually a slab of concrete, must be spread over enough ground to distribute vertical loads over an area which can support them without sinking. The slab must resist substantial internal shear stress unless ground conditions permit it to be small in area; it is usually provided with reinforcing bars. The horizontal loads on the base of a guyed tower, being quite small, are taken by a few bolts or anchor rods locating the tower base on its footing. Base insulators for guyed vertical radiators have to be quite substantial to take the downward thrust of the guy strains and gravity loads. However, porcelain has a high strength in compression, so pivot insulators of the type illustrated in Fig. 9 can support even the most massive structures.

Guy anchors require careful investigation of soil conditions and installation. For strains up to a few tons in medium or hard soil, galvanized guy anchors equipped with bearing plates or suitable for use with a deadman buried in the ground are often employed. These are inexpensive and easy to install; even if the largest size cannot support all the guys in a set it is worthwhile providing more than one anchorage if this allows their use. In soft soil, and where guy strains are several tons, concrete footings must generally be designed. Shaping them along the line of average direction of guy pull saves material and labor and the use of a wedge-shaped plate transmitting guy pulls to the anchor allows self-alignment of the guys.

Materials

Steel towers are low in first cost, but their weight is a factor in ship-

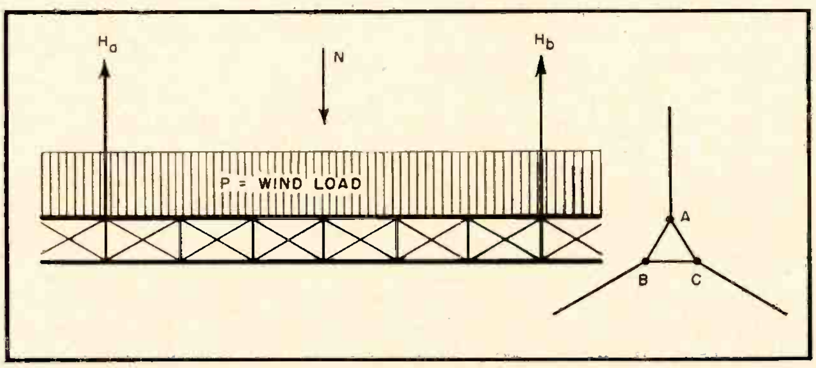

FIG. 7—Wind pressure on triangular tower section between guys

ping and erection expense. Even though galvanized they are usually painted periodically in all but quite dry climates; this expense is necessary in any case where the Civil Aeronautics Authority declares a tower to be a hazard to air traffic and requires that it be painted in orange and white stripes for maximum visibility.

Aluminum has become important as a tower material since the development of strong and corrosion-resistant alloys. Having a modulus of elasticity about one third that of steel, an aluminum-alloy tower under load deflects roughly three times as much as a steel tower made to the same design. The alloys used for towers weigh about one third as much as structural steel, and their yield point in tension is about a third higher. In order to reduce deflection, deeper sections are used, but good designs are on the market which are about 40 percent of the weight of a structural steel tower having the same load capacity. They are more expensive than steel structures, but in many cases the additional first cost is offset by savings in shipping and erection.

Stainless steel is the best material for towers from the corrosion standpoint, but is quite expensive. In its annealed state, 18–8 stainless steel has a yield strength about the same as structural aluminum and higher than structural steel. However, most stainless steel used for antenna-support structures is in the form of tubing, where the cold working accompanying the drawing operations materially raises its strength. Especially where a tower need not be painted, stainless steel towers, like aluminum, effect savings in shipping, erection and maintenance.

Magnesium alloys will undoubtedly play an important part in the future of antenna support structures. Substantially lighter and more corrosion resistant than aluminum, they permit the erection of massive towers with little gear. Research is producing stronger alloys and gradually eliminating detrimental factors such as the susceptibility of magnesium to notch-effect failures.

Phenolic resin-bonded plywood was used for mass-produced masts up to about 100 feet in height during World War II. It has the advantages of low cost, easy erection, low maintenance and the employment of noncritical material. However, it has a shorter life and less load capacity than most metal types and must be lowered when antennas are to be tuned or serviced. Postwar development, particularly in the direction of using fiberglass as a filler material, has improved the quality of this type of product; it is especially useful for testing work and temporary installations where frequent moving of equipment is necessary.

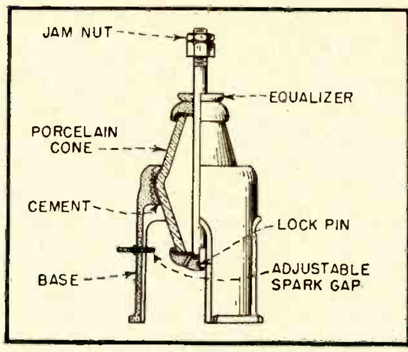

FIG. 8—Support for unguyed tower

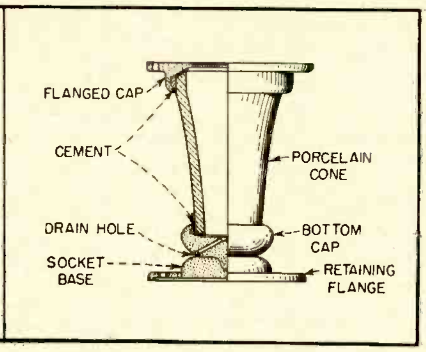

FIG. 9—Support for guyed tower

Wooden masts and towers are rarely satisfactory at heights above 50 feet althought many up to 250 feet were built in wartime because of the shortage of metals. Design requires great care and flawless materials must be used. The allowable stress being low, sections are bulky and the wind loads consequently quite high.

Selection of Site

Guyed towers require substantial areas for guy anchorage. Installation on a rooftop adds to the height but roof framing must often be reinforced for the tower base and sometimes for guy anchorage as well. One method of anchoring guys on a rooftop of limited area is shown in Fig. 10; alternate methods include running one or more guys to the ground or to another building.

Self-supporting towers require less room for the base, but legal liability exists where the structure might fall onto property owned by others; insurance must be figured into the maintenance cost so sometimes it is cheaper to acquire land around the tower to reduce this charge. Reinforcement of roof framing to anchor a self-supporting structure is usually more costly than for a guyed structure of the same height because of the tensile loads the base must resist, but guy anchorages are eliminated.

Soil conditions should be determined before the selection of a tower to be ground mounted. Soft or swampy ground may dictate the choice of a self-supporting tower with the base spread as much as possible. A guyed structure mounted on soft ground should be as small and light as possible; some of the stainless steel towers made of round tubing are costly but their wind loads are low, their vertical thrust against the ground correspondingly small and the base required less elaborate than for more massive steel units. In temperate or cold climates the footings should go at least below the frost line for safety.

Rock footings are relatively simple. Usually holes are drilled, steel rods with appropriate cross-members for bonding inserted, and the holes filled with concrete. In the case of the lighter structures, the rod itself can be used as an anchor bolt attached to one leg of the tower. For heavier structures a triangle or square of metal fitting the leg angles of the tower is buried.

Accessibility of the site will sometimes be a major determinant in selection of an antenna support where there are serious limitations of carriers and roads.

Erection Methods

For crane erection, either an entire structure or a few bottom sections are assembled on the ground. A truck or crawler crane hooked to the structure just above its center of gravity lifts the unit and lines attached to the bottom end swing it into an upright position. The crane then lowers it onto the anchor bolts. Crawler cranes capable of lifting up to ten tons at the end of a 100-foot boom are available in most centers of population in this country, so units up to possibly 200 feet high can be erected by this method. However, great care must be exercised in raising units over 100 feet high, because the guyed units especially are quite limber, and buckling may occur. Rental of cranes is expensive, but the crane is needed only for the minimum hiring period of one day. Gin poles and A-frames can take the place of the crane for smaller units.

For piecemeal erection the bottom section of the structure is erected as a unit. A jib is then attached to one corner post, projecting up more than half the length of the next corner post. This jib is used with a pulley and rope to raise the members of the next bay. After the bay is completed the jib is again raised. A winch on the ground may be used to lift the material, or a jeep or truck may be used, employing a pulley on the ground to change the direction of pull. Piecemeal erection is necessary on the more massive towers; when mounted on prefabricated sections the jib may raise an entire tower section. Some manufacturers supply jibs suitable to their towers on a sale or rental basis. Where a massive structure is to be erected on a rooftop it must be determined whether there is room on the roof to install a hoisting derrick to lift the members or whether they must be carried up in elevators. These conditions may dictate a maximum size of members, which would control the basic design.

For boom erection many guyed masts are equipped with four sets of guys instead of the minimum three. The boom, which may be one quarter to a third the length of the mast, is attached to the mast base at right angles to it, and the base itself is equipped with a hinge. The mast, including all the guys, is assembled on the ground and the boom is attached in a vertical position. One set of guys is attached to the boom, shortened as necessary. Two sets are attached to their ground anchors. The fourth set, opposite the boom, is attached to a truck or held by manpower. A line fastened to the end of the boom is pulled in the direction opposite the mast, and, as the boom end is pulled down, the mast is raised. At some point near plumb the weight of the boom balances the weight of the mast; beyond this point the mast falls into an upright position and the fourth set of guys opposite the boom must take up their slack and ease the mast into position.

Maintenance

Materials of construction, fastenings, climatic conditions and required length of life determine mantenance requirements.

Painting is the most costly repetitive item and the one most often neglected. Aluminum structures need not be painted unless they are exposed to salt air or industrial fumes corrosive to the metal; in the former case they need painting less often than galvanized steel if a zinc chromate priming coat has been well applied. In dry climates galvanized steel does not need painting either, though both it and aluminum are subject to weathering which may make their appearance undesirable. Galvanizing provides a better paint base than bare steel, as also do Parkerizing and similar chemical treatments for metals.

Bolts are the first parts of a tower to show signs of corrosion in most cases, even when painted. Streaks below a bolt head may indicate only the combined effects of rain and dust; nothing need be done about them until wire brushing shows bare metal has been exposed or pitting started. When bolts and nuts begin to rust on an aluminum tower wire brushing and painting will save them.

About six months after a tower has been erected, or after its first winter, all the bolts should be tightened and any showing signs of corrosion painted or replaced. Subsequent tightening need only be done once a year, but signs of misalignment or damage should be promptly attended to.

Guys should be adjusted at erection so that the structure is perfectly plumb and straight with all the slack taken out of the guys and all equally taut. Some manufacturers supply guy-tensioning devices based on spring-adjusted turnbuckles, but screw turnbuckles should be provided in addition to these. Guys should be checked four times a year or after severe storms; all wire rope is subject to stretching.

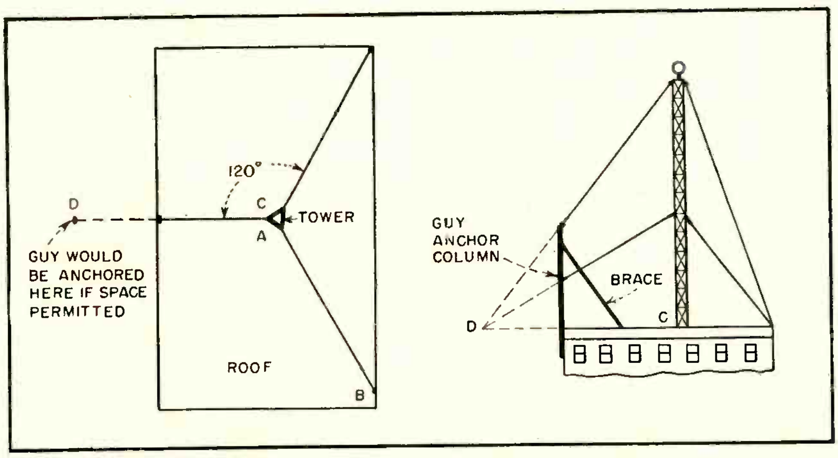

FIG. 10—Use of guy anchor column on rooftop of limited area

Lighter units generally have bracing handy for climbing, and more massive units are usually provided with a ladder. Where bracing is too widely spaced for climbing, extra horizontals on one face may be provided to form a ladder, or one corner post may be fitted with cantilever climbing rungs.

Tubular masts can be fitted with ladders or rungs attached to clamp rings. These, of course, add to wind resistance. A mast is usually painted by lowering it, or by using a boatswain's chair suspended from the top if it is erect.

Electronic Control of
HOME HEATING

Amplifier fed by a-c bridge containing resistance-wire sensing elements maintains room temperature within 0.25 deg F by sensing outdoor weather changes and automatically cycling burner on and off. Outdoor sensing element automatically raises control temperature to assure constant comfort when weather turns colder

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THE ULTIMATE GOAL for all good heating systems is to supply constantly just enough heat for a structure to balance heat loss—no more and no less. Only when that goal is reached can an even, steady room temperature be expected.

In a home or building with several large rooms it is desirable to control at more than one point to provide averaging results so that a better over-all condition of comfort could be maintained. Temperature within large buildings can vary considerably from one end to the other due to strong winds or sun effect, but outside temperature is the major source of heating load.

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

An outdoor control can help overcome system lag by altering the basic rate of heat input the instant it senses a change in temperature, rather than waiting for the outdoor temperature to be reflected through the mass of the building walls to the inside thermostat.

In mild weather a room temperature of 72 degrees may be perfectly comfortable. When outdoor temperature drops considerably, however, an inside air temperature of 72 degrees may not be sufficient for comfort because the individual is radiating heat from his body to cool walls. To overcome the sensation, during colder weather most people raise the control point of the thermostat until they again feel comfortable. It is desirable to have automatic means of doing this according to outdoor conditions, particularly at night.

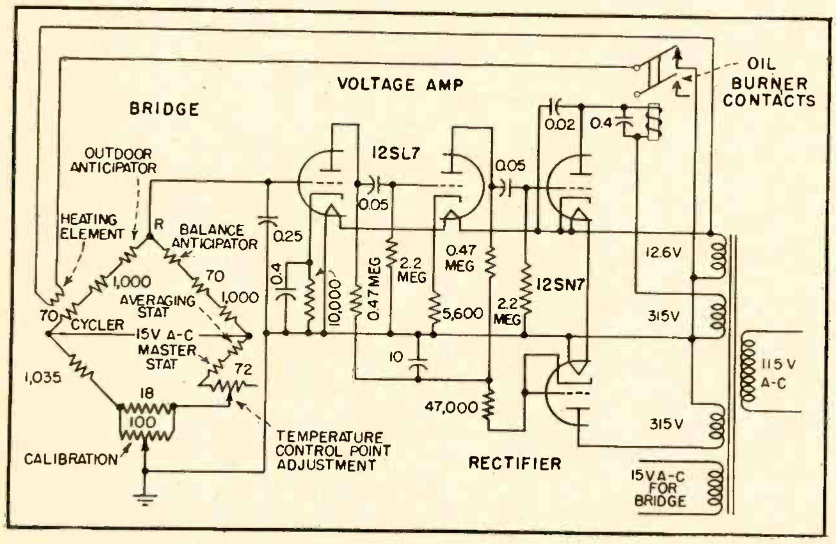


FIG. 1—Complete circuit of electronic control for heating systems

Electronic System

The introduction of electronic controls to the field of heating comfort gives results never before believed practical, closely approximating the ultimate goal for heating comfort. Control within a fraction of a degree with extreme stability is realized.

The basic electronic heat control system consists of a Wheatstone bridge arrangement, an electronic amplifier and a relay. Signals are picked up by elements of the bridge circuit and amplified by the electronic amplifier, which in turn provides a signal voltage for the relay unit whose output circuit can operate any common heating system employing an oil burner, gas burner or stoker.

An electronic circuit that can control a heating system, incorporating all the features that were just considered desirable, is shown in Fig. 1. Basically it consists of a Wheatstone bridge, an amplifier and a relay.

In the lower right-hand leg of the bridge are two resistors in series, one labeled MASTER THERMOSTAT and the other AVERAGING THERMOSTAT. A third, fourth or fifth thermostat could

Replacing tube in electronic control unit for gas furnace in home

Snipping out shorting segments from stamped wiring of electronic home heating control after soldering all joints

be added to produce nearer average control temperatures for the whole structure, but experience has shown that two thermostats give excellent control results and require a minimum of installation wiring.

A rheostat in the same leg of the bridge is integral with one of the thermostats and acts as a control point selector calibrated from 55 to 85 F.

In the upper left-hand leg of the bridge is a resistor labeled OUTDOOR ANTICIPATOR. This gives a signal to the control system as the outdoor temperature changes, thereby initiating corrective action before the space temperature varies. In addition, the value of resistance for this outdoor anticipator may be selected so that as the outdoor temperature falls the control point of the system is automatically shifted to give a slightly higher room temperature.

Circuit Operation

The output of the bridge feeds a two-stage voltage amplifier utilizing the two triode sections of a type 12SL7 tube. The voltage amplifier feeds one half-section of a 12SN7 tube, the plate circuit of which operates a relay in response to signals from the bridge circuit. The second section of the 12SN7 acts as a half-wave rectifier to furnish plate voltage for the two voltage amplifier stages.

The plate supply voltage for the power amplifier is 315 volts a-c. A large capacitance is placed across the relay coil to smooth out a-c ripple and prevent chattering.

When the bridge circuit is unbalanced sufficiently in the direction to produce 45 volts d-c across the relay, the relay pulls in and establishes a circuit to an external load (the furnace) as well as to the cycler heater. As the bridge circuit approaches balance, the voltage across the relay will drop steadily. At 25 volts the relay armature will drop out. The control system thus has a differential of 20 volts. Amplifier gain is such that this voltage differential is produced by a net charge of 0.6 ohm in bridge resistance.

For best results it has been determined that each leg of the bridge circuit should be approximately 1,000 ohms. If two thermostats are used, to average conditions in different rooms and obtain better over-all comfort, each unit will be 500 ohms at some pre-determined temperature (70 degrees). If a single thermostat is used, the entire 1,000 ohms is in one housing.

The Balco temperature-sensitive wire used for sensing elements is a nickel alloy having a positive temperature coefficient of 0.0024 ohm per ohm per degree F. With 1,000-ohm elements, the resistance will change approximately 2.4 ohms for every degree change in temperature. Since 0.6-ohm change in the bridge is required to produce the 20-volt differential to operate the relay, the system differential actually is ¼ degree F.

Typical bimetal-operated thermostats in homes are adjusted to have a minimum differential of between 1½ to 2 degrees. The electronic system thus has a considerably greater sensitivity than conventional mechanical systems.

Heating Load

One of the most important functions of a temperature control system is to provide heat input during periods when room sensing elements are not calling for heat. This keeps the temperature and flow of the heating medium relatively constant for any given condition of load. Figures 2 and 3 indicate the importance of the cycling device in performing this function.

Figure 2 shows the load line that can be drawn for any automatically fired heating system, neglecting sun and wind loads that are other than normal. On this graph 70 degrees F has been considered the fade-out temperature, or the temperature at which no heat input to the building is required, and −40 degrees is considered the point at which the furnace would have to be running 100 percent of the time to furnish the heat necessary to overcome the losses. The graph thus gives the approximate percent on time for any outdoor temperature between −40 and +70 degrees F. This assures that the heat losses from a building are at a relatively steady rate, while the heat input as a result of burner operation is intermittent due to the on and off characteristics of conventional burners.

Figure 3A graphically demonstrates the operation of the burner and resulting room temperature conditions under 50-percent load with an average control system. The temperatures shown are arbitrary as to value, but they do indicate that there will be a considerable variation of room temperature. This graph also indicates the lag of room temperature behind the burner cycle.

In Fig. 3B, the heating load is still 50 percent but the burner operations are shorter and more frequent. Temperature fluctuations are clearly lower than for Fig. 6A.

In Fig. 3C, burner operations are still more frequent, with the total time on per hour exactly the same as in Fig. 3A. Room temperature fluctuations are now practically unnoticeable.

In general, it is safe to say that as the frequency of burner cycling is increased, for a given load, the temperature becomes more uniform. With modern-day burners, it is not practical in many cases to have cycles less than three minutes on. In the majority of domestic heating plants, a time interval or minimum cycle of 3½ to 5 minutes will produce excellent results as far as the room temperature is concerned.

Automatic Cycling

Automatic controls have been available that mechanically set the cycling rate of a heating plant. These devices do a fine job, providing the heat loss is at a constant rate. However, as the outside temperature changes, the heat loss requirements change, and therefore the cycling rate has to be changed also. With the mechanical system this is not very practical.

An electronic cycler is used in the control system under discussion, to produce the proper frequency of burner operation under varying load conditions. This cycler consists of a bridge element (shown in Fig. 3), an electric resistance heater, a switch, and a power source, in this case a transformer. The resistance of the cycler bridge element is chosen so it will demand heat input from the burner at approximately the same rate as the heat losses from the building. The switch is a contact on the same relay that starts and stops the burner. When a call for heat is indicated, the relay closes and heat is furnished to the heater of the cycling unit. Because the bridge element of the cycler is wound close to the heater, its resistance begins to increase as soon as heat is applied. When the amount of resistance increase equals 0.6 ohm, the relay contact opens and the heater is de-energized. The bridge element begins to cool; when it reaches the temperature of the surrounding air, the bridge is restored to its original condition of unbalance (assuming room temperature has not yet changed) and the relay again closes to repeat the cycle. The rate of heating and cooling depends upon the cycler design.

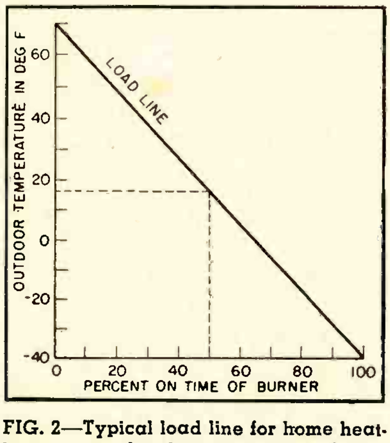


FIG. 2—Typical load line for home heating system, showing percentage of time the oil burner must run for comfort at each outdoor temperature

As the resistance of the cycler increases and decreases it tends to balance and unbalance the bridge circuit periodically, even though there is no change in temperature at the thermostat units. A cycling rate for the burner is thus automatically established. The next question is how this cycling rate is automatically varied as the heating load changes.

The instant the heating load varies, due to a change in outdoor temperature, this change is felt by the outdoor anticipator which consists of a bobbin of temperature-sensitive wire located outdoors and wired in the same bridge leg as the cycler element. Electrical resistance of the outdoor anticipator decreases as the outside temperature drops, and unbalances the bridge circuit. As a result of this condition, the cycler heater must remain energized for a longer time, heating the cycler bridge element to a higher temperature, in order to restore the bridge to its original balanced condition. Because the bridge element follows a typical cooling curve, the unbalancing due to the cooling of the heater will be more rapid and the next cycle will occur sooner. The net result is an increase in the length of the burner on cycle and decrease in the length of the off cycle.

If the heat input to the building is not adequate to maintain a constant temperature, the indoor thermostats feel this change and their electrical resistance lowers slightly. The change in thermostat resistance again tends to change the cycling rate until the proper balance is obtained. Since the thermostats have roughly 15 times the nominal resistance of the cycler or the outdoor anticipator, it only takes 1/15 of a degree temperature change at the thermostat to get the same effect as a one-degree change at either the cycler or outdoor anticipator used in the system.

If the temperature outdoors rises, the cycling rate will decrease. When the heat loss of the building reduces to zero (for equal indoor and outdoor temperatures), the cycling will stop altogether.

The cycler performs one other important function in connection with a morning pickup period after a night of reduced temperatures. With a standard type of control system, the heating system is started as soon as the thermostat setting is restored to the daytime level, and runs continuously until a predetermined control point is reached. At that point the heat source is shut off, but heat stored in the furnace and in the heat distributing system continues to raise the room temperature until all excess heat is dissipated. In many cases this results in room temperatures several degrees higher than desired for short periods. With the electronic system, incorporating a cycler, the burner runs continuously until the room temperature has restored the bridge balance to a point where it comes within the field of control of the cycler. This usually occurs about 2 degrees below the desired control point; here the cycler causes the burner to begin cycling, and the control point is approached at a decreasing rate so that no overshoot occurs.

System Droop

Any type of thermostatic control system which by means of artificial heat tends to anticipate the eventual rise in room temperature has a characteristic called droop. This is the amount the room temperature must drop below the thermostat set point before the burner runs 100 percent of the time. Droop often contributes to the discomfort one feels within a building as the outdoor temperature lowers.

The electronic controls also provide droop, due to the fact that the cycler is always attempting to restore the bridge balance and shut the system off. To provide continuous burner operation, room temperature must fall enough so the decreased resistance at the thermostat more than offsets the increased resistance due to the heating of the cycler.

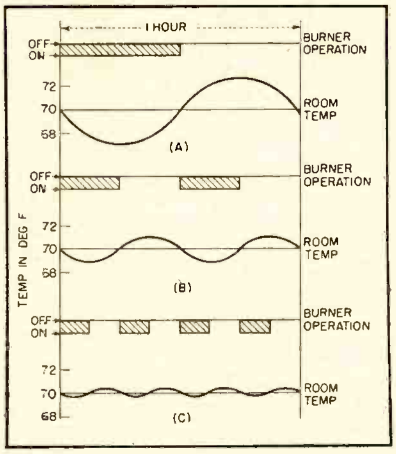


FIG. 3—Effect of cycling on constancy of room temperature. The more often the burner comes on, the less variation there is in room temperature

Where droop is almost impossible to eliminate in a mechanical thermostat system, it is easily overcome in the electronic system. The outdoor anticipator can be used very handily to offset droop. It can even go further and actually raise the control point as the outdoor temperature falls. Because droop is a direct function of heating load, and the load can be considered virtually a direct function of outdoor temperature, as shown in Fig. 2, a nominal resistance value can be assigned to the outdoor anticipator so that the bridge unbalance due to the cycler heating is offset by the changed resistance of the outdoor anticipator.

To correct exactly for the droop in the system, the outdoor anticipator must have sufficient authority to just overcome the cycler resistance when it is heated continually, indicating full load. Any additional resistance in the outdoor anticipator raises the control point of the system inversely as the outdoor temperature changes. Knowing the coefficient of the Balco wire used for the temperature-sensitive element, it is a simple matter to determine the amount of resistance necessary over a certain outdoor temperature span to raise the control point the desired number of degrees.

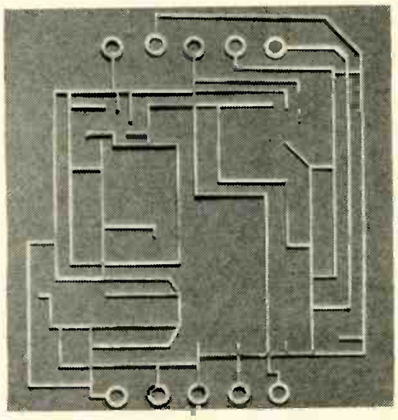
Stamped Wiring

Internal wiring for the entire amplifier is punched out of a sheet of 0.025-inch thick brass in one operation. The various circuits are held together by small webs of brass. After the components are completely wired into the amplifier, the webs or short-circuits are removed by clipping. The entire wiring grid is silver-plated for ease of soldering.

Ten screws are used to fasten the amplifier unit to its base. These same ten screws act as terminal connections to complete the circuit to the external components. This type of attachment of the amplifier to the terminal base allows a quick change in case of internal trouble, without having to change installed wiring connections. Tubes can be easily replaced from the front of the amplifier while it is mounted.

The cycler is made of plastic in a cylindrical shape with seven slots. In the bottom slot is the Nichrome heater element. The temperature-sensitive cycler element is placed in a slot which gives the desired timing, by determining the minimum burner cycle during mild weather conditions. If this is wound in the slot next to the heater, the cycler will go through its heating period in approximately 30 seconds. With the temperature-sensitive element wound in the top slot, which is the maximum distance from the heater, the approximate timing is 5 minutes. Nominal timing for most burner installations is approximately $3\frac{1}{2}$ minutes to provide completely satisfactory results, this timing being determined by experience on many installations.

Actual results produced with the electronic system indicate that in many cases the temperature within the controlled space varies less than one-fourth degree.



Stamped wiring, ready for placing in grooves of molded plastic chassis. With this, no wires can be omitted or connected wrong

Color Fundamentals

PART I
of a three-part series

By DONALD G. FINK
Editor, ELECTRONICS

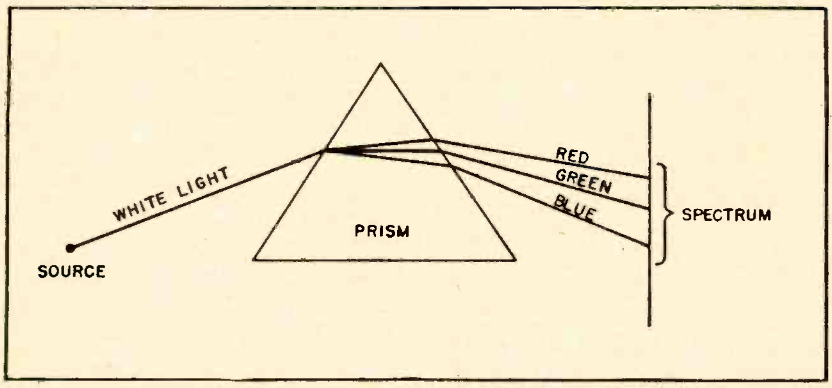


FIG. 1—Physical nature of color, as illustrated by the spectrum formed by passage of white light through a prism. Variation of speed of light in glass causes separation of color components

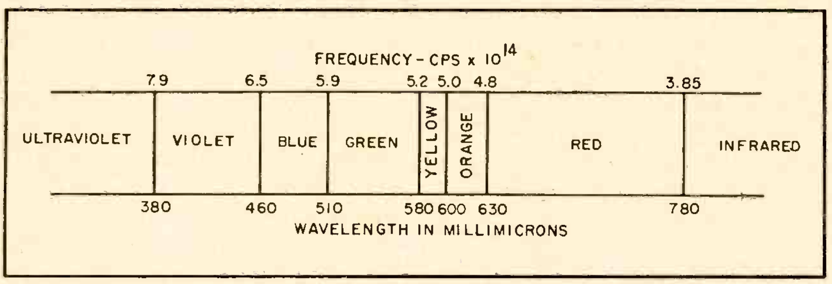


FIG. 2—Relationship between color sensations, frequency and wavelength. Additive primary colors used in tv (red, blue and green) are taken from ends and middle of spectrum

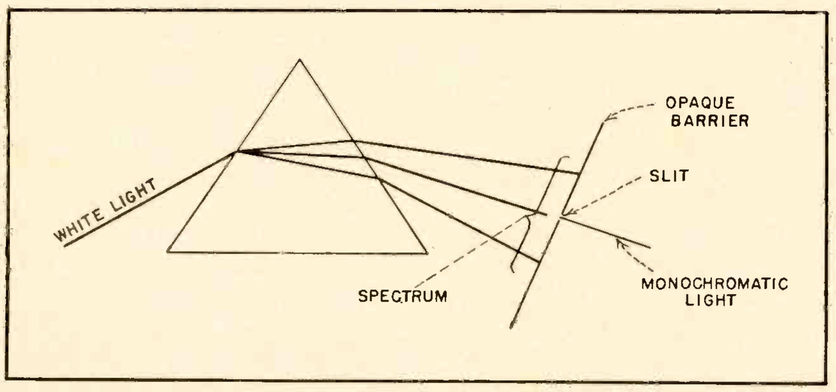


FIG. 3—Monochromatic light is formed by passing a narrow band of the spectrum through a slit in an opaque barrier. Standard I.C.I. monochromatic primary colors occur at wavelengths of 700, 546.1, and 435.8 millimicrons

IT IS COMMON experience that the objects in a scene can be distinguished by characteristics independent of their geometric form. Such distinctions are based on the *color quantities:* brightness, hue, and saturation.

The brightness of the objects is the degree of lightness or darkness exhibited.

The hue is the redness, greenness, yellowness, blueness, and so on, of the objects.

The saturation is a measure of the degree of dilution of the hue by white light.

Since the eye can distinguish (by direct comparison) at least a hundred degrees of brightness, hundreds of hues, and many degrees of saturation, it is evident that the number of distinguishable variations in color, when viewed under suitable conditions, ranges into the tens of thousands. If the color television system were required to reproduce as individual items of information each of these distinguishable color quantities, the rate of transmitting information would be many hundreds of times as great as it is in a black-and-white system of the same resolution and continuity. This follows from the fact that such a system would have to specify, as each picture element is reproduced, not only the brightness of the picture element (as in the black-and-white system) but also its particular hue and its particular saturation. If this method of transmission were mandatory, it is doubtful that television in color would have emerged as a practical reality.

Fortunately, as we shall see in more detail later, the eye perceives color on a relatively simple basis, whereby the hundreds of distinguishable hues and saturations may be represented as combinations of three primary colors. Therefore, it is necessary to specify, as each picture element is reproduced, only the relative brightness of three specified colors, and the rate of transmitting information in a color system is only three times as great as that of a black-and-white system of the same resolution and continuity. This three-to-one increase in the transmission rate, while burdensome, is entirely feasible within the framework of established television technology. Moreover, the color values add so much to the sense of realism that it is worth sacrificing a certain amount of resolution and/or continuity to obtain them.

The exchange of one form of pictorial merit for another is clearly

for TV Engineers

Adoption of field-sequential color system by FCC for commercial broadcasts finds video technicians puzzling over the chromaticity diagram and wrestling with trichromatic coefficients. This series of tutorial articles on color is taken from the forthcoming second edition of "Principles of Television Engineering"

evident when an object, just resolved as such in the image, has a distinctly different color from that of its surroundings. The color distinction then aids the eye greatly to apprehend the presence of the object, and the effective resolution of the reproduced image is visibly enhanced by the addition of color. Such color contrasts have a similar effect in delineating the edges of extended objects, offering a subjective resolution noticeably greater than that of the same image viewed in black-and-white.

The presence of color brings with it severe requirements in other directions. Thus color adds to the realism of a reproduction only if the colors are in themselves reasonably realistic. The eye is accustomed to associate particular colors with certain contexts (a ruddy complexion with good health, pallor with sickness, and so on). If the colors shown are inaccurate, particularly if they have the wrong hue, the result may be so distracting as to make the color of questionable value. In such cases, in fact, the effect of realism may actually be greater in a black-and-white image, on which the mind "paints" the missing hues in accordance with the emotional reaction of the viewer.

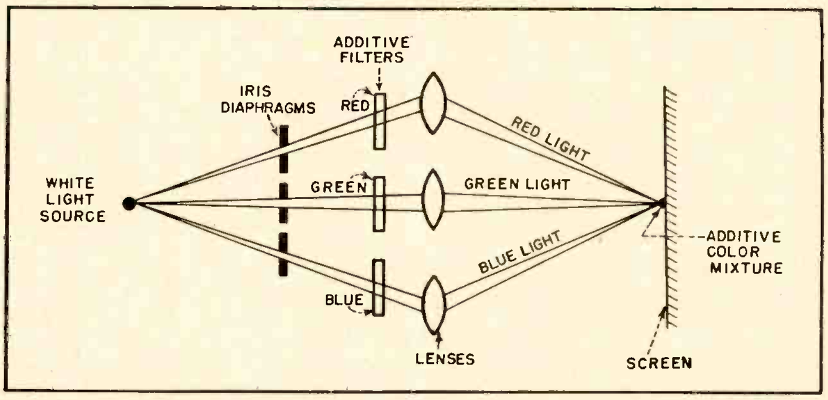


FIG. 5—Additive method of color mixture. Colored beams are formed by passing white light through primary-color filters located side by side, then focused on same area of screen. Variations of this method are used in all color tv systems

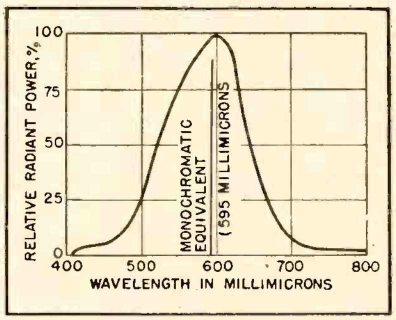


FIG. 4—Spectral distribution curve of an extended (non-monochromatic) color source. The effect of this light on the eye is substantially the same as that of monochromatic light having a wavelength corresponding to the peak of the curve

Physical Nature of Color

The physical nature of color phenomena is conveniently introduced by a description of the spectrum of colors formed by the dispersion of a beam of light. When a beam of white light (sunlight) is passed through a prism (Fig. 1) the beam is separated into a spectrum according to the wavelengths of the radiation. The dispersion of the light results from the fact that light of short wavelength travels slower in glass than does light of longer wavelength.

Inspection of the spectrum reveals that waves of different wavelength display different hues. In order of decreasing wavelength, the hues are red, orange, yellow, green, blue, and violet. If the light source is an incandescent solid, the colors appear to blend one into the next, in continuous fashion. If the light source is a gas or vapor, the spectrum is a discontinuous assemblage of colored lines or bands.

The limits of the visible spectrum are commonly taken as 380 to 780 millimicrons (one millimicron $= 10^{-7}$ centimeter). The range of practical interest is from 400 to 700 millimicrons. Figure 2 shows the relationship between color, frequency and wavelength of the spectrum.

If a narrow portion of the spectrum is passed through a slit (Fig. 3) light of one hue may be separated from the others. Light so separated is known as "monochromatic light". It might be expected that the sensation associated with a given spectral hue could be excited only by monochromatic light so derived from a spectrum. But such is far from the case. The sensation of monochromatic orange, for example, can be caused by viewing a combination of a monochromatic red and a monochromatic yellow.

The technique of securing monochromatic light from a spectrum provides sources of color which can be combined in various intensities. When monochromatic lights are so combined, it is found that a great variety of other colors can be formed. One group of such mixture colors comprises the so-called "desaturated colors", that is colors having a dominant hue mixed with white light. There are also mixtures, which appear to take on simultaneously two hues such as bluish red, greenish yellow and greenish blue.

Thus far we have considered colored lights of the monochromatic type only, obtained by blocking off all but part of a spectrum. It is equally feasible to use sources which radiate an extended distribution of energy with a prominent peak of energy in the visible region. As might be expected, such a source displays a hue which closely approximates the monochromatic hue corresponding to the peak of the spectral distribution curve (Fig. 4). Examples of such sources are glass or colored gelatine filters and phosphors excited by electrons. These extended sources are evidently more easily set up and manipulated than are monochromatic sources. Monochromatic sources are of interest, in fact, only because they provide light whose properties are easily defined and calibrated. Once the calibration is performed, extended sources producing the same sensation may usually be substituted for the monochromatic sources.

Trichromatic Nature of Vision

Early in the study of light it became clear that any given color can be matched very closely by combinations of three primary colors. To match the widest possible range of colors, the primary colors should be chosen in widely separated regions of the spectrum (that is those at the two ends of the spectrum, red and blue, and that at the center, green) and they should be highly saturated (that is, have little or no admixture of white light).

To match colors with primary colors, it is necessary to provide a means of varying the apparent brightness of each primary independently and to combine the three colors so that they cover the same area. Then, by adjusting the relative brightness of the three primaries, it is possible to match a very wide range of hues, with any degree of saturation. By adjusting the absolute level of brightness of the primaries, keeping their proportion unchanged, it is possible to match not only the hue and saturation of a given color, but also its absolute brightness.

The fact that three primary colors suitably combined can match virtually any color is rather difficult to explain on physiological grounds. Consider two monochromatic sources, a red of frequency 4.6×10^{14} cps (wavelength 650 millimicrons) and a yellow of frequency 5.2×10^{14} cps (wavelength 580 millimicrons). On the assumption that the eye reacts in some manner to the frequency of visible radiation, it might be expected either that both colors would be seen, or that the response should bear some relationship to the sum or difference of the two frequencies.

But the fact is that neither color is seen as such. Instead an orange hue appears. If the red and yellow have equal intensities, the orange corresponds to a wavelength of about 600 millimicrons, or a frequency of 5.0×10^{14} cps. The frequency associated with the mixture color, orange, has no observable relationship to the two frequencies of the red and yellow stimuli which excite the sensation. Moreover, as the intensity of the red is varied relative to that of the yellow, the mixture color ranges over the whole range of hues from red to yellow, and the equivalent frequency of the mixture color changes correspondingly, while the frequencies of the sources remain fixed. Evidently, then, the eye is not a frequency-sensitive device.

At present, there has been uncovered no physical demonstration of the seat of the color perception properties of the eye. It is commonly supposed that the retina contains three color receptors associated with each foveal cone in the retina. Each type of receptor responds over a range of wavelengths, but has a peak of response in a particular region of the spectrum that is, there are red-sensitive, green-sensitive and blue-sensitive receptors, each of which passes nerve impulses to the optic nerve. When a monochromatic source is viewed, it excites two (or three) of the receptors having responses at the particular wavelength present, and the resultant nerve impulses are a combination of two (or three) types which induce the sensation corresponding to the monochromatic stimulus. If two monochromatic stimuli are presented in different regions of the spectrum they may excite an identical combination of nerve impulses, and thus create the same sensation. The fact that substantially all monochromatic sensations may be matched by three primary colors is evidence that at least three types of receptors, having overlapping spectral responses, are present.

The physiological mechanism by which the eye perceives color is of little practical importance, since the properties of color vision can be expressed simply in an empirical way. The empirical approach leads to a coherent expression of color values, embodied in the *chromaticity diagram* which expresses color matching problems on a numerical basis.

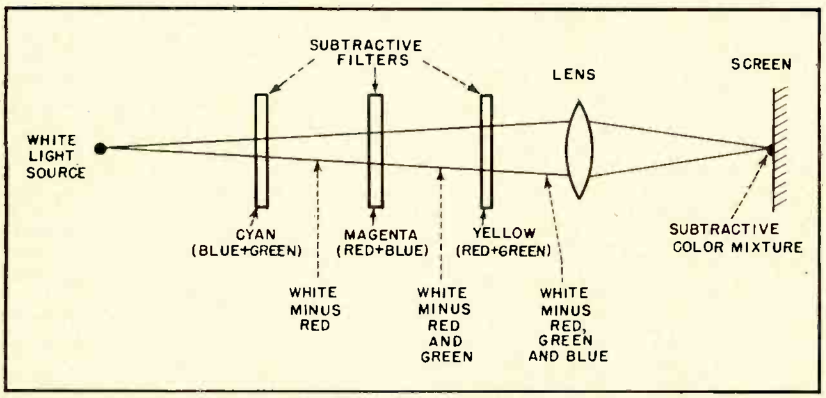


FIG. 6—Subtractive method of color mixture. Beam passes in succession through subtractive filters located on a line. By adjusting absorption of filters, left-over portion of white light can be made to have any required color

The color combinations referred to above may be formed in two different ways, the additive method and the subtractive method. In the additive method, the primary colors exist as separate entities produced by sources (such as spectral slits or filters) located side by side. The colored lights from the three sources fall on the same surface (Fig. 5). It is not essential that the colored lights fall on the surface continuously. If they illuminate the surface in rapid sequence, persistence of vision produces the appearance of simultaneous illumination by all the sources, and the color sensation is the same as if the sources were active continuously.

All color television systems use this additive principle of combining colors. In the simultaneous color television system for example, the three primary-color images exist side by side and are either projected one over another on a viewing screen or are combined in a tricolor screen so that they fall, one superimposed on another, in the retina of the eye. In the sequential color systems, only one primary color is present at any instant of time, but the three primary colors are presented in such rapid sequence that the effect is the same as that of continuous illumination by all colors.

The primary colors used in the additive system of color reproduction are red, green, and blue. These are the hues previously identified as being located at the two ends and at the center of the spectrum. Let us consider first combinations of two primaries. When combined in the additive manner red and green produce the intermediate hues of orange and yellow. Green and blue so combined produce the green-blue hues. Red and blue combined produce the purples.

When the three primaries are combined additively, in appropriate amounts, white light is produced. This white light, if its intensity is less than that of the other light present, appears gray, and the gray so produced may have any intensity.

If the three primaries are combined in unequal proportions, the white light is tinged by the hue of the predominant primary or primaries. In this manner, a particular

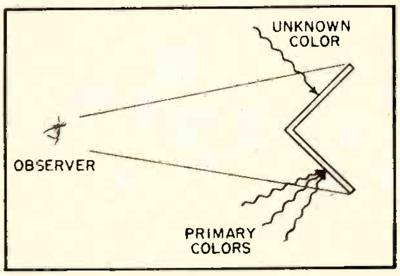


FIG. 7—Essential elements of a simple colorimeter. Light of "unknown" (unspecified) color falls on one surface, while adjustable amounts of primary colors are mixed additively on other surface. By adjusting amounts of primaries, a color match can be obtained. In some cases, one primary must be transferred to unknown side to secure the match

primary hue may become "desaturated" (diluted with white light) by adding appropriate amounts of the other two primaries. Finally a hue intermediate to two primaries may be desaturated by adding an appropriate amount of the third primary.

Additive and Subtractive Color Matching

Those unfamiliar with additive color matching will object that the additive primaries, red, green, and blue, are not the primary colors with which they are familiar. The primary colors which are used in painting and in color printing and photography are the subtractive primaries. As named in common usage, the subtractive primaries are red, blue, and yellow. Actually substractive primary colors are a bluish red ("magenta"), a bluish green ("cyan"), and a greenish yellow ("lemon yellow").

These designations, as well as the appearance of the subtractive primaries, indicate that each is a mixture. The mixture is produced by the process of subtracting a particular hue from white light, leaving the remaining hues of the spectrum which in combination produce the sensation of a complex mixture color. (Fig. 6) Thus the magenta subtractive primary is formed by removing green light from white light. A magenta pigment or dye is, in fact, one which absorbs green light strongly, so that white light passing through it takes on a bluish-red appearance. Similarly, cyan is produced by removing red light from white light and lemon yellow by removing blue light from white light.

Subtractive primaries are combined by placing the pigment, dyes or filters one on top of the other and passing white light through them in succession. A typical example is the Kodachrome photographic transparency.

By so combining the subtractive primaries, it is possible to subtract from white light any portion of the visible spectrum, and leave the equivalent of a spectral hue. By thus manipulating the absorption of hues from white light, the resultant may be made equivalent to any combination of spectral hues, and the whole range of hues and saturations may be matched, substantially as if additive primaries had been used.

What, then, is the relative advantage of the additive versus the substractive process of color reproduction?

The choice depends on the manner in which the primary colors are produced. If the three primary color sources are self-luminous, and exist as separate entities and hence can be combined only by adding one to another, (Fig. 5) the additive system must be used to match the full gamut of colors. But if the three primaries are formed by passing white light in succession through three layers of colored material, one on top of the other, (Fig. 6) the materials absorbing part of the spectrum as the light passes through them, then the subtractive primaries must be used to match the full gamut of colors.

The outstanding example of the additive type of color reproduction is that performed in color television receivers, in which the primaries are self-luminous and separate. Examples of the subtractive method are painting, color printing and color photography, in which superimposed layers of dye or pigment are traversed in succession by white light, and in which the unabsorbed portion of the white light affects the retina of the eye.

An additive primary color filter absorbs from white light passing through it all the light but that of the primary. The subtractive filter is the complement of the corresponding additive filter, that is, the subtractive filter absorbs the energy which the primary filter passes. For example, the additive red filter absorbs blue and green, passing red. The subtractive cyan filter absorbs only red, passing blue and green. In general, therefore, the absorption of subtractive filters is lower than that of the additive filters. Hence, for a given amount of white light the subtractive process produces a somewhat brighter color reproduction, and this would weigh in its favor for color television. Unfortunately this fact is overruled by the mechanics of the reproduction process which require the additive process to be used whenever the primary images are separate, self-luminous entities as they are in present-day color television receivers.

Henceforth we shall confine our attention to the additive primaries and the additive method of color matching.

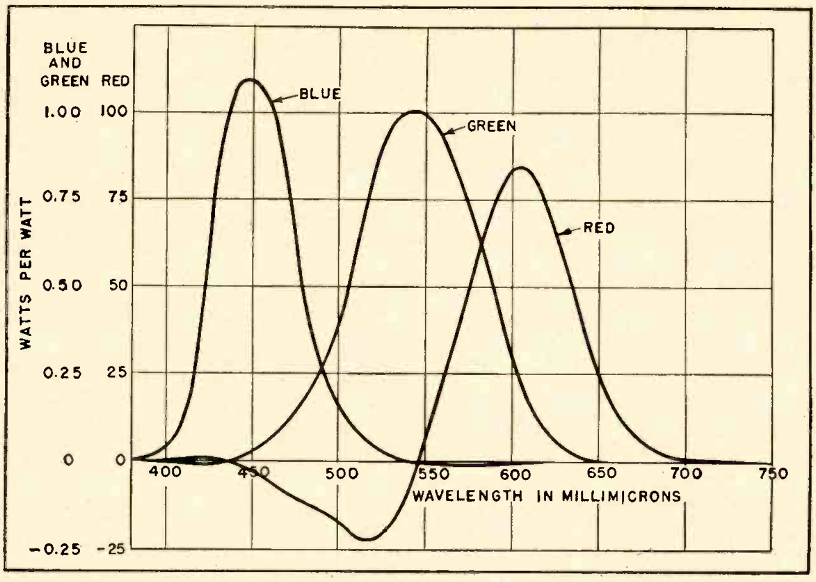


FIG. 8—Color mixture data representing the I.C.I. standard observer, showing relative amounts of I.C.I. spectral primaries which must be added or subtracted in colorimeter to match each color in the spectrum

The Trichromatic System

We proceed to the numerical specification of color quantities. These specifications are quantitative indices of hue and saturation which define the color filters and light sources used at the transmitter and receiver of a color television system. The basis of the specification is the chromaticity diagram, which provides not only an elegant basis of visualizing the relationships of different hues and saturations but also a figure which bounds the gamut of colors which can be matched by a given set of primary colors.

The numerical specifications of a color comprise values representative of its brightness, its hue and its saturation. It is convenient to perform the computations on a basis independent of the brightness, thus removing one of the variables from the equations. This computational device is permissible because the match between the three primary colors and the matched color is preserved when the brightness of each color is multiplied by the same factor.

Since the subjective reactions of observers to colors vary widely among individuals, it is necessary to make measurements with a number of observers and to adopt as a standard the mean values of the quantities observed. The results of such tests, conducted by Guild and Wright, were adopted in 1931 by the International Commission on Illumination (I.C.I., sometimes referred to as the Commission Internationale de l'Eclairage, C.I.E.) as the basis of the so-called I.C.I. System of Color Specification.

In the I.C.I. system, the red, green and blue primaries are defined as monochromatic light of the wavelengths 700, 546.1 and 435.8 millimicrons, respectively. The green and blue primaries are prominent lines in the spectrum of the mercury arc and hence are readily and precisely reproducible. The red primary is not critical as to wavelength, since the hue in this region of the spectrum remains sensibly constant over an appreciable range of wavelengths.

Taking these primaries as light sources, and combining them in a colorimeter, (Fig. 7) it is possible to determine the relative amount of light flux (lumens) of each primary which must be combined in a mixture to match a given number of lumens of each hue in the spectrum. These measurements are repeated for a large number of observers and average values are taken as representative of the "I.C.I. Standard Observer". These standard values are plotted in the three curves of Fig. 8. It will be noted that the amount of the red primary must be greater, by a factor of nearly 100, than the blue and green, because the luminosity of the red primary is small. At the wavelength corresponding to one of the standard primaries, the amount of the other two required for a match must necessarily be zero, as is indicated in the illustration.

One striking fact is that negative amounts of the primaries are shown in Fig. 8, in the region from 450 to 550 millimicrons for example. Since a negative amount of light evidently has no physical significance, the color match is interpreted as follows: It is not possible to match the spectral hues in this region, using the standard primaries, unless the red primary is subtracted from the other primaries. In other words the spectral hue to be matched is added to the amount of red light indicated below the zero axis. This mixture color matches the combination of the amounts of green and blue indicated for that wavelength above the zero axis. Similarly, whenever negative values are shown in Fig. 8, they represent the amount of primary color which must be added to the spectral hue of a given wavelength to match the indicated positive amounts of the other two primaries at that wavelength.

Since any color can thus be matched by combining appropriate amounts of the spectral hues, Fig. 8 contains information required to determine the amounts of the standard primaries required to match any color. But these curves give no evident indication of the interrelationships among the primaries, the spectral hues and the various saturations of mixture colors. These relationships can be explicitly indicated if the information in Fig. 8 is transformed and related to a standard white light which contains equal amounts of the three primaries. The result is the chromaticity diagram.

There are two forms of the chromaticity diagram. The first, the so-called RGB diagram, is more readily understood in terms of the concepts just advanced, but has the disadvantage that certain spectral and other highly saturated colors have negative values. This may lead to confusion if the negative sign is omitted. The second type, known as the XYZ diagram, is a linear transformation of the first. The transformation replaces the negative values with corresponding positive values of a different set of variables.

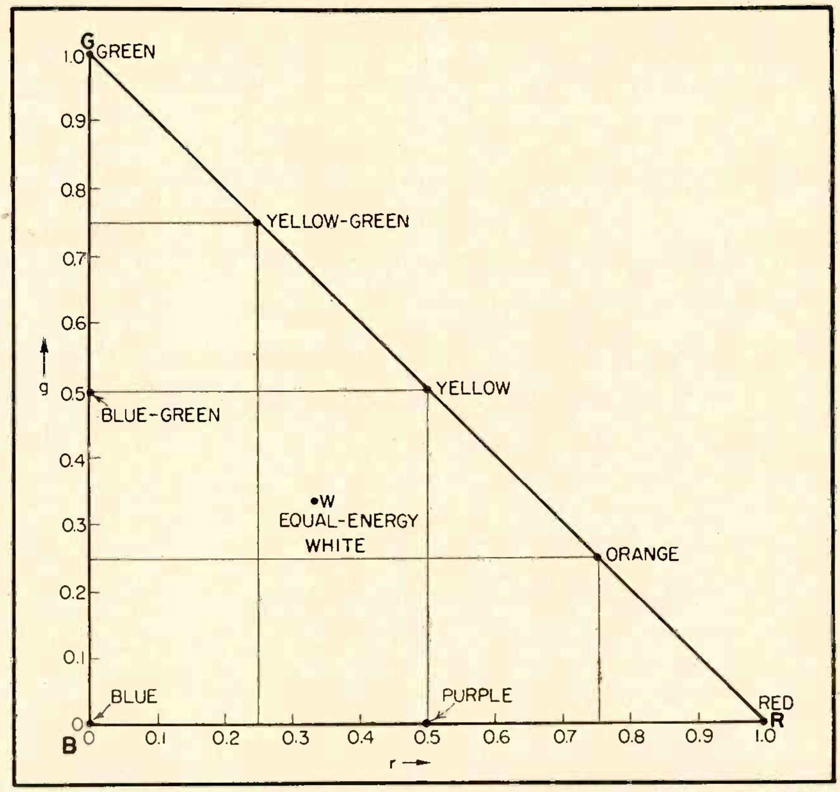


FIG. 9—A numerical basis for color matching is established by the RGB chromaticity diagram. Use of the triangle is detailed in Part II of this series

The RGB Chromaticity Diagram

The RGB chromaticity diagram is based on a particular color match, that between selected primaries (as in the standard I.C.I. spectral primaries) and a standard "equal-energy" white. This white is produced by combining all the hues of an equal-energy spectrum, that is, one in which the energy present in each wavelength is the same throughout the visible region.

In performing the match between the standard primaries and the equal-energy white, one half the visual field of a colorimeter (Fig. 7) is illuminated, with l_w lumens of equal-energy white light. The amount of the selected standard primaries falling on the other half of the field is adjusted until a match is obtained, and it is found that l_{rw} lumens of red light, l_{gw} lumens of green and l_{bw} of blue are required to match the white light. The white light is then removed and the "unknown" color, whose numerical specification is desired, is substituted. The flux of this color is taken as $l_c = l_w$ lumens. It is found that l_{rc} lumens of the red primary, l_{gc} of the green, and l_{bc} of the blue are required to match the unknown color.

We then define the following quantities as describing the unknown color

$$r = \frac{l_{rc}/l_{rw}}{l_{rc}/l_{rw} + l_{gc}/l_{gw} + l_{bc}/l_{bw}} \quad (1)$$

$$g = \frac{l_{gc}/l_{gw}}{l_{rc}/l_{rw} + l_{gc}/l_{gw} + l_{bc}/l_{bw}} \quad (2)$$

$$b = \frac{l_{bc}/l_{bw}}{l_{rc}/l_{rw} + l_{gc}/l_{gw} + l_{bc}/l_{bw}} \quad (3)$$

The quantities r, g, and b, plotted in rectangular coordinates, constitute the chromaticity diagram.

Inspection of Eq. 1 to 3 shows that

$$r + g + b = 1, \quad (4)$$

so it is necessary to plot only the values of r and g, in a two-dimensional plot.

We note that the quantities r, g, and b are independent of the actual numbers of lumens involved in the colorimeter, since they are defined as a ratio of the ratios l_{rc}/l_{rw}, etc. The chromaticity diagram is, therefore, independent of the brightness of the colors, and indicates only hue and saturation.

The RGB chromaticity diagram (the plot of r versus g) is shown in Fig. 9. We can locate certain colors on the diagram as follows: The green primary evidently is matched by l_{gc} only, that is, $l_{rc} = 0$, $l_{bc} = 0$. So, by Eq. 1 to 3, $g = 1$, $r = 0$. Similarly for the red primary $r = 1$, $g = 0$, and for the blue primary $r = 0$, $g = 0$.

We can also locate the point corresponding to the equal-energy reference white on which the colorimeter measurements are based. For this color, the subscript c evidently has the same meaning as w so $l_{rc} = l_{rw}$; $l_{gc} = l_{gw}$; $l_{bc} = l_{bw}$, provided $l_c = l_w$ as has been assumed. Then all the ratios in Eq. 1 to 3 are unity and $r = 0.333$, $g = 0.333$, $b = 0.333$. This point, identified as W on the diagram, represents the equal-energy white. It occupies the center of gravity of the triangle, that is, the point on which a flat plate of uniform density having the triangular shape *RGB* would balance.

The central location of the equal-energy-white point gives the clue to the distribution of other colors within the triangle. As a point recedes from the edge of the triangle and approaches point W, the corresponding color becomes increasingly diluted with white light, that is, the color becomes less saturated.

Mixer Crystal Checker

Quickly determines sensitivity loss of silicon crystals used in first stage of microwave radar or communications receiver, with accuracy comparable to that of more complex laboratory test setups. Basis of design is newly developed theory that minimum conversion loss can be predicted from static voltage-current curve of crystal

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Using new d-c crystal checker to choose crystals for use in microwave measuring equipment in background

THE SENSITIVITY of a microwave radar or communications receiver is limited chiefly by the noise generated in its first stage and by signal losses which occur prior to amplification. The first stage of most microwave receivers is a crystal mixer; therefore, determining the quality of the mixer crystal from the standpoint of excess noise and signal loss is the most important check to be made in maintaining optimum sensitivity of the receiver.

Unless proper equipment is available for routine tests, appreciable deterioration in crystal sensitivity may go undetected. The reason is that the noise output of the receiver changes little, if any, due to crystal burnout. Usually, the only evidence of crystal burnout is a reduction in maximum range of a radar set or a reduction in signal-to-noise ratio in other types of receivers. During routine operation, it is difficult to detect deteriorations in either of these parameters.

Instruments for detecting and determining the extent of the loss of sensitivity due to crystal burnout are of two general types. There are laboratory types, such as the standard-signal generator and the noise generator, with which noise figure measurements can be made. From noise figure measurements, crystal quality can be deduced, since the crystal is the chief contributor to the noise figure and the other contributing components are seldom subject to deterioration. There are also field types, such as the echo box with which overall radar system efficiency checks can

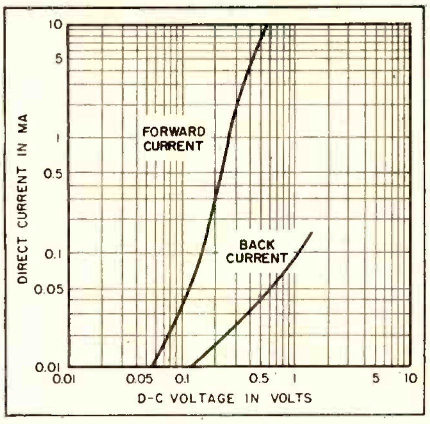

FIG. 1—Static voltage-current characteristic of typical silicon mixer crystal

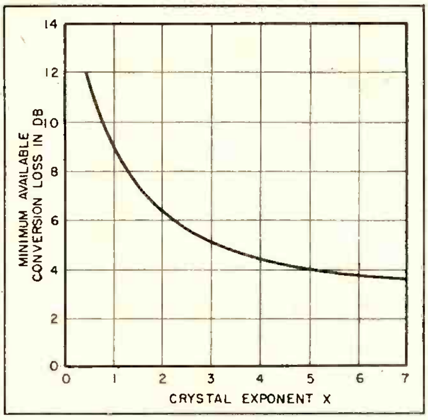

FIG. 2—Minimum available conversion loss as function of exponent X

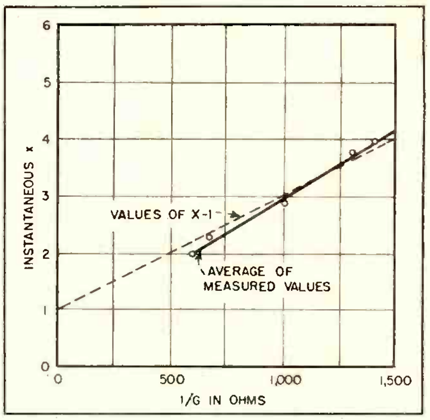

FIG. 3—Variation of instantaneous X with $1/G$ when X is constant

be made, and the d-c crystal checker of the type measuring front-to-back resistance ratio and back current. This last type of test set, officially designated TS-268/U, has achieved widespread use even though its ability to determine the quality of a crystal is limited to an approximate indication of whether the crystal is good or bad. Design was based on an experimentally determined approximate correlation between its indications and measured values of conversion loss and noise temperature. The tolerance on the certainty of good-bad indication was found to be approximately $\pm$ 2 db and virtually no correlation was found for slightly damaged crystals.[1]

The crystal checker to be described here is designed for field use to give accurate indications of crystal quality. The basis for design is a recently developed theory with which the minimum conversion loss available from a crystal can be predicted from the static voltage-current curve of the crystal.[2]

Theoretical Background

Theoretically, the quality of a crystal as a mixer is dependent primarily on the degree of nonlinearity of the forward portion of its E-I curve and not to an appreciable extent on the front-to-back resistance ratio or back current. Figure 1 shows the E-I curve of a typical mixer crystal plotted on logarithmic coordinates. It is seen that the forward portion of the curve can be closely approximated by a straight line over any 10-to-1 range of current between the limits of 0.05 and 5 ma, which is the region of most interest for mixer calculations. At the same time, the back current is negligibly small compared to the forward current. Such an E-I characteristic can be represented mathematically by the expressions

$$i = ke^X \quad (e > 0) \qquad (1)$$

$$i = 0 \quad (e < 0) \qquad (2)$$

where i is instantaneous current, k is a constant, e is instantaneous voltage, and X is the time average of the slope, $d(\log i)/d(\log e)$, of the forward portion of Fig. 1 for the particular operating conditions. The magnitude of X is somewhat variable with d-c bias or with a nonsinusoidal local-oscillator voltage wave. However, for the excitation conditions usually met in practice, such as 0.5 to 1.0 mw applied local-oscillator power from a sinusoidal source and negligible d-c bias, X is usually between 2 and 3 for acceptable crystals.

From a harmonic analysis of the conductance pulses which occur when the crystal described in Eq. 1 and 2 is excited by a local oscillator, it was possible to calculate the minimum conversion loss available from a particular crystal. It was found that the minimum available conversion loss is a function of X only. The relation between minimum available conversion loss and X is shown in the curve of Fig. 2. This curve and the other pertinent points of the theory from which the curve was calculated have been verified experimentally.

The crystal checker described here gives an indication proportional to the parameter X.

To show how a d-c measurement can be made to give indications of X, it is necessary to go a little further into the theory.

At any point on the E-I curve of the crystal the small-signal conductance is defined as the slope di/de of the curve and the large-signal conductance is defined as the ratio i/e. In terms of the characteristic of Eq. 1 the small-signal conductance is

$$g = \frac{di}{de} = k\,x\,e^{x-1} \quad (e > o) \qquad (3)$$

and the large-signal conductance is

$$G = \frac{i}{e} = k\,e^{x-1} \quad (e > o) \qquad (4)$$

where x has been used instead of X to indicate that actual instantaneous values of g or G are determined by instantaneous values of the exponent x instead of time-average values.

Although it was found theoretically that the minimum conversion loss available from a crystal is dependent on X, it was necessary to determine experimentally a relation between an easily measured d-c quantity and X. From a study of a large number of crystals, a close approximate relation was found between the shape of the E-I curve in the vicinity of 100 microamperes and the value of X which is obtained for conditions of zero bias and 0.5 ma rectified current due to local-oscillator excitation.

In Fig. 3 is shown the relation between instantaneous x and instantaneous large-signal conductance for six crystals having approximately equal values of X. The relation is seen to be nearly linear;

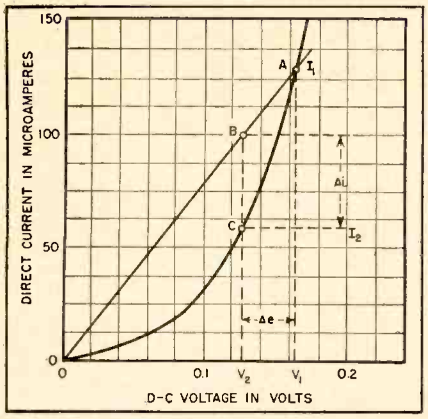

FIG. 4—Method of making d-c measurement of average value *X*

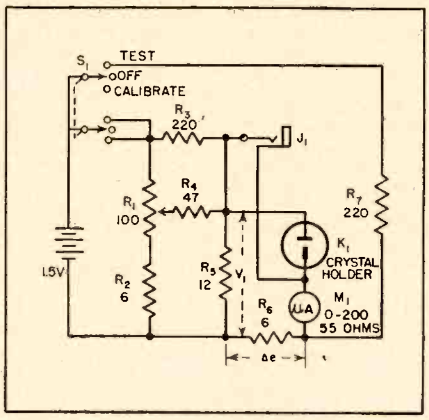

FIG. 5—Arrangement of components in d-c crystal checker

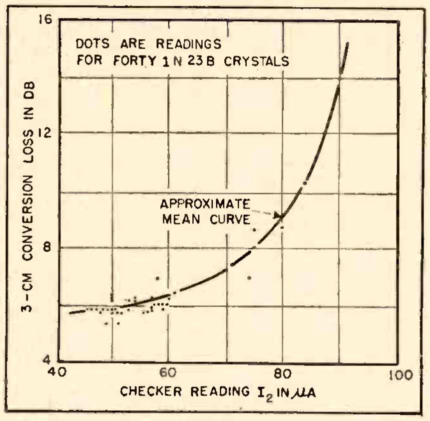

FIG. 6—Correlation of checker with measured 3-cm conversion loss

also, it is seen that, from the dashed line representing $(x-1)$ proportional to $1/G$, one would predict somewhat higher values of X for high-conductance crystals than the data indicates and vice-versa for low-conductance crystals. This discrepancy is in the direction to account for the effect of finite back conductance of crystals. That is, for high-conductance crystals the increase of conversion loss due to back conductance is less than for low-conductance crystals. As is evident from the experimental data showing the accuracy of the tester, the compensation is approximately correct. It may, therefore, be stated that $(x-1)G$ at 100 microamperes is approximately proportional to the value of X obtained with finite back conductance.

With reference to Fig. 4, it can be shown that a simple d-c measurement can be made that gives indications proportional to $(x-1)G$ and hence to X.

D-C Measurement Technique

Reference to Eq. 3 and 4 shows that

$$(x-1)\,G = g - G \tag{5}$$

The checker was designed to give an indication of current proportional to this difference.

An incremental change in d-c voltage is used to measure g approximately, and an initial adjustment is made to indicate G and simultaneously subtract it from g.

For all crystals, the voltage increment $\Delta e = V_1 - V_2$ is maintained constant. The voltage V_1 is made adjustable and is initially set to give a crystal current I_1. By calibration of the network used to adjust V_1 the current I_1 is established for any linear resistance between 300 and 3,000 ohms such that when the negative voltage increment $-\Delta e$ is added to V_1 the current at point B in Fig. 4 will be 100 microamperes. This type of adjustment establishes a relation between I_1 and G; therefore, the calibration of the network for adjusting V_1 could be made to indicate G directly. In the figure, the large-signal conductance is

$$G = \frac{I_1 - (I_2 + \Delta i)}{\Delta e} \tag{6}$$

which is the slope of the line AB. However, in an actual test, the magnitude of G is unimportant and the network is calibrated only in microamperes indicating I_1.

For a nonlinear conductance such as a mixer crystal, the current indicated for the voltage V_2 will be less than 100 microamperes by an amount Δi, which can be shown to be approximately proportional to $g - G$. The slope of the E-I curve at point A is exactly g; however, the slope defined by points A and C is a reasonably good approximation. Therefore, the approximate expression for small-signal conductance is

$$g \cong \frac{I_1 - I_2}{\Delta e} \tag{7}$$

It therefore follows that

$$g - G \cong \frac{\Delta i}{\Delta e} \tag{8}$$

Since Δe is a constant and $(g-G)$ is proportional to X, it is seen that Δi is proportional to X. Since the current at point B is 100 microamperes for all crystals, it is seen that I_2 is a direct indication of Δi. The current I_2 may, therefore, be calibrated directly in X or minimum available conversion loss.

No attempt was made to analyze theoretically the probable errors of indication caused by the approximations involved in the theoretical basis for the measurement. The experimental verification showed that the errors are small from this source. The maximum errors encountered were only of the order to be expected in comparing two methods of measuring conversion loss when one method is subject to errors due to the use of a fixed-tuned, fixed-adjustment mixer such as the production-testing type of conversion-loss test set.

Operation of Checker

The circuit of the crystal checker is given in Fig. 5. The initial adjustment to voltage V_1 is made by varying potentiometer R_1 with switch S_1 in the CALIBRATE position. Resistors R_2, R_3, R_4 and R_5 merely set the limits to which V_1 can be adjusted.

The calibration of the scale of R_1 is carried out in the following manner:

(1) Linear resistors between 300 and 3,000 ohms are placed in crystal holder K_1.

(2) With switch S_1 in the TEST position, R_1 is adjusted for each resistor until meter M_1 indicates 100 microamperes (point B in Fig. 4).

(3) Switch S_1 is then placed in the CALIBRATE position and the current indicated on M_1 is marked directly under the pointer of R_1 (point A in Fig. 4.)

(4) When enough resistors have been used to indicate the calibration law, a complete scale can be interpolated.

The voltage increment Δe is established by resistors R_6 and R_7 when S_1 is placed in the TEST position and has the same value for all crystals.

When a crystal is to be tested, it is placed in K_1 with the usual precautions about static discharges and other types of accidental crystal burnout. Switch S_1 is placed in the CALIBRATE position and R_1 is adjusted until the indication on M_1 coincides with the calibrated scale reading of R_1.

This initial adjustment establishes point A of Fig. 4. Switch S_1 is then placed in the TEST position, which establishes the voltage of V_2 or point C of Fig. 4. The indicated current, I_2, is then a measure of X as shown above and, therefore, is a measure of minimum available conversion loss.

Crystal Checker Accuracy

A group of 88 type 1N21B crystals and a group of 40 type 1N23B crystals were used in tests to determine the accuracy of the d-c crystal checker, using production-testing types of conversion loss and noise temperature test sets as standards. The 1N21B crystals were tested on a 10-cm conversion-loss test set and a 30-mc noise temperature test set. The 1N23B crystals were tested on a 3-cm conversion-loss test set. No noise temperature measurements were made on the 1N23B crystals.

If it is considered that the checker is a device that actually measures conversion loss, the data can be analyzed to determine the mean and maximum deviations between the checker indications and the conversion loss standards. On this basis, the 1N21B crystals showed a mean deviation of 0.3 db and a maximum deviation of 1.0 db for 19 units of manufacturer A, 0.3 db and 0.7 db respectively for 25 units of manufacturer B, and 0.3 db and 1.1 db respectively for 44 units of manufacturer C. For the 40 1N23B crystals, the products of three manufacturers were considered together, giving a mean deviation of 0.2 db and a maximum deviation of 1.0 db. The data for the 1N23B crystal are plotted in Fig. 6 to show the correlation with the mean calibration curve.

On the other hand, the checker can be compared with the TS-268/U checker which gives an accept-reject indication. In this case, it should be evaluated on the same basis as the TS-268/U. The procedure to be followed, then, is logically that used in the original evaluation of the TS-268/U.

The criterion used in the evaluation of the TS-268/U was overall receiver noise figure, using an assumed noise figure of 5 db for the i-f amplifier. The noise figure limit for the 1N21B crystals was determined from the JAN limits of 6.5 db for conversion loss and 2.0 for noise temperature, plus the JAN allowed tolerances of 0.5 db for conversion loss and 0.5 for noise temperature. The data for the 1N23B crystals are insufficient for an evaluation using noise figure as a criterion; however, a similar evaluation was made based on the JAN conversion loss limit of 6.5 db plus a 0.5-db tolerance.

Table I—Data Indicating Reliability of Crystal Checker Based on JAN Test Limit Plus JAN Tolerance

Type	Number Tested	False Acceptances	False Rejections	Mean Error of False Acceptances (db)	Maximum Error of False Acceptances (db)
1N21B	88	2	1	0.5	0.5
1N23B	40	0	1	....	....
Totals	128	1.6%	1.6%	0.5	0.5

Table II—Comparison of Reliabilities of New Crystal Checker and TS-268/U, Based on JAN Test Limit Plus JAN Tolerance

	TS-268/U	New checker
Number tested	600	128
False acceptances, %	2.2	1.6
False rejections, %	12.6	1.6
Mean error in noise figure of false acceptances, db	0.8	0.5
Maximum error in noise figure of false acceptances, db	2.1	0.5

Table I shows the accept-reject evaluation of the checker for 1N21B and 1N23B crystals. In Table II, a direct comparison is made of the errors of the two checkers on the accept-reject basis. It is seen that the new checker is the more accurate by a significant margin.

These tests indicate good accuracy of the new checker with respect to the production test equipment; however, it should be pointed out that the conversion-loss test equipment has a theoretical error ranging from 0 db to about 0.5 db due to differences in impedance from crystal to crystal and separate from mismatch loss. Furthermore, the conversion loss in decibels is read on a meter scale on which 1 db occupies less than 0.2 inch. Errors in reading such a scale are of the order of ±0.1 db. With possible errors of this magnitude, it is apparent that the accuracy of the d-c crystal checker is comparable with that of the production test equipment.

The accuracy and simplicity of operation of the checker make it a valuable aid in maintaining optimum performance of any microwave receiver or other equipment using mixer crystals.

REFERENCES

(1) H. C. Torrey and C. A. Whitmer, "Crystal Rectifiers," Vol. 15, p 297, Radiation Laboratory Series, McGraw-Hill Book Co., 1948.

(2) J. C. Greene, J. W. Kearney and P. D. Strum, Mathematical Theory and Applications of Silicon Crystals for Mixing and Harmonic Generation at Microwave Frequencies, unpublished paper presented at 1950 IRE National Convention.

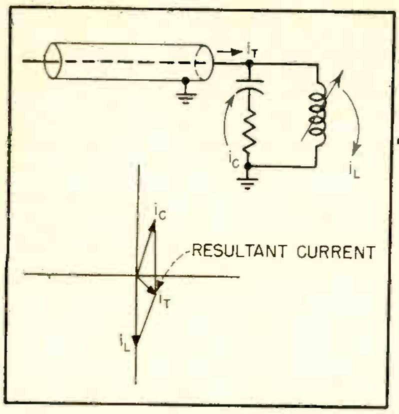

FIG. 1—Load-tuning scheme, consisting of partially parallel-tuning the dielectric load with shunt inductance to increase the apparent load impedance

Load-Matching

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MOST DIELECTRIC-HEATING applications that require 10 kw or more of power need a transmission line to connect the generator to the load because, unlike smaller r-f heating applications, it is not always possible to locate the load adjacent to the generator.

With dielectric loads, the effective series resistance of the load may be only a fraction of an ohm. Matching such a load to a 50-ohm line, for example, means a high ratio of transformation. This makes the load-matching circuit complicated and extremely critical, a serious problem for both the generator manufacturer and the user.

Load tuning can be simplified by assuming that it is not necessary to match the load to the transmission line. Since lines rarely exceed a quarter wave in length, losses due to standing waves on the line can be minimized by using a transmission line designed specifically for such use. Most r-f generators are more suitable for coupling into loads having resistance considerably less than the surge impedance of an average line, so it is impractical to transform the low resistance of the load into an apparent high resistance to match the transmission line.

A conventional load-matching system, by matching the transmission line, reflects zero reactance into the r-f generator. With the proposed method, however, no attempt is made to reflect pure resistance into the tank circuit of the generator. It is not important to have the generator operating on a fixed frequency. Reflection of some reactance into the tank circuit merely changes the oscillator frequency. Radiation affecting other services must, of course, be suppressed, but this does not necessarily require constant generator frequency.

Basic Theory

In the field of dielectric heating, where electromagnetic radiation must be suppressed to avoid radio interference, a coaxial line is generally used, and it usually consists of a rectangular duct and an inner conductor which is supported by insulators. The inner conductor may be any shape, and is not necessarily centrally located.

General transmission line equations are derived from analysis of a two-parallel-conductor line. Assuming that the transmission line has no losses does not introduce an appreciable error. For such lines the general steady-state equations are:

$$E_S = E_R \left(\cos\alpha + j\,\frac{R_c}{Z_R}\sin\alpha\right) \qquad (1)$$

$$I_S = \frac{E_R}{Z_R}\left(\cos\alpha + j\,\frac{Z_R}{R_c}\sin\alpha\right) \qquad (2)$$

$$Z_S = \frac{R_c\,(Z_R + j\,R_c \tan\alpha)}{R_c + j\tan\alpha} = \frac{E_S}{I_S} \qquad (3)$$

where

Z_S = sending-end impedance
R_c = surge impedance of the line = $\sqrt{L/C}$
Z_R = receiving-end impedance
E_S = rms sending-end voltage
I_S = rms sending-end current
E_R = rms receiving-end voltage
α = electrical length of the line in degrees

$$= \frac{\text{length of line}}{\text{wavelength}} \times 360 \text{ degrees}$$

In Eq. 3, if the receiving-end impedance is equal to the surge impedance of the line in magnitude and phase, that part of the equation enclosed by the parentheses becomes unity and the sending-end impedance is equal to the surge impedance of the line which is pure resistance at radio frequencies. Under these conditions the load is said to be matched to the line, the voltage and current on the line being constant and in phase everywhere along the line.

In the case of imperfect lines, the voltage and current will fall off in the direction of the receiving end, the rate of attenuation being a function of the conductor size and configuration. In dielectric heating work, attenuation is of little concern since the lines are relatively short and generally have very low losses.

From Eq. 3, if the line is less than a quarter wave in length and short-circuited at the receiving end, the line looks like an inductance and the reactance is given by

$$X_L = j\,Rc\tan\alpha \qquad (4)$$

Likewise, if the line is less than a quarter wave in length and is open-circuited, the line looks capacitive.

$$X_c = -\,j\,Rc\cot\alpha \qquad (5)$$

One other important characteristic of transmission lines is the property of load impedance transformation. A high-impedance load at the end of a quarter-wave line appears as a low-impedance load at the other end.

Rewriting Eq. 3,

$$Z_S = \frac{R_c\left(\cos\alpha + j\,{}_{Z_R}\sin\alpha\right)}{\frac{R_c}{Z_R}\cos\alpha + j\sin\alpha} \qquad (6)$$

For a quarter-wave line,

$$Z_S = \frac{R_c^2}{Z_R} \qquad (7)$$

Load-Tuning

The matching scheme consists of partially parallel-tuning the dielectric load with shunt inductance to increase the apparent load imped-

Dielectric Heaters

Increased efficiency is accomplished when transmission lines coupling radio-frequency generators to loads in dielectric-heating applications are used as part of the load tuning system to simplify problems of load matching

ance, as in Fig. 1. The parallel-tuned circuit is connected to the receiving end of the transmission line, terminating the line as close to the load electrode as possible.

The reason for increasing the apparent load impedance by partial tuning is that, in general, if a load is such as to require 20, 50 or 100 kw of r-f power, the dielectric load impedance is generally quite small. Such a low-impedance load at the end of the transmission line would require a sending-end voltage greater than the receiving voltage unless the line is extremely short, so that the transmission-line effect can be neglected.

In addition, the line current at the receiving end would be extremely high. When standing waves occur on transmission lines, the voltage and current maxima are displaced by 90 degrees along the line; high voltage and high current cannot appear at the same point on a transmission line. Since the high voltage is desired at the end of the line, conditions must be such as to satisfy this phenomenon.

Equation 1 shows that the receiving-end voltage E_R is a function of receiving-end impedance, assuming R_c, E_S, and line length constant. With this method, almost any load may be properly coupled to the generator merely by partially parallel-tuning it to increase the apparent load impedance at the end of the line and selecting the proper length of line to use. Experience shows that the majority of loads can be properly handled with a transmission line between $\frac{1}{8}$ and $\frac{1}{4}$ wavelength.

The effective impedance of the parallel circuit will depend on the load reactance and power factor. This indicates that very high capacitance loads cannot be made to present very high impedance to the transmission line; therefore, the receiving end voltage will be correspondingly lower. A high-capacitance load has large electrode area so that less electrode voltage is needed to obtain a given power. However, it is usually possible to increase the air gap between the dielectric material and the top electrode to obtain higher effective load reactance. By this means it is possible to parallel-tune the load to a higher impedance.

Use of Resonance Curve

Figure 2 is the resonance curve of a typical dielectric load of high capacitance and low power factor, encountered in the frequency range of 5 to 30 mc. This curve illustrates the importance of plotting a curve before deciding what effective load impedance can be obtained by parallel tuning.

High-Q loads narrow down the operating range and in operation the load electrode voltage may change rapidly with change of load capacitance. In the case of low-Q loads, the opposite is generally true. The magnitude of the apparent load reactance and effective series resistance is dependent on the magnitude of the dielectric load reactance and effective series resistance. For this reason, very high capacitance,

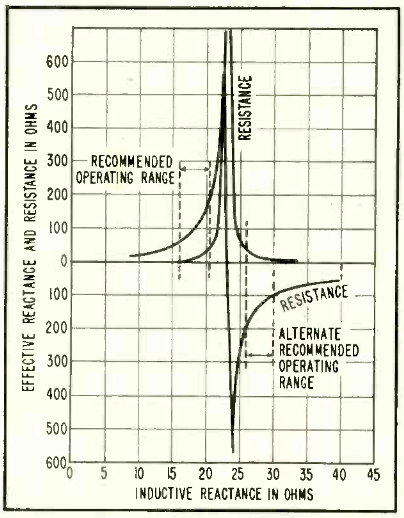


FIG. 2 — Parallel-resonance curve of fixed dielectric load of 0.46 —j23 ohms, parallel tuned with variable inductance and frequency assumed constant

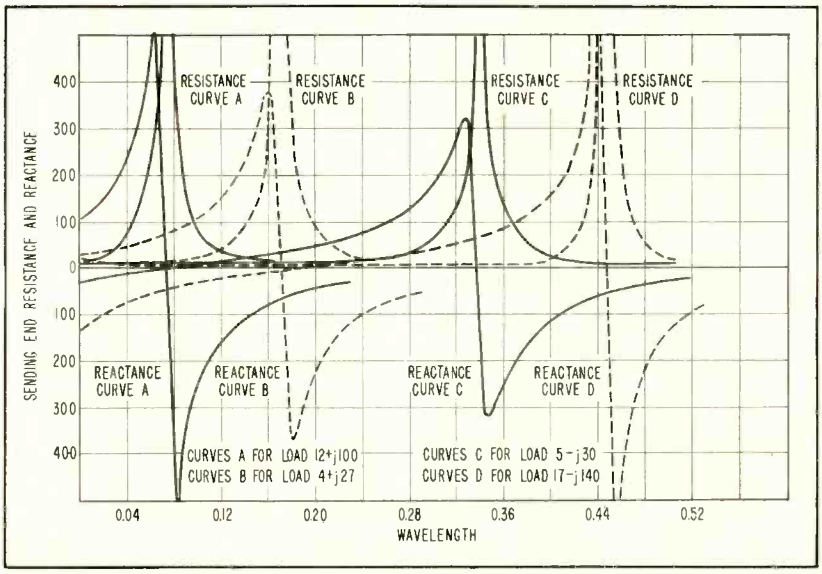


FIG. 3—Sending-end resistance and reactance plotted against transmission line length with a 50-ohm line

low-power-factor loads are more difficult to work with.

The resonance curve of Fig. 2 has two recommended operating regions marked by dashed vertical lines. Operation must be sufficiently up on the curve to result in an appreciable increase in the apparent, or effective load impedance. It must be far enough away from resonance to avoid possible frequency instability and erratic operation.

The particular application dictates the choice of the side of resonance on which to operate, provided it is possible to use a transmission line of the desired length.

If the length of the transmission line is fixed by conditions other than load-tuning requirements, the length of the line may be such that tuning on either capacitive or inductive side of resonance is no longer a matter of choice but of necessity.

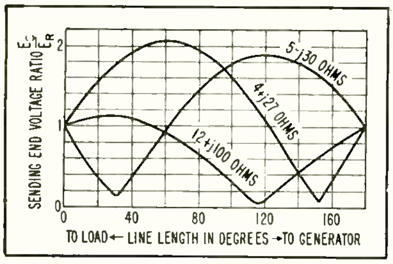


FIG. 4—Plot of voltage on the transmission line

For example, with an effective high-impedance inductive load at the end of a short line, the receiving-end impedance may be extremely high. The short section of the line in effect parallel tunes the load. In this case it generally will be difficult to couple such a load to the generator properly. Under such a condition, it will be more desirable to tune the load circuit on the capacitive side of resonance.

Sending-End Impedance

After the effective load is selected from the resonance curve, the sending-end impedance of the line may be plotted against the length of line.

Figure 3 is a plot of sending-end resistance and reactance versus transmission-line length for high and low inductive and capacitive reactance loads. The high inductive and capacitive loads were selected from the resonance curve of Fig. 2. In this case of the high-reactance inductive load, the sending-end impedance rises to a very high value with a very short section of line.

A 5.5-ft line at 13.6 mc effectively parallel-resonates the load. A small change in the load impedance will cause a very large change in the sending-end impedance of the line. It may even change the sign of the effective reactance.

This emphasizes two important facts: a short transmission line cannot always be disregarded as a transmission line and treated merely as so much inductance in series with the load; and a short transmission line, with a high inductive reactance load at the receiving end, may result in the sending end impedance being in the region of parallel resonance (antiresonance). The resulting high impedance at the sending end of the line may not be suitable for coupling to the generator output circuit. In addition, since a small change in the load impedance may actually change the sign of the sending-end reactance, this may cause oscillator instability. This emphasizes the importance of plotting the sending-end impedance against transmission line length for a given parallel-tuned load at the receiving end of the line.

Another factor is that with effective capacitive loads, the sending-end impedance goes through effective series resonance before approaching parallel resonance. With this type of load, the transmission line must be considerably longer than for inductive loads to make the sending-end impedance high.

Curves such as Fig. 3 enable one to determine the approximate length of transmission line needed to couple the load properly to the generator. The length of line need not be an exact value, because it can be corrected by changing the effective impedance of the parallel-tuned load circuit or by adjusting the generator coupling circuit.

Line Voltage

Figure 4 is a plot of the voltage on the line at any point, with a receiving-end voltage of one, for several typical effective loads. The sending-end voltage, in terms of the receiving-end voltage, is determined by reading the voltage on the line at a point X degrees from the receiving end, where X degrees represents the electrical length of the transmission line being used. The curve between this point and the receiving end is then the voltage distribution on the line.

For a relatively low effective reactance load at the receiving end, the maximum voltage on the line occurs some distance back from the receiving end. By proper choice of the length of line, the sending-end voltage can be less than the receiving-end voltage. Caution must be exercised with extremely high capacitance loads requiring relatively high electrode voltage, since this will place a very high voltage on the line. This can cause voltage breakdown in the line as well as oscillator instability because of the very high volt-amperes stored in the line.

Generator Coupling Circuits

The arrangement of the transmission line and load circuit to get a certain sending-end impedance is determined by the coupling circuit. The two most commonly used coupling schemes, inductive and direct, are shown in Fig. 5.

Direct coupling has the advantage of being adjustable over a wide range. The output voltage may range from a very low value to a maximum which is the full tank voltage. The load impedance that can be matched, in either case, will depend on the degree of coupling, maximum allowable current in the coupling circuit, and the maximum allowable change in oscillator frequency. The first two conditions

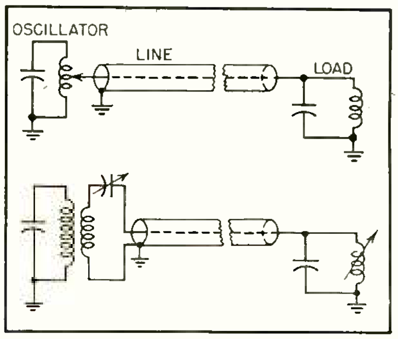


FIG. 5—Direct and inductive coupling schemes

usually determine the load-impedance limitations.

As a rule, within the current rating of direct-coupling circuits, low-impedance loads are usually connected at a low-voltage point on the oscillator tank inductance, and the high-impedance loads are connected at a high-voltage point. Knowing the maximum allowable current in the coupling circuit, the lowest effective load resistance that can be coupled may be calculated from the relation $R = W/I^2$ ohms, where W = power output rating of r-f generator in watts and I = maximum rms current rating of the coupling circuit.

This is the effective load resistance in series with the coupling circuit. The effective load reactance may be any value such that, with the load resistance in series, the IZ drop is equal to the applied voltage of the coupling circuit. In somewhat similar manner it is possible to determine the maximum effective load resistance in series with the coupling circuit. In this instance it is necessary to assume that the effective load reactance is negligible in comparison with the resistance.

Thus, the applied voltage of the coupling circuit appears across the resistive load and $R = E^2/W$ ohms, where E = maximum rms voltage output of the coupling circuit and W = power output rating of the r-f generator.

Lead Inductance

In the case of the direct-coupled circuit, the lead inductance may require special consideration if the effective load is capacitive. Since the two reactances are in series the voltage across the load may be considerably higher than the tapped voltage on the oscillator tank inductance. The opposite is true in the case of an effective inductive load. For this reason the connecting lead inductance must always be considered.

The effective inductive coupling circuit is shown in Fig. 6. The induced voltage and the coupled inductance of the coupling coil must be known to determine the maximum and minimum load resistance that can be coupled to the oscillator. Capacitor C_1 is an adjustable type (usually high-voltage, high-current vacuum capacitors in parallel), adjusted so that the load reactance, the coupling capacitor reactance, and the coupling coil reactance are near series resonance.

Adjustment of C_1 varies the net reactance in the circuit and in this manner varies the voltage across the load. In the case of transmission-line load tuning, C_1 will vary the sending-end voltage of the line. The limiting factors to consider are the resulting voltages across the coupling coil and the coupling capacitor.

Calculation Technique

The first step is to select a reasonable load Z_S from the plotted curve Z_S versus line length and calculate the current required for full output of the generator from the simple relation $I = \sqrt{W/R}$ bearing in mind that this current must not exceed the maximum allowable current in the coupling circuit.

Next, determine whether adjustment of the coupling circuit will provide the required circulating current. This is calculated from the known coupling coil induced voltage and the resultant impedance around the closed circuit. At this point the voltage across each section should be computed to see that it is not excessive.

If these checks show that the selected Z_S is satisfactory, then the transmission line length which corresponds to this value of Z_S is the proper length.

If the coupling coil reactance is high, it is recommended that the sending-end reactance be capacitive, otherwise the coupling capacitor necessary to partially series-tune the circuit may be very small, resulting in excessive voltage across it. The sending-end reactance may be inductive provided it is of low value as compared with the coupling coil inductance.

Transmission-Line Calculator

The Smith impedance chart[1] is an extremely useful tool for transmission-line calculation. The first step in the use of this chart is to rationalize the terminating impedance by dividing it by the surge impedance of the line. The rationalized load Z is located on the chart,

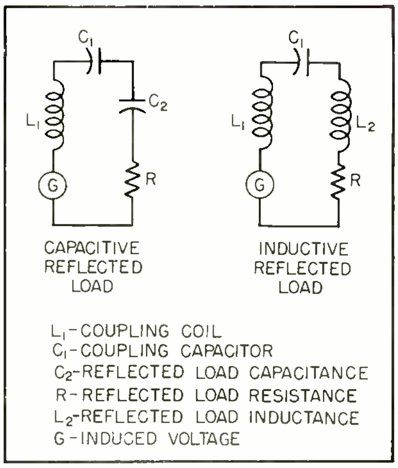


FIG. 6 — Effective inductive coupling circuit

bearing in mind the sign of the load reactance. The intersection of the rationalized load resistance and reactance line locates Z.

On the outer edge of the chart directly in line with Z and the center of the chart, read "wavelengths toward generator." Add to this the ratio of l/λ, length of line and wavelength respectively, and rotate clockwise to this point. Locate the rationalized sending-end impedance at the intersection of the reactance and resistance curves on the line between the center and the new location of "wavelength toward generator" at the same distance from the center as Z. Multiply these readings by the surge impedance of the line for the true values.

Example

Given $R_e = 50$, load $4 + j\,25$, $\dfrac{l}{\lambda} = 0.125$, find Z_S.

(a) Rationalized load $= \dfrac{4 + j\,25}{50} = 0.08 + j\,0.5$.

(b) Locate Z and read 0.074 wavelength toward generator.

(c) Add $0.074 + 0.125 = 0.199$ and rotate to this point.

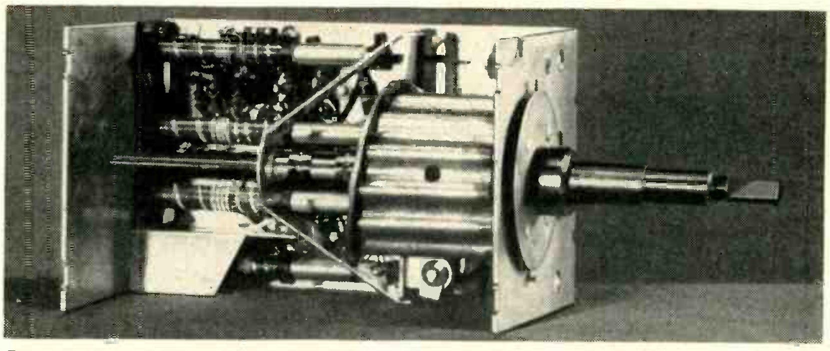
(d) Read $0.65 + j\,2.9$ rationalized Z_S.

(e) Multiply by 50 for true Z_S which is $32.5 + j\,145$ ohms.

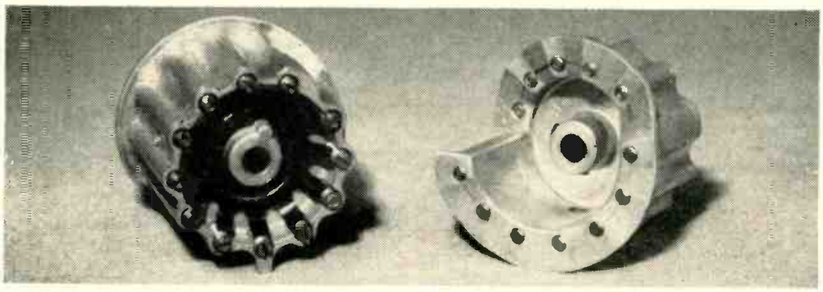
Experience has shown that the majority of dielectric loads can be tuned by this method, with a transmission line approximately $\frac{1}{8}$ to $\frac{1}{4}$ wavelength. In most installations requiring 20 kw or more of r-f power, the load is just about this distance away from the generator

REFERENCE

(1) P. H. Smith, Transmission-Line Calculator, ELECTRONICS, Jan. 1944.



Bottom view with shield removed showing sliding-secondary tubes within coils



Cam mechanism by which the tuning cylinders are mechanically driven. Section at left remains stationary. Screws are for initial adjustment

A Variable

By D. R. DeTAR and H. T. LYMAN, Jr.

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PERMEABILITY tuning has been used for many years in the medium and high radio-frequency ranges, where its advantages of low cost, ruggedness, compactness, uniform high gain, freedom from microphonics, and complete absence of moving contacts have been useful. Attempts to cover wide tuning ranges at much higher frequencies have generally met with failure, because no core materials were available with simultaneously high Q and high permeability.

Tuning by the short-circuited-turn effect of a metallic vane has been successfully applied to relatively narrow bands, such as the f-m broadcast band, but has not been practical for much wider bands because of the marked variation in Q with frequency. By combining permeability and short-circuited-turn tuning, a system having highly desirable characteristics can be obtained.

When designed for small frequency ratios, the Q of this combination may be high, but for ratios in the order of 4-to-1 it becomes so low as to prohibit its use for many applications. However it has proven to be ideal for the television band, where a relatively wide pass band is required. The Aladdin television tuner illustrated takes advantage of the unique characteristics of this tuning scheme.

Tuning Inductor

Such a simple tuning element, shown in cross-section in Fig. 1 is advantageous in compactness, low cost, and freedom from microphonics. The ferromagnetic core is stationary, and the conductive sleeve slides into the annular space between the core and the coil form, progressively decreasing the coil inductance by shielding out the core, as well as by virtue of the short-circuited-secondary effect. A smooth gradation in frequency is obtained. By a proper choice of parameters, a substantially constant bandwidth is obtained over a wide frequency range.

The curves in Fig. 2 show how the core losses at some frequencies, and the sleeve losses at other frequencies, can be balanced to secure uniform bandwidth. The core losses are determined by the magnetic and electrical characteristics of the core, and its spacing from the coil turns. The sleeve losses are determined almost entirely by its proximity to the turns. The metal of which it is made and the wall thickness have little effect on either Q or tuning range.

In tuning large frequency ratios, it is sometimes desirable to use composite cores, the material at the high-frequency end having higher Q and lower permeability compared to that at the low-frequency end,

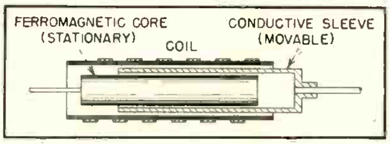
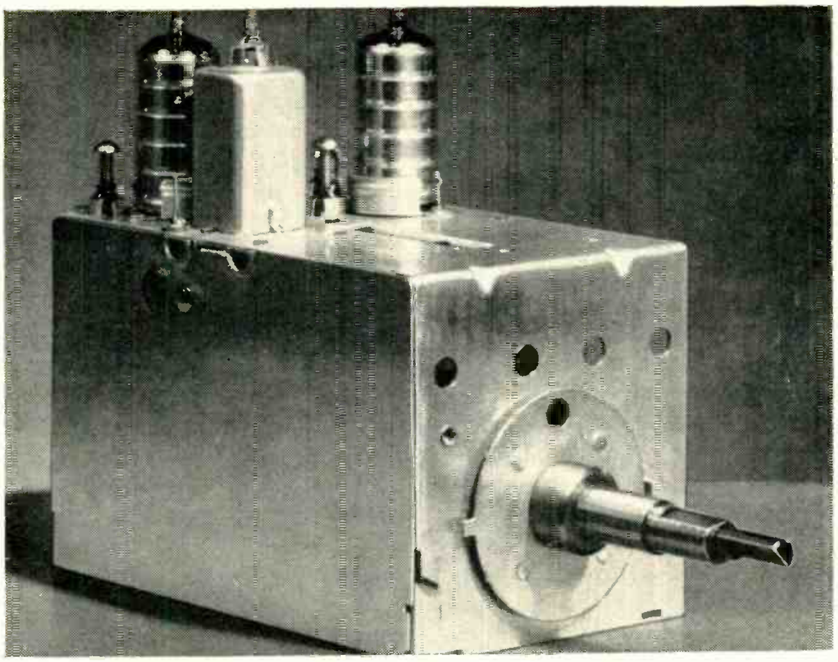


FIG. 1—Cross-section of the tuning inductor

in order to obtain both sufficient coverage and uniform bandwidth. The cylindrical shape of the shorted-turn element obviates the microphonic difficulties encountered with a flat vane.

In a tuner of earlier design, two sets of such inductors were used, one set covering channels 2 to 6, and the other channels 7 to 13. The transfer switch used in this tuner required but a fraction of the number of contacts used in tuners of the tap-switch and turret types in common use. Moving contacts are a potential source of trouble in any circuit because of variation in resistance and the possibility of intermittent open circuit owing to corrosion, dirt, mechanical wear, and changes in contact pressure. At the higher frequencies, where the



The completed tuner can be adjusted through the hole in the vernier dial for the channel, then tuned in

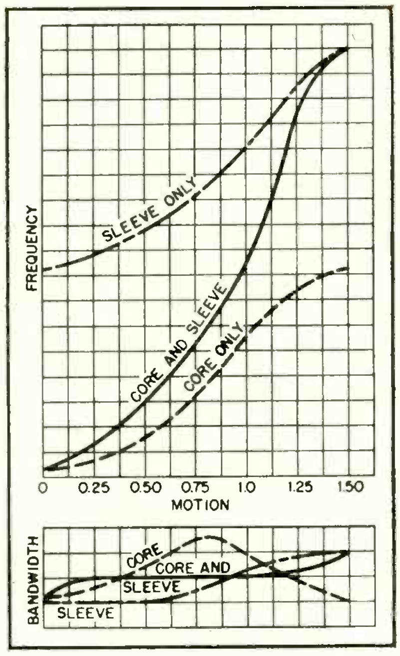


FIG. 2—Tuning effects of core and sleeve and the bandwidths obtained

Inductance TV TUNER

Combination of permeability and shorted-secondary tuning permits covering all vhf television channels without the use of switches or sliding contacts. The new device eliminates 143 switch contacts and reduces to four the 48 tuned coils found in representative conventional designs

total circuit inductance is necessarily very small, there may be an intermittent variation in the inductance of the contacts, because of a shift of the actual contacting point within the area of the mating surfaces. For these reasons, it was felt that a mere reduction in the number of switch contacts was not sufficient, and that the design of a tuner having no moving contacts at all would be an important forward step.

The development of new magnetic materials, having much higher permeabilities, combined with good Q values, has made possible the design of the sleeve-permeability tuner illustrated. It covers the entire vhf tv band, channels 2 to 13 inclusive, with a single inductance variation. No switches or moving contacts of any kind are required in the signal circuit.

The curve of frequency versus displacement for a tuning inductor of this type, with uniformly wound coils, is substantially a straight line for small frequency ratios, but assumes the characteristic elongated S-shape for larger ratios. In view of the wide gap between channels 6 and 7, this shape is actually advantageous, because it assigns more of the total tuning motion to the two tv bands, and less to the undesired frequencies between the bands. In the production coils, shown in Fig. 3A and 3B, this shape is greatly accentuated by bunching the turns at the center of the coil. This construction further minimizes the waste motion between the two bands as indicated in the curve of Fig. 4.

A straight permeability tuner for this wide frequency range would require a core material of very high permeability, with resultant low Q, so that the bandwidth would be excessive over part of the range. A straight shorted-turn tuner would require close spacing between coil and sleeve, causing excessive bandwidth at the high-frequency end. By using a combination of the two, it has been possible, by careful design, to maintain the desired bandwidth throughout the range.

Tuner Design

In the mechanical layout, due consideration has been given to the proper location of components to insure the shortest possible lead

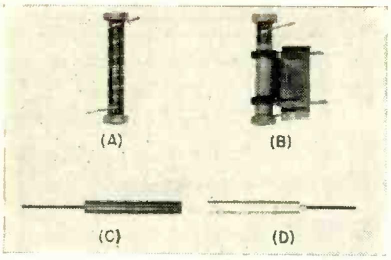


FIG. 3—Intermediate-frequency coil (A) oscillator coil (B) with high-permeability core below (C) over which the aluminum shorted-secondary (D) slides

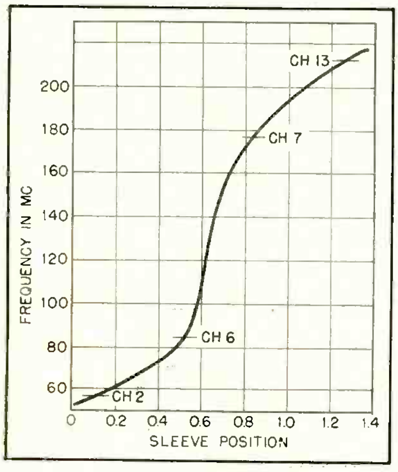


FIG. 4—Sleeve position versus frequency in the variable inductance tuner

lengths in the high-frequency circuits, minimizing undesirable capacitive and inductive couplings, access to adjustments and ease of assembly. The overall size and shape have been chosen to fit present thinking regarding receiver chassis layout. Trimmer and i-f adjustments, which usually require some touching-up when tubes are changed, are accessible from the top of the chassis. Channel-setting screws, which are properly adjusted after assembly into the chassis, are accessible from the front. Other adjustments, made only at the time of tuner assembly and test, are readily accessible from the underside of the tuner chassis.

The tuning coils are wound on thin-walled forms, using silver-plated copper ribbon instead of round wire in order to obtain a high inductance ratio and a satisfactory value of Q. The turns are distributed nonuniformly (Fig. 3A) in order to provide a desirable law of inductance variation. The three r-f coils are identical except for small variations in turn spacing as required to track the different circuits. The oscillator coil is wound with fewer turns to provide the required frequency difference.

The tuning sleeves shown in Fig. 3D are formed from aluminum tubing. Higher conductive materials give no better results in this application and are more expensive and harder to fabricate. The cores are formed from materials especially developed for the purpose, having permeabilities sufficient to cover the range, and Q's as required to provide proper overall bandwidth. The oscillator cores are lower in permeability, as they cover a smaller frequency ratio, and of higher Q in order to provide better oscillator stability.

Rotary detent actuation of the channel-selector knob, as used in switch-type tuners, has enjoyed good consumer acceptance, and so was chosen for this tuner. A positive-drive helical cam, is used to transfer the knob rotation into linear motion to position the tuning sleeves. The cam has a dwell at each channel position, so that angular errors in the detent will not affect tuning accuracy. At each dwell position, an adjusting screw is provided for accurate channel-frequency setting.

A sliding carriage, bearing the four tuning sleeves, rides on accurately machined ways, and is consecutively moved to the channel positions by rotation of the cam. Fine tuning is accomplished very simply by means of a fine-thread screw that moves the carriage a small distance when the fine-tuning knob is rotated. Access to the channel-adjusting screws is through a single hole in the front plate, and one in the disc on the fine-tuning shaft, so that a screw can only be adjusted when the selector knob is set to the corresponding position, and the fine-tuning knob is in the center of its range.

Because of the large frequency range covered by the tuning coils, and the required channel-setting accuracy, a high degree of precision is necessary in positioning the sleeves. The design of the cam carriage is such as to eliminate all backlash. The tuner chassis and overall shield constitute a box structure that is very rugged. Sliding friction is held to a minimum by careful design of the carriage bearings and by supporting the cores and sleeves on flexible spring leads

Table I—Summary of Tuner Characteristics

Channel	Noise Factor in Db	Gain	Bandwidth in Mc, 90 Percent Response
2	9.0	105	6.0
4	9.7	87	6.0
6	10.0	69	6.0
7	12.0	56	7.5
9	10.0	63	6.5
11	12.1	56	6.0
13	16.0	60	6.0

Channel	Image Rejection (X Down)	I-F Rejection (X Down)
2	491	2,000 or higher in low band.
4	450	
6	333	
7	250	
9	422	3,000 or higher in high band.
11	707	
13	800	

Channel	Turns Ratio, balance-to-unbalance	Oscillator voltage at 300-ohm antenna terminals
2	71	Less than 5 mv all channels, balanced or unbalanced.
4	61	
6	39	
7	36	
9	29	
11	31	
13	29	

to provide self-alignment and prevent binding. The actuating mechanism will continue to reproduce the initial channel-frequency settings throughout a long period, under all normal conditions of use.

Tracking of the individual circuits is mainly built-in by careful control of the effective permeability of the cores, sleeve and coil-form diameters, and by use of a specially built winding machine that spaces each turn increment accurately. To make up for unavoidable small manufacturing variations, three final adjustments are provided. The capacitance trimmers compensate for variations in lead and socket capacitances, in addition to tube capacitance, and are used for alignment of the high-frequency end. The positioning of the sleeves is most effective at the middle of the range where the inductance changes most rapidly. The positioning of the core has no effect at channel 13 where it is shielded out, and the greatest effect at channel 2. These three adjustments, together with close control in the manufacture of the tuning elements, permit tracking well within the required limits.

A close-fitting overall shield reduces oscillator radiation to a low figure, and contributes to the mechanical rigidity of the unit.

Tuner Circuit

The circuit diagram is shown in Fig. 5. The usual tube complement consists of a 6AG5 r-f amplifier and a 6J6 mixer-oscillator. A 6AK5, 6BC5 or 6BC6 may be substituted for the 6AG5, with the addition of a small unbypassed cathode resistor for agc response stabilization if desired.

The input circuit makes use of a matched-primary, tuned-secondary antenna transformer shown in Fig. 3B. The match of the primary to a 300-ohm transmission line is maintained throughout the range by the coupled reactance and loading of the tuned secondary, and by the variation of primary inductance produced by the motion of the tuning sleeve.

The characteristics of the core are so chosen that the damping is sufficient to maintain proper match and bandwidth in the lower frequency range where the r-f amplifier loading is low. In the upper frequency range, tube loading and tuning sleeve losses are such as to provide proper match and bandwidth. The primary is balanced to ground, and is electrostatically shielded from the secondary by means of a wire braid over the bifilar primary. This construction maintains the interwinding capacitance at a desirable low value. An excellent match to a 75-ohm line is obtained by connecting to one half of the primary—bandwidth and power-gain being substantially the same as when a 300-ohm line is used with the full primary. By a proper choice of

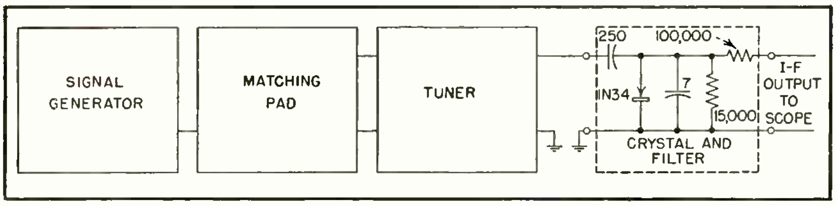


FIG. 6—Test circuit used with the tuner

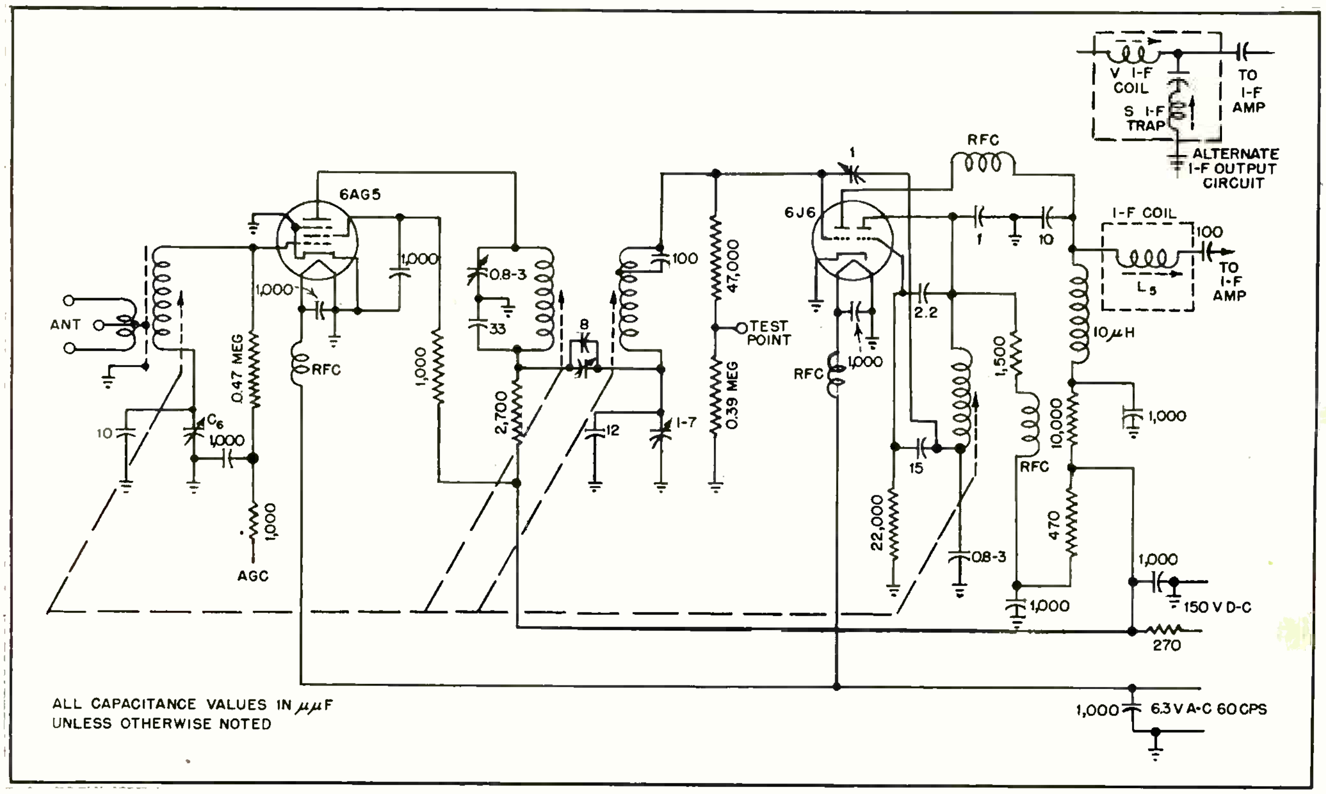


FIG. 5—Complete circuit diagram of the new tuner. Alternate i-f output circuit is shown at upper right

turns ratio and careful matching to the antenna line, the signal-to-noise ratio and gain has been made equal to that obtained when separate air-core antenna transformers, each optimized for a particular channel, are employed in switch-type tuners.

This type of antenna transformer, when used with adequate shielding between the plate and grid circuits of the amplifier, together with an overall shield, provides excellent isolation of oscillator voltage. It is possible to hold the oscillator voltage at the antenna terminals to less than 5 millivolts, either balanced or unbalanced. By including additional shielding and other changes to isolate oscillator feedback and radiation from the i-f amplifier, the oscillator voltage appearing at the antenna terminals may be reduced still further. This is important in view of increasing restrictions on radiation.

The r-f tube is used as a conventional pentode amplifier (but the interstage coupling circuit is somewhat unusual in that low-side fixed capacitance coupling is employed between the amplifier plate coil and the mixer grid. Constant bandwidth is maintained by control of the magnetic coupling, which aids the capacitive coupling, and by making use of the variation of stray intercoil capacitance as the carriage changes position.

The 6J6 oscillator operation and mixer excitation is conventional. The use of a suitable mixer plate choke produces negative input conductance to overcome increase in the mixer grid loading at the high-frequency end.

Two i-f output circuits are shown on the schematic. One is the usual single coil for use in a stagger-tuned i-f amplifier, and the alternate contains a coupled-in trap for the sound carrier, which is useful in some intercarrier receivers in placing the sound carrier at the proper level with respect to the video carrier. The same dual coil construction can be used for sound take-off since Q's in the order of 130 are obtainable, even with the small shield cans used.

Test Circuit

The commonly used test circuit for the i-f output is shown in Fig. 6. It comprises a crystal, a 7-$\mu\mu$f capacitor to represent the usual i-f tube and wiring capacitances, and a low-pass filter. Sensitivities are usually expressed as the r-f input for 0.1-volt output, while the gain figures in the performance chart are expressed as a ratio:

$$\text{Gain} = \frac{0.1\text{v i-f output} \times \text{match. pad atten.}}{\text{signal gen. input (volts)}}$$

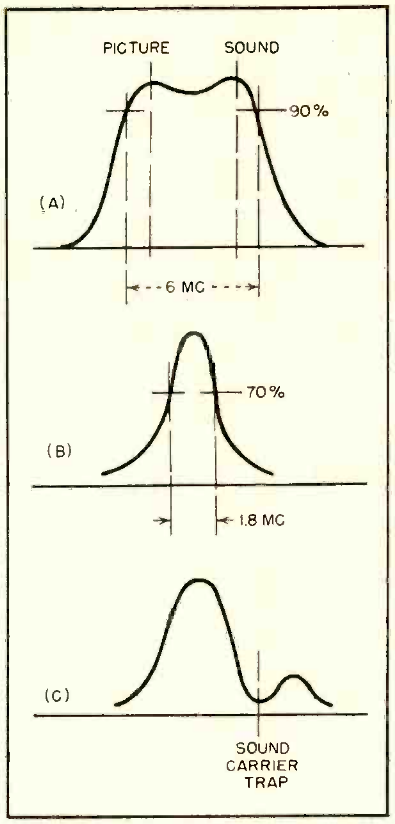


FIG. 7—Typical response curves (A) at the r-f test point (Fig. 5); (B) test output for single coil; and (C) test output with double coil

Performance

The overall performance characteristics are shown in Table I, which is further explained by the response curves of Fig. 7.

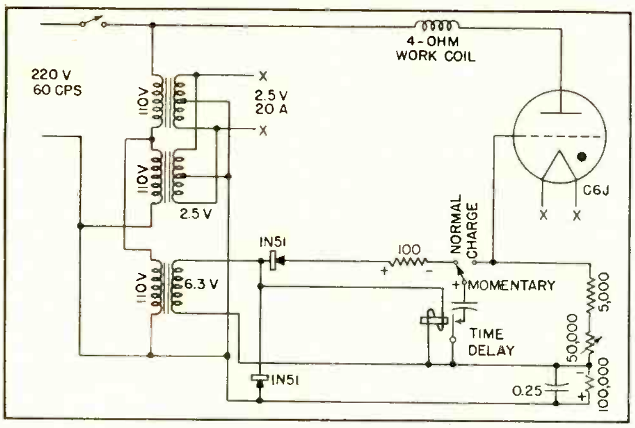
Although i-f rejection is high, still further rejection can be obtained if desired by the addition of an i-f series-tuned circuit across the mixer-grid circuit to ground. A high-Q coil and a capacitor, tuned to any frequency in the i-f band will suppress that particular frequency. A lower-Q coil may be used with a little more capacitance to achieve wider suppression. In either case little effect on the r-f response is observed, and the conversion is increased owing to elimination of i-f loading caused by residual i-f impedance in the grid circuit and by the tube interelectrode capacitance. The latter effect is, however, not so large as the mixer-plate r-f loading.

Image rejection is good and adjacent-channel attenuation is above average because of the rigid tracking and bandwidth control maintained in the manufacture of the tuner. A representative tuner response curve is shown in Fig. 7. This data is taken at the mixer grid test point.

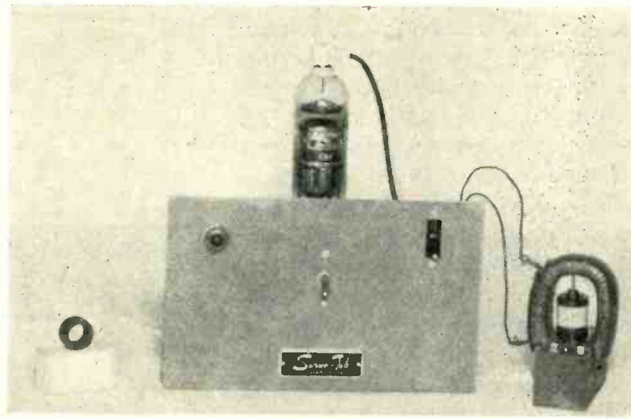
Thermal, mechanical and voltage stability are good in all channels. Reset accuracy is well within the usual sound-channel limits, so that once the tuner is properly adjusted to each channel, very little adjustment of the fine tuning control will be required. Because there are no switch contacts or other parts to become noisy or change calibration with normal use, service difficulties are practically nonexistent, except for usual occasional tube replacement.

In the evolution of any new device, the trend is usually toward simplification. As the process of evolution continues, each succeeding degree of simplification becomes more difficult to achieve, until it becomes necessary to introduce basically new ideas to achieve further significant progress. The switched-coil type of tuner has undergone considerable evolution, and further simplification is likely to consist of relatively minor design changes. The introduction of the radically new concept of switchless permeability tuning into this field results in a major degree of simplification in a single step.

In comparing basically different designs, the choice of criteria to provide a fair comparison is always difficult. On the basis of total number of parts (not counting fastenings such as standard screws and rivets, but counting resistors, trimmers and other components common to both designs as one part each) the subject tuner has 107 parts as compared to 298 for a popular tuner of conventional design. A major part of this simplification results from the elimination of 143 switch contacts, and the reduction in the number of tuned coils from 48 to 4.



Circuit of the unit contains a capacitor that controls the length of time the thyratron conducts the magnetizing current



Complete setup of the magnetizer and work coil. A ring magnet of the type employed in small motors is shown at left

Motor Magnetizer

To avoid accumulation of metal particles by the field magnet during assembly of small permanent-magnet motors, the complete motor is subjected to the magnetizing field after assembly. A thyratron rectifier does the job semiautomatically on the production line

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CONVENTIONAL shunt-wound d-c motors and generators are limited in size reduction due to the extra heat that must be dissipated due to a wound field. The wound field is further undesired since constant field strength is not easily achieved with such construction. The constant field strength of a permanent-magnet field allows such motors to be used in many motor integrator applications, provides smaller motors and allows for precision rate or tachometer generator construction.

In the manufacture of small motors and generators it becomes necessary to magnetize such materials as Alnico V after having ground that material to precision tolerances. It is further advantageous to perform this magnetization on the completed motor or generator to prevent accumulation of metal chips and impurities.

The magnetomotive force recommended for saturation magnetization of Alnico V is 3,000 oersteds (6,000 ampere-turns per inch). This is readily obtained with a simple thyratron rectifier circuit utilizing the peak current-handling capability of an Electrons, Inc. C6J tube, which is 77 amperes.

A magnetizing coil having a sufficiently large number of turns and small enough ohmic resistance to cause this current to flow through the thyratron from a 220-volt line is required. A coil meeting these requirements was constructed to allow the standard line of Servo-Tek p-m motors and rate generators to be inserted in the coil for magnetization. To date, many hundred magnets have been so charged.

Magnets of other configurations and considerably greater mass have also been charged with this unit. Experimental fields of Alnico for motors up to 1/15 horse power have been charged using other coils.

Circuit

The magnet charger operates from the 220-volt line, which, having a peak voltage value of 1.42 x 220, allows for a peak current somewhat in excess of 75 amperes to flow as rectified half-wave pulses through the low-resistance charging coil. A time delay switch to provide 30 to 45-second filament warmup is used to prevent application of conduction-level grid potential during filament warmup.

Approximately 8 volts of negative bias supplied by the 1N51 germanium diode holds the C6J nonconductive. A second 1N51 charges a capacitor to approximately 8.5 volts and, when the CHARGE switch is depressed, that voltage is connected in series opposition with the negative hold-off bias and reduces the net grid voltage to a momentary zero value. A resistor discharge path for the capacitor allows the voltage to decay so as to restore the net grid voltage to a negative nonconducting value in a period of a few one-half-cycle pulses of plate current. That time may be adjusted by the potentiometer in the discharge circuit. Reliable firing repeatability not influenced by time of switch closure with respect to plate-voltage phase necessitates a setting which can hold the grid in the conduction region for at least 1.5 cycles of the plate voltage.

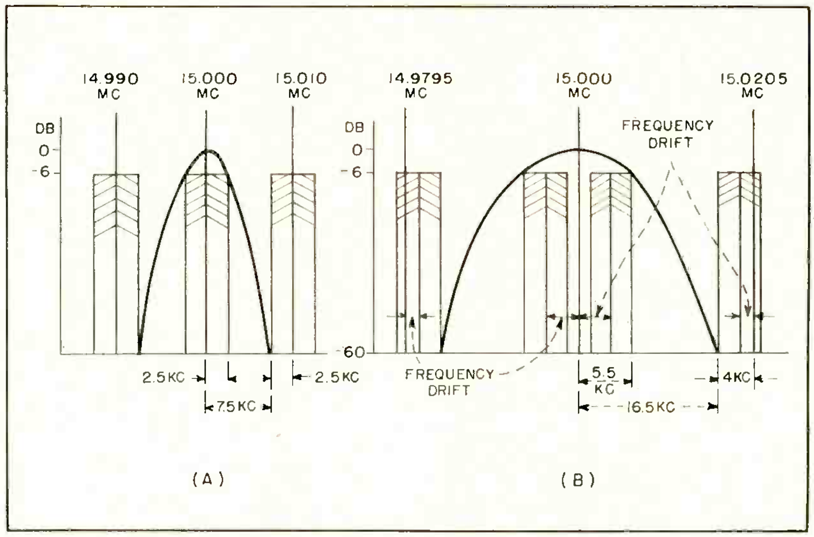

FIG. 1—Example illustrating how transmitter and receiver frequency instability increase the spacing required between communication channels

STABILIZED

By E. W. PAPPENFUS
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Cedar Rapids, Iowa

THE STABILITY of the transmitter and receiver in a communication link plays an important part in the channel spacing of the system. This is shown in Fig. 1A, which illustrates a typical communications receiver selectivity characteristic with the receiver tuned to a voice channel at 15 mc and having 2.5-kc sidebands centered in the selectivity curve. Reception is considered satisfactory if receiver selectivity does not drop more than 6 db at the limits of the sidebands. Undue interference from the adjacent channel can be avoided even when this is a strong signal if the attenuation of the adjacent channel is at least 60 db. If we assume a selectivity curve with a 3-to-1 shape factor, the space to the edge of the adjacent channel will be 7.5 kc, giving rise to channels of 14.990, 15.00, and 15.010 mc for the example illustrated.

If we assume an instability of 100 parts per million (0.01 percent) in the transmitter and receiver frequency-generating system, we have the condition shown in Fig. 1B. Here the transmitted frequency is assumed to have drifted higher and the receiver local oscillator lower, or vice versa, broadening the required selectivity characteristic. Of course, when transmitter and receiver drifts are in opposite directions the effects are reduced and approach the condition of Fig. 1A.

To allow for the maximum deviation of the channel within the selectivity characteristic, a bandwidth of 11 kc is required at the 6-db points of Fig. 1B. With a shape factor of 3 to 1, this results in a skirt selectivity at the 60-db point of 16.5 kc which, when added to the 2.5-kc sideband and the 1.5-kc instability assumed for the adjacent channel, calls for a channel spacing of 20.5 kc or channels centered on 14.9795, 15.0000 and 15.0205 mc. This shows the increased channel spacing and consequent reduction in the number of available channels due to instabilities in transmission and reception.

Oscillator Stability

The crystal oscillator provides a satisfactory answer to the stability problem for many applications. During World War II, however, military forces found that it was strategically unwise to be bound to a single channel or even a moderate number of channel frequencies. Accordingly, interest in variable-frequency master oscillators and other multifrequency generating schemes was renewed.

With increased development of temperature-compensating capacitors and stable permeability-tuning cores, it was possible to maintain the temperature and calibration accuracy of a variable-frequency oscillator without temperature control to within 400 parts per million for 1.5 to 1 tuning ratio. Recent developments with temperature control indicate that stabilities in the order of 200 parts per million will be attainable in the near future.

The present state of the crystal oscillator art indicates that within the range 0 to 50 C, a tolerance of 30 parts per million is possible. Use of a crystal oven reduces this to about 3 parts per million. Commercially available laboratory 100-kc standards are available with long-term stabilities of about 0.1 parts per million. About the ultimate in stability is that of the Bureau of Standards radio station WWV, which is 0.02 parts per million.

With a master oscillator, equipment can be adjusted to a multiplicity of frequency channels, while the crystal oscillator is limited to just a single frequency of operation or a multiple. A system is needed that combines the accuracy of the crystal oscillator with the versatility of the master oscillator. This paper will describe several systems which provide this desired end effect.

Multicrystal System

A method which has been used on the Collins 51R navigation receiver involves synthesis of the desired output frequency through addition of a number of stable input signals. In the descriptions to follow, the frequency values are chosen for ease of explanation and may not be ideal from the standpoint of spurious output.

As indicated in Fig. 2, a crystal oscillator and tap switch provide stable crystal-controlled frequencies from 10.2 to 12.2 mc spaced every 0.1 mc. The selected signal is fed through an isolation amplifier and bandpass filter to a mixer for combining with the output of another multicrystal oscillator that

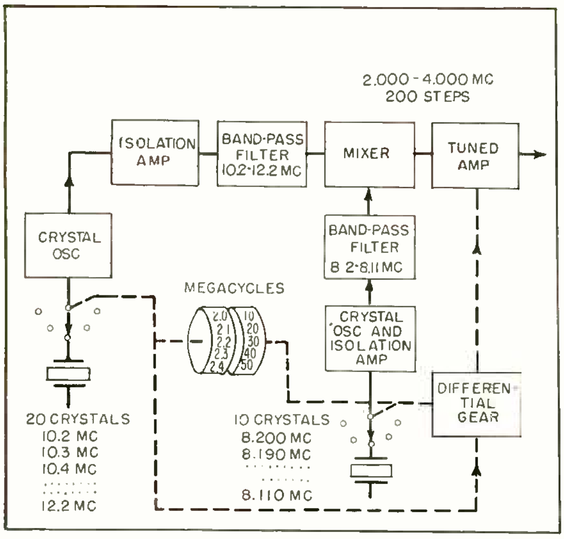

FIG. 2—Synthesis of desired frequency by mixing outputs of two multicrystal oscillators

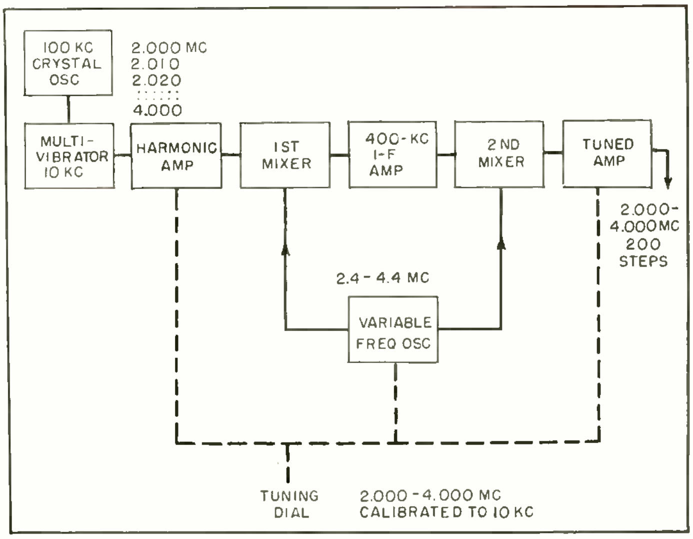

FIG. 3—Superheterodyne method using single crystal, harmonic amplifier and vfo

MASTER OSCILLATOR for Multichannel Communication

Crystal-conserving systems for precise, stable generation of r-f energy are analyzed, with details of commercial 31-tube version using a single 100-kc crystal and motor-controlled afc to provide any desired frequency from 2 to 4.5 mc with 5-ppm accuracy

provides frequencies spaced 0.01 mc in the range of 8.200 to 8.110 mc. The difference frequency as selected in a tuned amplifier yields an output of 2 to 4 mc.

This system is readily adaptable to a direct-reading frequency dial in which megacycles and tenths of a megacycle are indicated by a dial connected to the first tap switch, and 10-kc increments are indicated by a dial connected to the second crystal tap switch. At each position of the first tap switch there are available ten different output frequencies depending upon the position of the second tap switch, so the system illustrated provides 200 10-kc steps in the range of 2 to 4 mc. This output can be multiplied as desired to provide transmitter excitation or receiver injection.

The disadvantage of the system is that it has certain spurious output frequencies and a stability which is less than with direct crystal control because the source crystals are higher in frequency than the available output from the generator.

Superheterodyne System

The foregoing system requires a large number of crystals (30 for 200 output channels). This is a disadvantage which can be avoided through the use of the circuit of Fig. 3. Here a 100-kc crystal oscillator of high stability is subdivided to 10 kc with a multivibrator or regenerative divider. The resulting highly accurate 10-kc signal is then fed into a harmonic amplifier that produces a spectrum of frequencies spaced 10 kc apart in the range of 2 to 4 mc.

The desired output frequency could be selected from the harmonic amplifier with sharp filters and a variable-frequency amplifier but it is quite difficult to secure the desired rejection at the output frequency in this way. Instead, an ingenious application of the superheterodyne principle is used to secure the desired selectivity for selecting and amplifying the desired harmonic to get essentially single-frequency output. In this method (devised by M. L. Doelz—U. S. Patent No. 2,445,664), a 2.4 to 4.4-mc oscillator is fed into a mixer together with the output from the harmonic amplifier, yielding a spectrum centered on 400 kc. A highly selective 400-kc i-f amplifier can be built yielding attenuation of up to 100 db or more for the adjacent undesired channel. Output of the 2.4 to 4.4-mc variable-frequency oscillator is also fed into a second mixer along with the 400-kc i-f output signal. The difference frequency is used here to give the desired output in the range of 2 to 4 mc.

The frequency-indicating dial, which controls the tuned circuits of the variable-frequency oscillator range eight times as wide as would be the case in directly comparing the oscillator with a reference frequency. This deteriorates the accuracy of control at very low-frequency beat notes, but in the commercial version of this system the motor is responsive to applied voltages having a frequency as low as a few cycles per second so the resulting error is quite small.

The motor is a four-pole two-phase instrument-type motor with a high-resistance squirrel-cage rotor. The motor operates with an applied voltage up to 400 to 500 cps, which allows a pull-in range at the comparison frequency of from 3,200 to 4,000 cps.

If greater accuracy is required, a 100-kc standard voltage can be derived from an external source to reduce the error from ±2 parts per million as contributed by the internal crystal-controlled oscillator at 100 kc to a value of as low as 0.1 part per million using the best available laboratory standards.

It is interesting to note the contribution of the interpolation oscillator to the frequency stability of the system. The output of the interpolation oscillator is divided by eight and then compared to the master oscillator at a frequency which is always five times the output frequency of the stabilized master oscillator. Thus the error, in cycles, at the output of the interpolation oscillator is divided by a factor of 40 as referred to the output frequency of the instrument. Since the tuning ratio of the interpolation oscillator is small, its stability is such that it does not contribute more than one to two parts per million to the output inaccuracy.

Perhaps the best method of indicating the operation of the stabilized master oscillator equipment is to give examples of the frequencies present at the different circuits for several values of output frequency. In Table I, example A shows the result of operation on a 5-kc point of the master oscillator. Example B indicates a frequency displaced from a 5-kc point by 2,170 cps. It should be borne in mind that the interpolation oscillator dial covers the range 0 to 5 kc. Because of this the base frequency, to which the interpolation dial reading must be added, changes every 5 kc on the main dial. Therefore, to tune to 3.517170 mc, the master oscillator would be set above the 3.515 point and the interpolation dial again would read 2,170 kc.

Example C corresponds to Example B except that here an error of 300 cycles is assumed at the output frequency of the equipment. This example indicates the error voltages present in the various parts of the equipment and shows the beat frequency applied to the tuning motor.

Circuit Details

The 100-kc crystal-controlled oscillator used as a frequency standard is shown in Fig. 6. A switch allows the substitution of an external 100-kc source, in which case the left-hand section of the dual triode functions as an r-f amplifier feeding succeeding stages of the equipment. The parallel-tuned *L-C* circuit serves to trap out a spurious mode present in some 100-kc crystals. A

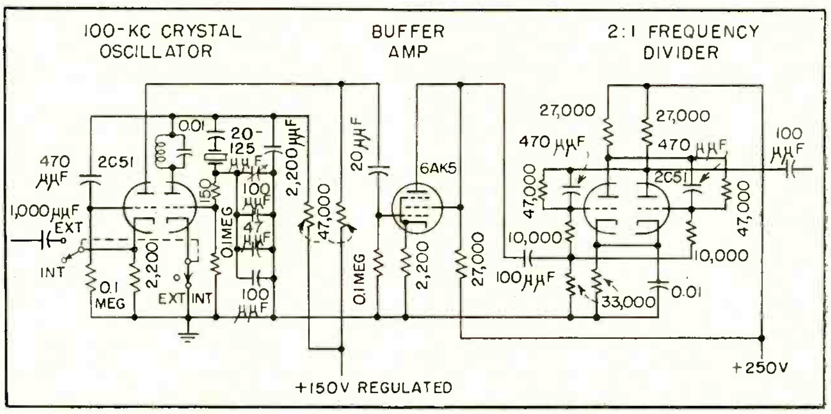

FIG. 6—Crystal oscillator that determines accuracy of output frequency generated by afc-stabilized variable-frequency oscillator

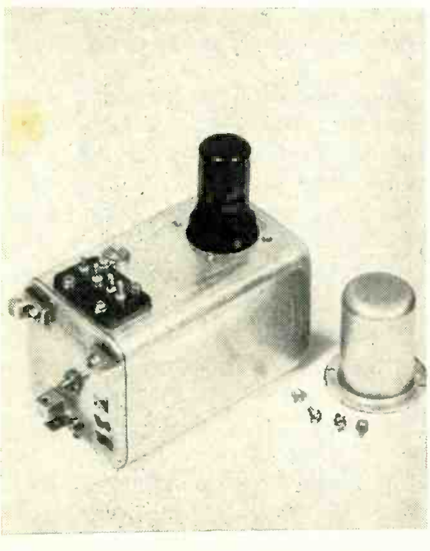

FIG. 7—Hermetically sealed variable-frequency oscillator, with tube sealing can removed

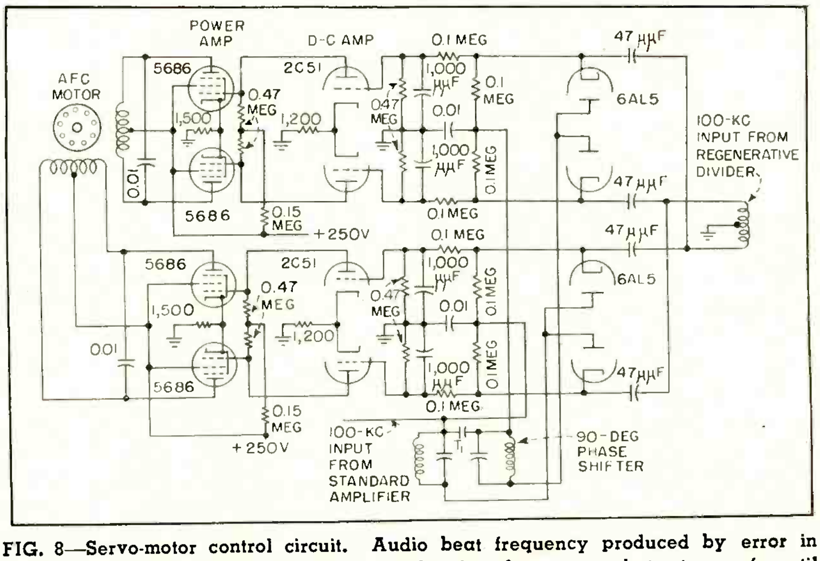

FIG. 8—Servo-motor control circuit. Audio beat frequency produced by error in master variable-frequency oscillator is amplified to drive motor that retunes vfo until beat frequency disappears

6AK5 triode-connected amplifier serves as an isolating stage between the 100-kc oscillator and the 50-kc divider. The divider has the advantage of fail-safe operation, wherein there is no spurious output if the 100-kc source fails.

The heart of the entire stabilized master oscillator is the hermetically sealed variable-frequency oscillator illustrated in Fig. 7. This oscillator uses a powdered iron core traveling within a solenoid coil, with variable space between turns to secure a linear relationship between frequency and dial rotation. By hermetically sealing the oscillator and rotating the shaft through a pressure-tight seal, it is possible to secure calibration and temperature stability of ±800 cycles at the fundamental frequency of the oscillator. Temperature compensation is accomplished by using ceramic capacitors with the desired temperature coefficient and by appropriate design of the tank coil. Final production linearity adjustment is realized with an adjustable cam that compensates for manufacturing variations in the coil and core. The interpolation oscillator has the same physical characteristics and differs only in the resonant circuit components.

Table I—Three Examples of Frequencies Present in Stabilized Master Oscillator System

	100 kc standard	Divider output	Harmonic amp mc	1st mixer kc	1st I-F amp kc	2nd mixer kc	2nd I-F amp kc	Regen dividers kc	Motor frequency cps
A	100 kc	25 kc	16.600 16.625 16.650 etc	900 875 850 etc	875 900	 800 825	800	100	0
B	100	25	16.650 16.675 16.700	910.85 885.85 860.85	885.55	800	800	100	0
C	100	25	16.650 16.675 16.700	862.35 887.35 912.35	887.35 Δf= +1,500 cps	801.5 Δf= +1,500 cps	801.5	100.1875 Δf= +187.5 cps	187.5

	Output freq mc	MO dial freq mc	MO freq mc	Multiplier ×10 ×15 mc
A	3.500000	3.500	1.166666	17.500000
B	3.512170	3.512	1.170723	17.560850
C	3.512470 Δf= 300 cps	3.512	1.170823 Δf= +100 cps	17.562350 Δf= +1,500 cps

	Interpol divider kc	Interpol osc freq kc	Interpol dial kc
A	75.00	600	0.000
B	85.85	686.8	2170
C	85.85	686.8	2170

AFC Motor Control

The motor control circuits are quite interesting. The output of the 800-kc second i-f strip is subdivided in a regenerative divider and then fed into 6AL5 diodes along with the output from the 100-kc amplifier, as shown in Fig. 8. Loosely coupled resonant circuits in T_1 provide a 90-degree phase shift in the 100-kc reference voltage so that push-pull two-phase a-f voltage is fed into the 2C51 d-c amplifiers. These in turn drive 5686 beam tetrode tubes that serve as power amplifiers feeding the two windings of the afc motor in push-pull. The push-pull arrangement is used to eliminate d-c flux in the motor windings. Only the flux due to the beat-frequency voltage drives the armature. Relay contacts, not shown, connect the motor windings to 60-cycle power for initial tuning of the equipment.

In tuning, a SETUP-OPERATE switch is thrown to the SETUP position, which drives the afc motor and capacitor to a centered position and disables the motor control circuits. The master oscillator dial is then set to frequency as closely as possible. The interpolation oscillator dial is adjusted to indicate the frequency increment to be added to the 5-kc point next below the desired frequency and an output tuning dial is set to the correct position as indicated on a direct-reading dial. A headphone jack across the motor control circuits provides aural indication of the accuracy with which the master oscillator is adjusted. If a fairly low beat note is heard (0 to 400 cps), the adjustment of the master oscillator is sufficiently accurate for afc operation. If not, further adjustment of the master oscillator dial will yield a low beat note suitable for afc control. The switch is then thrown to OPERATE, which restores the motor control circuits. The motor then operates under control of the beat-frequency signal and rapid correction of the master oscillator frequency occurs. Thereafter the frequency of the master oscillator is under continuous surveillance so that it is constantly corrected for thermal, humidity or voltage effects.

The 31 tubes used in this circuit might appear excessive until it is realized that the accuracy of adjustment and the stability after adjustment of this frequency generator are far in excess of that obtained previously in variable-frequency oscillators. A decided advantage of this method is that failure of the afc circuits does not necessarily destroy the usefulness of the system. Only three tubes are essential for operation as a normal master oscillator-power amplifier with moderate stability.

The writer wishes to express his appreciation to R. T. Cox for suggesting the basic system used in the stabilized master oscillator.

CRYSTAL DIODES

Five useful and novel circuits for video terminal gear at television studios. Included are gamma correction amplifiers, studio amplifier brightness clipper and a deflection failure protective unit for kinescopes and monitor picture units

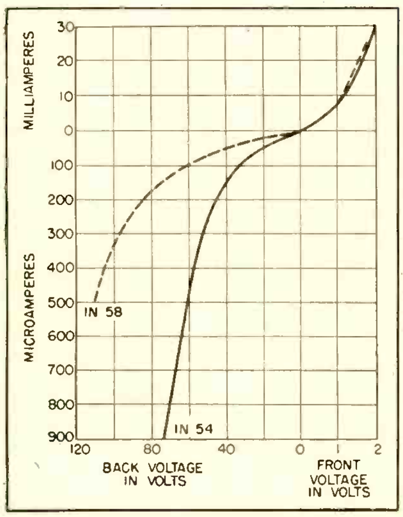

FIG. 1—Typical voltage and current characteristics of two crystal diodes

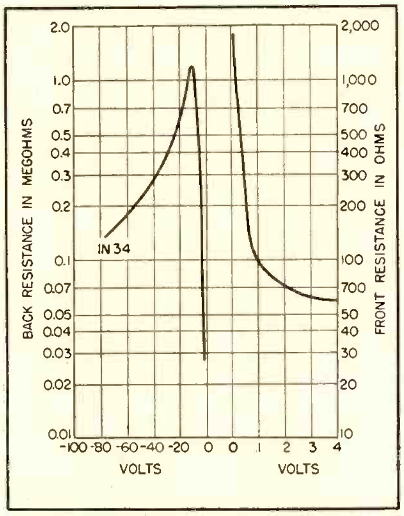

FIG. 2—Front and back resistance plotted against voltage for the 1N34

GERMANIUM diodes have many applications in video circuits as detectors and rectifiers in which unidirectional conduction is the property used. In addition, such diodes have limiting and nonlinear properties which suit them to many other circuits of use in the television studio and transmitter. Several circuits of the latter type are here described. The circuits utilize the 1N34 and 1N58 crystals. These are relatively inexpensive and typical of the class. It should not be construed, however, that these particular designations are specifically necessary in the circuits to be discussed.

The following specifications of crystal diodes are of special interest to the design engineer:

Minimum forward current—the smallest expected current at a given d-c potential applied with positive to the anode lead.

Shunt capacitance—usually 1 $\mu\mu$f or less for all units.

Peak inverse voltage—the maximum transient voltage polarized negatively at the anode which may be tolerated before breakdown occurs.

Maximum operating inverse voltage—the allowable continuous inverse voltage for satisfactory operation.

Average rectified or forward current—the allowable steady current carried by the crystal without undue change of characteristics.

Ambient temperature range—the surrounding temperature during operation which will not be injurious to the unit, ordinarily from -50 to $+70$ deg C, outside this range the specified ratings may take a "set" and not return to normal when room temperature is restored.

Inasmuch as the devices under discussion are nonlinear, certain typical response curves are desirable for intelligent application. Figure 1 is a plot of forward and inverse currents against respective voltages. The sudden reversal of slope at the origin is of particular value in switching and clipping actions. Such sharp cutoff characteristics make the diode a superior limiting device to a pentode.

The corresponding curves of back and front resistance as functions of respective voltages are shown in Fig. 2. It is interesting to note the shape of the back resistance-voltage curve. The maximum back impedance occurs at a rather low value of voltage and rapidly falls off in either direction. For this reason, an ohmmeter is not an accurate enough instrument to indicate the true condition of a given crystal. A relatively high back resistance and low forward resistance, however, may presuppose a working diode not necessarily within prescribed ratings.

Since the resistance varies critically with applied voltage, the proper verification of data is made by the use of a low-impedance voltage source in series with a milliammeter and the crystal under test. The usual specified voltages are positive one volt and negative ten or fifty volts. Batteries are a convenient source of test potentials.

Applications

The reproduction of a scene by television must adhere to certain standards for acceptable portrayal of scene brightnesses. A completely linear system from pickup tube to kinescope would of course reproduce identically the original material. The limited contrast range of a kinescope, however, sometimes makes it more desirable to depart from an overall unity slope response in order to accommodate a high-gamma picture.

It is not necessary for accurate representation to strictly adhere to a one-to-one transmittal of information, rather the following equation holds true: reproduced scene brightness $=K$ (original scene brightness)$^{\gamma}$, where K is the constant of proportionality and the ex-

in TV Studio Equipment

By RUDOLPH KUEHN
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ponent, gamma, is a measure of the change in the original scene. The system gamma is the product of the responses in each series unit. Thus, assuming a film to be televised of gamma 2 and a kinescope gamma of 2, all other equipment of unity gamma, the resulting picture will have a gamma of 4. This is too great for accommodation at the receiver.

Ordinarily, pickup tubes, except for flying spot, are operated as nonlinear devices beyond the knee of the curve at white saturation. Such operation aids the compensation of the high kinescope white gradient, but the linear black region of the pickup device does not help the very low gradient of the kinescope in this area. The object is to insert into the system a series of amplifiers whose controlled nonlinearity can overemphasize the amplification at the desired brightness levels to achieve the optimum system gamma.

Gamma Correction

If a two-stage resistance-coupled video amplifier is connected as shown in Figure 3A, a degenerative feedback loop is present through R_1, and D_1, when the crystal diode is conducting. At no signal R_2 is adjusted to allow V_2 to draw more current than V_1. This establishes the voltage relationship $E_{b1} > E_{b2}$ if the circuit is otherwise symmetrical. Thus, the extent to which D_1 conducts establishes the maximum degeneration possible.

Assume a video voltage at R_{g1} with whites positive. At the plates of V_1 and D_1 the white excursion is negative, while at the plate of V_2 and the cathode of D_1 the white picture is again positive. As white signal increases, V_1 draws more current reducing the diode plate voltage.

In similar manner, V_2 is made to draw less current increasing the voltage at its plate and the cathode of the diode. There exists, then, with increasing positive signal excursion on the grid of V_1 a push-pull effect tending to drive the crystal to cutoff. The overall gain of V_1 and V_2 increases as the degenerative path increases its impedance with signal amplitude. Should the video at R_{g1} be opposite in polarity, the black signal material will be stretched. The point at which nonlinearity will begin depends upon the content and level of the input signal, and upon R_1 and R_2.

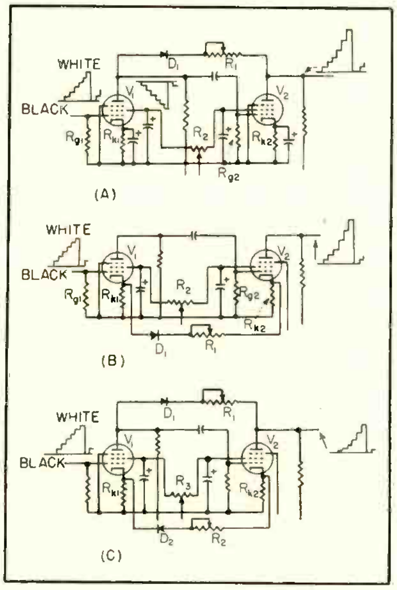

FIG. 3—Circuits of gamma correction amplifiers. Circuit *A* shows a degenerative loop, *B* a regenerative loop and *C* combined positive and negative feedback

Control

A convenient variable for controlling the point of diode departure is the potentiometer R_2 which changes the screen voltages of V_1 and V_2 in a push-pull manner. It is assumed that video at R_{g1} will always be maintained at constant peak-to-peak voltage, however, varying average brightnesses will change the a-c axis and thereby the relative steps which will be stretched. Use of d-c insertion in this circuit will eliminate the latter difficulty. The maximum attainable degeneration is determined by R_1 and once established would normally not be changed as an operating control. By combinations of such amplifiers the reversed S compensatory curve necessary for system linearity can be approached.

Instead of a variable degenerative path so provided, it is possible to accomplish the same thing with a controlled positive feedback as illustrated in Fig. 3B. Here D_1 and R_1 function as a regenerative loop whose impedance varies with the state of diode conduction. At zero signal R_2 is adjusted so that V_2

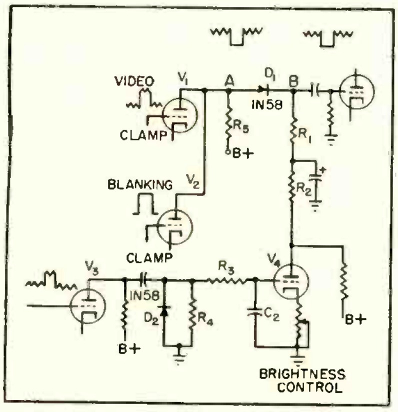

FIG. 4—Brightness control circuit for a studio video amplifier

made available for point B which varies in accordance to the signal at A, then the clipping level will adjust itself to maintain a constant setup regardless of picture material or amplitude. A portion of the video from an earlier stage is amplified by V_3 and rectified and filtered by D_2, R_4, R_3, and C_2.

The filtered output of D_2 controls the current in V_4, establishing a voltage decoupled by R_2 and C_1 which supplies point B through R_1. In this case the effective load impedance at V_1 consists of the parallel combination of R_5 and R_1. The potentiometer in the cathode of V_4 acts as a manual brightness control. A miniature dual triode serves for V_3 and V_4 and in combination with the two 1N58 germanium diodes requires little extra space and power.

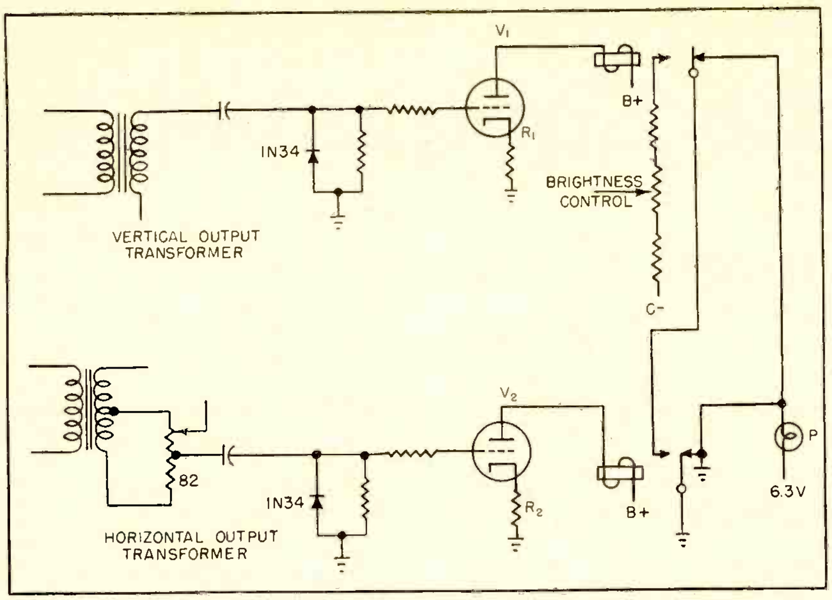

FIG. 5—Protection of the kinescope in case of failure of either the vertical or the horizontal sweep is provided by this circuit

draws more current than V_1. This produces a greater voltage drop across R_{k2} than R_{k1} and little feedback is present.

As positive signal swing at R_{g1} increases the voltage across R_{k1}, negative signal at R_{g2} decreases the voltage across R_{k2}. This push-pull action drives D_1 into conduction, whose impedance depends on the extent of the signal and the original bias. Thus, with increasing voltage at R_{g1}, the positive feedback increases and the gain of V_1 and V_2 correspondingly is raised.

An interesting result is obtained if the degenerative and regenerative loops are included between the same two stages as in Fig. 3C. Stretching either end of a signal will result in a change of peak-to-peak voltage necessitating a readjustment of output level. For a constant output, a stretch of one part of the signal is accomplished with the relative compression of the remaining signal.

If the zero-signal condition is such as to allow V_1 to draw less current than V_2, then both positive and negative feedback will be present since both D_1 and D_2 will conduct. In this particular case the cathode resistors are not equal, with R_{k1} being considerably smaller. If this were not the case, a complete cancellation of the two effects would cause little or no change.

With increasing positive signal both diodes are made to approach cutoff with D_2 lagging somewhat. The proper circuit components will allow a constant output voltage level to be maintained while varying the relative expansion and compression according to the setting of R_3 and the signal composition.

Brightness Clipper

A rather common requirement in studio video amplifier equipment is a means of controlling the clipping level of inserted blanking to establish brightness. In the circuit of Fig. 4, a series germanium diode is inserted in the signal line common to V_1 and V_2. With camera signal present as shown on the grid of V_1 and blanking on the grid of V_2, the output on the common load R_5 appears at the anode of D_1. The point at which signal causes the diode to conduct is determined by the dynamic plate-cathode voltage of D_1. By varying manually the current through V_1 or V_2, the voltage at point A may be controlled. This is disadvantageous in that either the video or blanking amplifier will change transconductance with an attempted change in brightness.

Alternately, the voltage at point B may serve as the brightness control. In either case, however, a change in video peak-to-peak voltage will alter the relative a-c axis to pedestal distance due to clamp action, and this causes a shifting setup.

Should a source of voltage be

Screen Burn Protection

A kinescope operating at 25 kv second anode voltage will burn almost immediately upon a loss of deflection. To protect against such occurrence, the circuit of Fig. 5 operates relays which open the ground leg of the brightness control placing full negative bias on the kinescope grid in the event of deflection failure. A portion of the voltage on the secondary of the vertical output transformer is coupled to a 1N34 detector whose output controls the grid of a triode. The plate load of the triode is a relay whose contacts break the ground side of the brightness voltage divider. A similar arrangement is provided for horizontal deflection.

The control triodes V_1 and V_2 are biased to cutoff by their respective cathode resistors R_1 and R_2. With deflection voltage present, enough positive bias will be applied to the grids to operate the tubes and relays, thus completing the return circuit for the brightness divider. Should any deflection component fail, including those in the protective circuit, the ground return will be lifted from the brightness control and applied to the indicator pilot lamp P. The control triodes V_1 and V_2 can be in one miniature envelope. If more sensitive relays are available there is no need for d-c amplification and direct operation from the diodes is possible.

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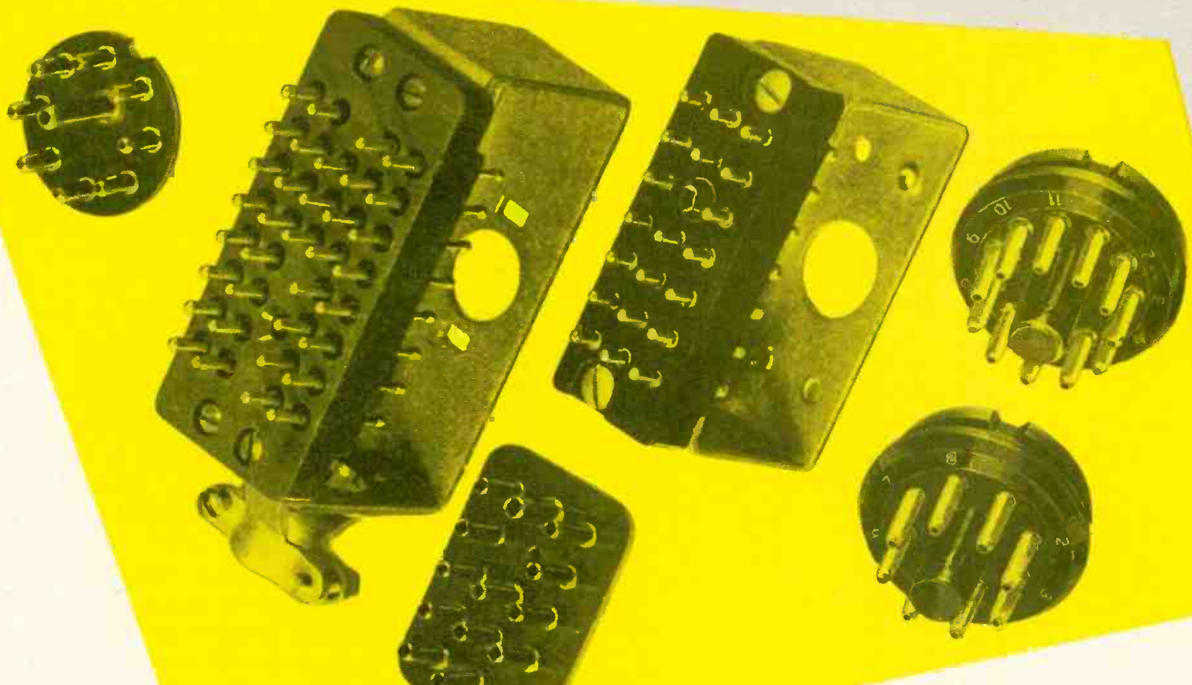

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Combining Sound Levels

Simple nomogram dispenses with the need for log tables, decibel tables or a slide rule when determining the total acoustical power resulting from the combination of two or more sounds

By W. B. CONOVER

Transformer and Allied Product Divisions Laboratory
General Electric Company
Pittsfield, Mass.

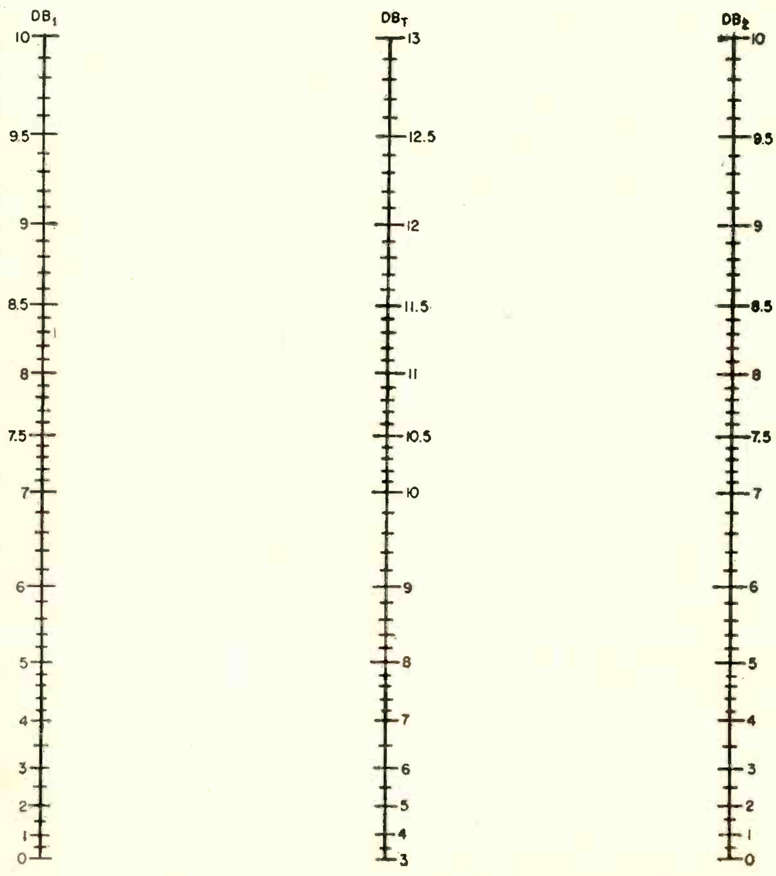
Two or more sounds combine to give a total sound whose acoustical power is the sum of the power involved in the individual components. Since sound levels are expressed in decibels, the sound level of each component must be converted to its corresponding power ratio, added to the power ratio of the other components, and the total power ratio reconverted to decibels to determine the total sound level.

A straightedge intersecting the outer scales of the nomogram at positions corresponding to the individual sound levels db_1 and db_2 intersects the center scale at db_T, which is the total sound level. For example, individual sound levels of 8 and 10 decibels will be found to give a total of 12.1 decibels.

Any two equal sound levels combine to produce a sound which is 3 decibels higher than either of them separately. Thus 7.5 db and 7.5 db combine to yield 10.5 db; 0 db and 0 db give 3 db.

It is necessary to choose a convenient reference level such that the individual components are within 10 db of it. Thus, for the total of 62 db and 67 db, a reference level of 60 db is chosen. Since the components are 2 and 7 db above this reference, the resultant 8.2 db given by the nomogram is added to the reference, giving a total of 68.2 db.

When a difference of more than 10 db exists between two sound levels, the contribution of the smaller may be neglected.



Other Uses

One component of noise can be found when the other component and the total noise are known. This is useful in correcting sound-level meter readings for ambient noise. For example, a sound-level meter shows 64.5 db in the neighborhood of a certain machine when it is operating, and an ambient noise reading of 60 db when the machine is turned off. What is the noise level at the same location due to the machine alone? Choosing 60 db as the reference level, a straightedge is aligned with 0 db (60-60) on the db_1 scale, and 4.5 db (64.5-60) on the db_T scale, giving a reading of 2.6 db on the db_2 scale. Adding this to the reference level of 60 db results in a noise level of 62.6 db for the machine alone.

When more than two sound levels are to be combined, the total of two components is determined and combined with a third component, the new total combined with a fourth component, and so on. This same process may be employed to determine, in decibels, the rms value of a complex voltage or current wave when its harmonics are expressed in decibels.

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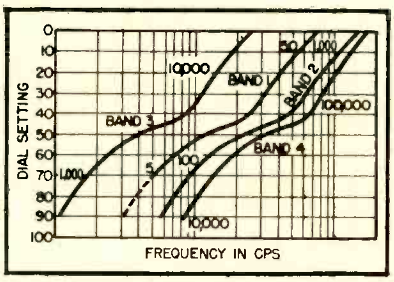
TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by VIN ZELUFF

Sine and Square-Wave Generator Selective Amplifier

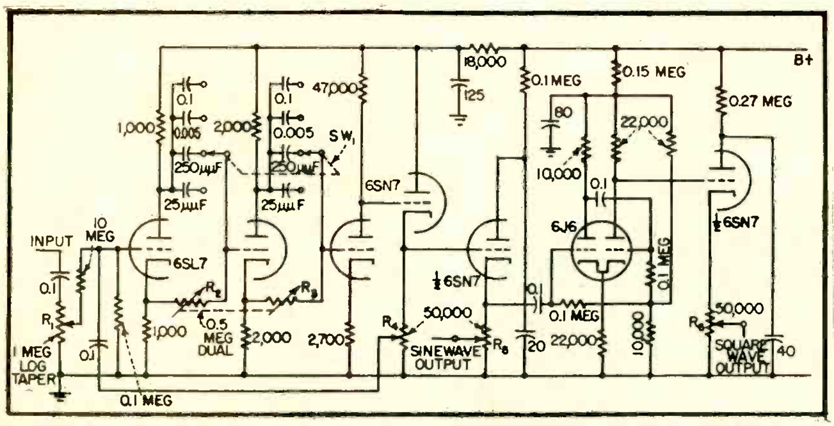
BASED UPON a half-lattice R-C type all-pass filter[1,2,3] a wide-range sine-wave generator has been designed and constructed which, in conjunction with a regenerative coupled cathode clipper amplifier[4], delivers both a sine and a square wave of about 28-volt peak-to-peak amplitude from about three cps to one hundred six kc.



Typical calibration curve for generator-amplifier shown in circuit diagram

The circuit is essentially that of Villard[3] but modified to include more direct coupling for better low-frequency characteristics and cathode-follower stages for improved isolation and low-impedance sources necessary for extending the high-frequency range.

Six controls are used. Switch 1 establishes the frequency range and ganged rheostats R_2 and R_3 give a fine control of frequency (a shaft rotation of 180 degrees providing a 20 to 1 frequency change). Potentiometer R_4 controls the amount of feedback and the amplitude of the generated sine wave. When this control is set so that just insufficient feedback is available to maintain oscillation, the circuit from attenuator R_1 to potentiometer R_4 acts as a sharp filter, passing the frequency at which oscillation would occur were more feedback used.



Circuit diagram of sine and square-wave generator and selective amplifier capable of delivering up to 28 volts peak-to-peak from 3 cps to 106 kc

Potentiometer R_5 controls the output amplitude of the sine wave and potentiometer R_6 similarly controls the square-wave output amplitude.

REFERENCES

(1) Chance, et al., "Wave Forms", p 137, Radiation Laboratory Series, McGraw-Hill Book Co., Inc., New York, 1949.
(2) E. W. Rosentreter, Single-Signal Single-Sideband Adaptor, ELECTRONICS, p 124, Jul. 1948.
(3) O. G. Villard, Tunable A-F Amplifier, ELECTRONICS, p 77, Jul. 1949.
(4) L. A. Goldmintz and H. L. Krause, *Proc. IRE*, p 1172, Sep. 1948.

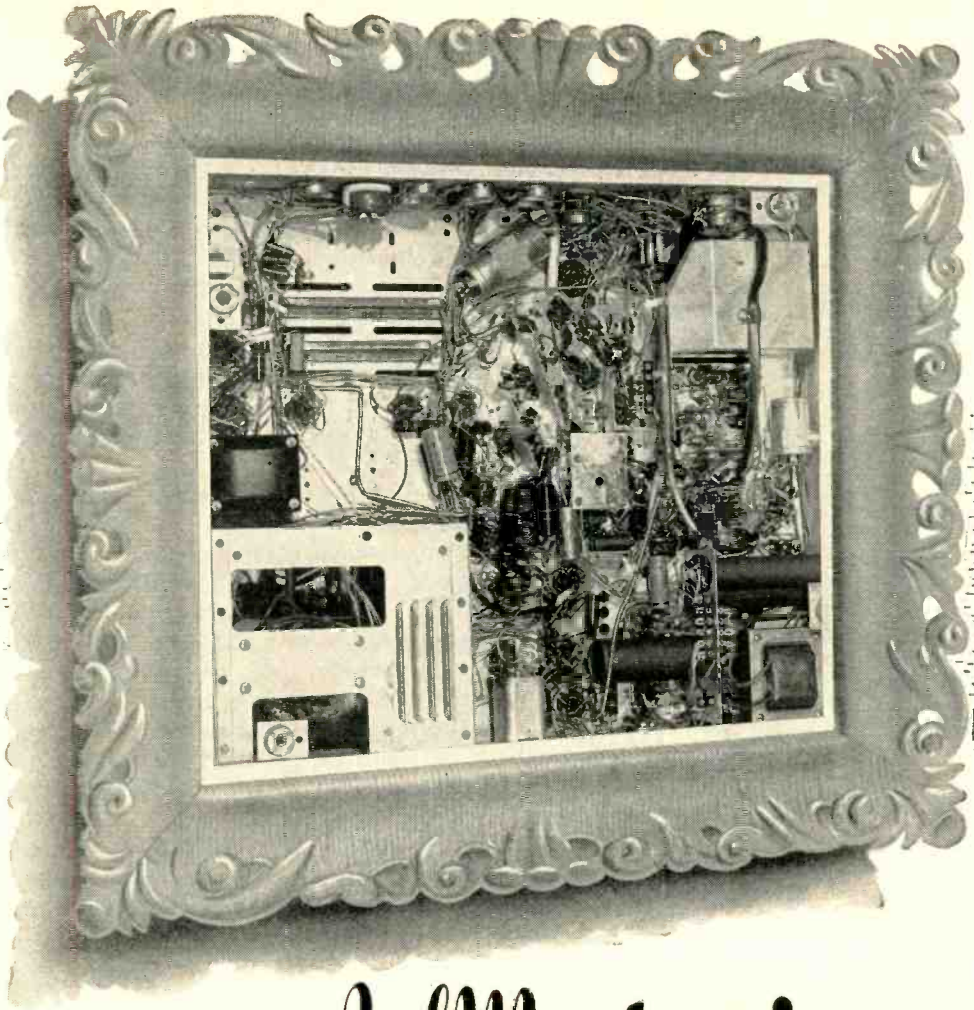
Amplified Cueing for Remotes

BY ANTONIO VACCARO
Chief Engineer
WHEB
Portsmouth, N. H.

ENGINEERS HANDLING remote broadcast pickups on a voice cue rather than a time cue often have difficulty hearing the cue because of low signal level and high adjacent crowd noise. The telephone companies restrict the levels of broadcast programs over wire lines to avoid cross-talk with communications services on adjacent wires. In order to save expense, broadcasters usually lease only one pair of wires and use the circuit for two-way communication except during the time the program is being fed from the remote location to the studio.

The circuit modification shown can be applied to any standard remote amplifier. A switch allows the engineer to feed the line into the amplifier input during the period he is waiting for the cue. By this means, the weak signal on the telephone line from the studio can be amplified to any desired level. As soon as the cue is received, the switch is returned to the normal broadcast position, and the line is then connected to the output of the remote amplifier. At the studio, the line is simultaneously switched to the transmitter. The engineer's monitoring headset is always connected to the output of the ampilfier so that he can hear the outgoing program.

Figure 1A shows the interconnection points X and Y where the normal wiring is broken to insert the switch and transformer shown in Fig. 1B. The parts indicated on the



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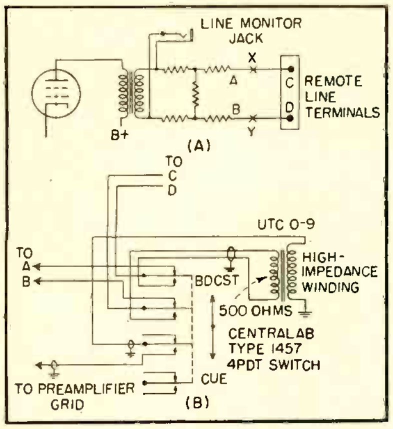

FIG. 1—Circuit modifications for a standard remote amplifier. The switch is shown in the normal or broadcast position

diagram are those actually used, but similar equipment of other manufacture can, of course, be employed. The entire modification requires a space about 1½ by ¾ in.

Sensitive A-C VTVM

By Lawrence Fleming

Washington, D. C.
National Bureau of Standards

Occasions sometimes arise in research work when small voltages must be measured at some point that is isolated, either electrically or physically, from ground. The circuit of Fig. 1 provides a full-scale range of 5 millivolts a-c rms for this purpose, with about 13 db of negative feedback, and has been built to occupy a space of 6 x 6 x 4 inches, including batteries. The instrument was built to measure voltages in the 15 to 40-cycle range, but is accurate within a few per cent up to about 20 kilocycles.

Low battery drain and space considerations dictated the use of low B voltage, a rather sensitive d-c indicating instrument, and an A battery common to all stages. To realize the benefits of feedback while employing a common filament battery, the feedback connection is made to the screen grid of the first stage. There are two disadvantages to this arrangement, the input capacitance is rather high and the sensitivity is not entirely independent of tube changes in the first stage because the grid-to-screen path of this stage is outside the feedback loop. In general, however, the linearity and stability of this circuit closely approach that of comparable commercial instruments, and the size and battery drain are much smaller.

The Daniels device of current amplification and current feedback[1] is employed, with the last stage designed to give the maximum transconductance commensurate with a reasonable value of d-c plate current, to keep the meter movement from being treated too roughly by overload voltages. Sen-

(Continued on p 162)

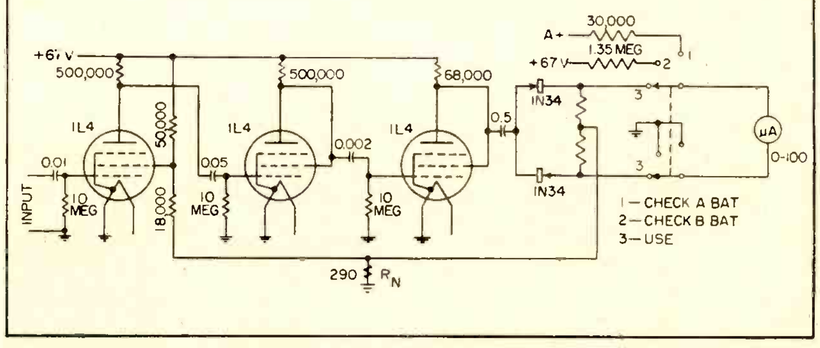

FIG. 1—Vacuum-tube voltmeter for a-c, using only one 67-volt B battery and one 1.5-volt A battery

THE FRONT COVER

The Kodachrome pictures on the cover were taken at the laboratory of the Hazeltine Electronics Corporation at Little Neck, N. Y. to illustrate the spectrum-saving property of the mixed-highs system of color television. The images are unretouched, just as they appeared on a dichroic-mirror receiver (three picture tubes with red, green, and blue images superimposed). The images are scanned at 525 lines, 60 fields per second.

The image at upper left (A) was transmitted by the simultaneous method, using a separate 4-mc video band for each primary color, or 12 mc in all. The shot at upper right (B) shows that substantially the same result can be obtained by the mixed-highs method, using a total bandwidth of only 4.2 mc.

The explanation of this seemingly impossible compression of spectrum space is found in the lower pictures. At left (C), is the color component of the image, which is limited to a bandwidth of 0.1 mc in each primary color (0.3 mc in all) and hence contains no fine detail. At right (D), is the detailed "mixed-highs" portion of the image, containing frequencies from 0.1 to 4 mc (3.9 mc band). This image, which appears in tones of gray, is produced by combining into a single signal the high-frequency portions of the primary color signals before transmission in accordance with their relative brightnesses in the original scene. When the images shown at (C) and (D) are combined electrically, using a bandwidth of 0.3 + 3.9 = 4.2 mc, the image shown at (B) results.

In the cover pictures, the "cross-over" frequency—where color terminates and mixed highs start—is 0.1 mc. Experiments with different pictorial subjects, and with cross-over frequencies ranging betwen 0.1 and 2.0 mc, have indicated that the optimum value for broadcasting in a 6-mc channel is probably between 0.5 and 1.5 mc.

The bandwidth saving resulting from the use of mixed highs can of course be used in a channel of fixed width to increase the useful resolution. Mixed highs are useful only in quasi-simultaneous systems such as the dot-sequential and frequency-interlaced systems. As a practical matter they offer no advantage in the line-sequential and field-sequential systems.

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THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK

Photoelectric Analog Computer

By ELDO C. KOENIG
Electrical Engineer
Allis-Chalmers Manufacturing Company
Milwaukee, Wisconsin

THE VACUUM PHOTOCELL with a silver-cesium oxide-cesium cathode has been found to have valuable application in an electric analog computer, which is used for solving problems involving single-valued nonlinear parameters. Besides its desirable current-voltage characteristics, the cell has other very important features which make the computer relatively simple in design and operation. These features are briefly as follows:

(1) A family of curves is obtained simply by varying the amount of light excitation.

(2) Cells to represent equal nonlinear parameters can be conveniently excited from the same source of light.

(3) Particular curves of the families of curves of a group of cells excited from the same source can be obtained simultaneously by varying the voltage across the exciting lamp.

(4) Since the light excitation circuit and the cell circuits of the analog are completely isolated, there is no problem of circulating currents through metallic connections between circuits.

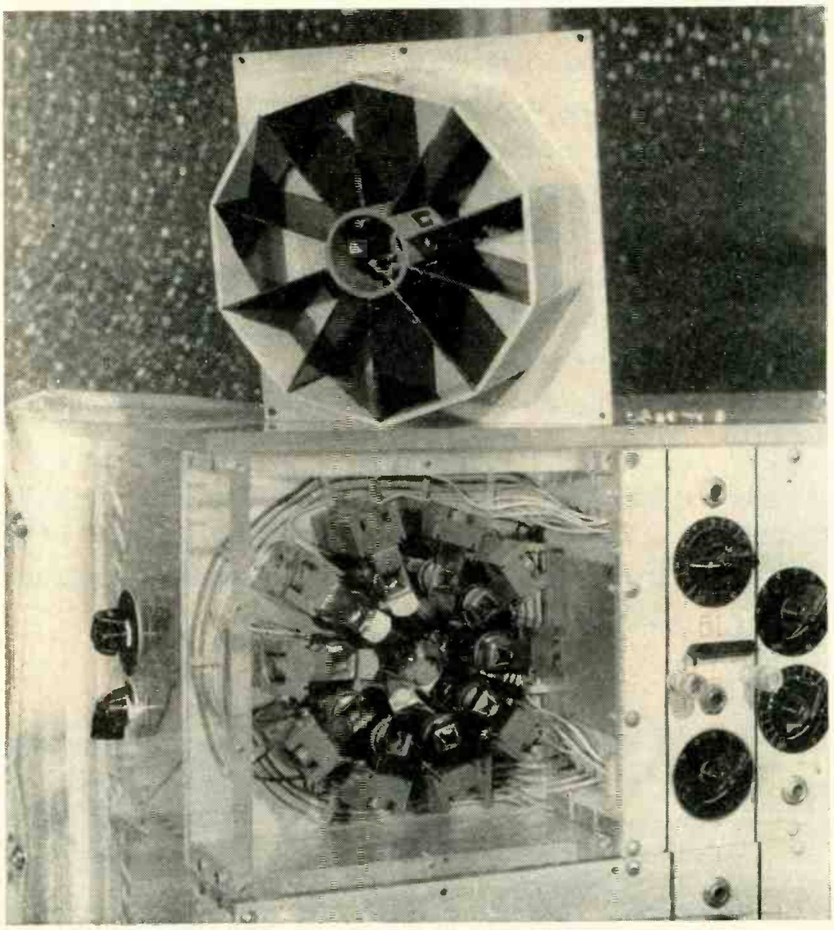
It was found that most cells are unstable and require some light ageing before they are suitable for use in the computer. By subjecting the cells to cyclic periods of excitation and zero excitation at higher voltages, with current outputs of relatively high values during the excitation period, they can be made to approach stable conditions. Approximately 25 of these cycles are required before they are suitable for use, and improvement progresses with continued use of the computer.

One or more photocells in combination with one or more resistors in series or parallel, and in some instances emf's within the element net work, form the several basic elements which may be used to represent nonlinear parameters of systems. An example of a basic element consisting of a cell and a resistance in parallel is shown in Fig. 1 and is the type used extensively in the computer for studies of magnetic circuits.

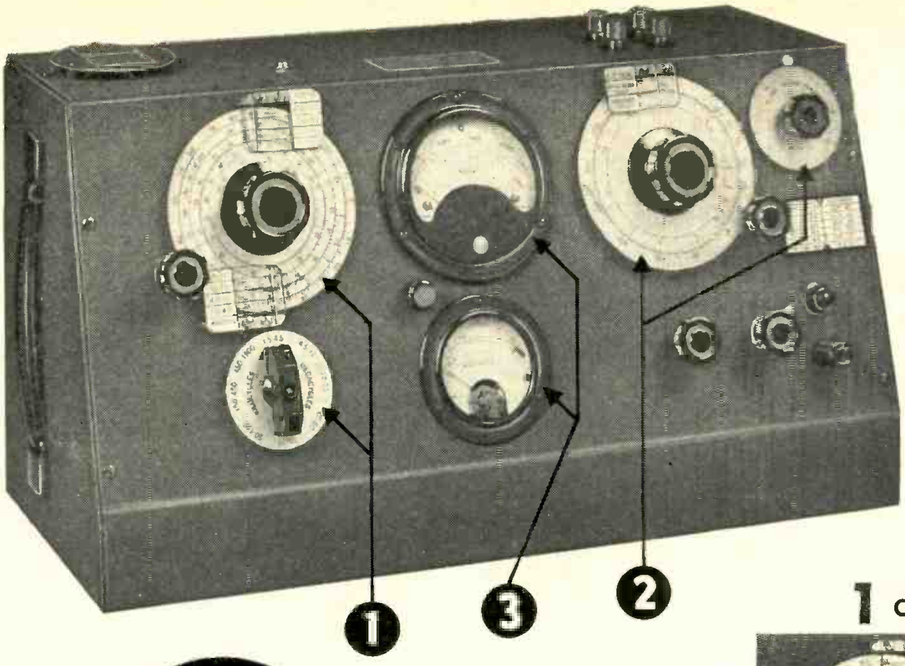
The resistor in parallel increases the slope of the current-voltage curve, as shown in the illustration, and thus makes possible the matching of the magnetization curve of one cubic inch of magnetic material with the characteristic curve of the basic element.

Excitation

The photocells of the basic elements of the computer are excited from six separate incandescent light sources with ten cells excited from each source. The excitation of each cell is adjustable by means of a shutter on the opening through which the light passes to the cell. The excitation of the ten cells in



One of the photocell units contains a single lamp for excitation and ten radially positioned photocells with separate apertures and outputs. Cylindrical light shield (shown in center of removed cover) fits over bulb (in center of phototube cluster)



EXAMINE THESE

Direct Reading Features—

WHICH SIMPLIFY ACCURATE MEASUREMENTS

The Q METER

TYPE 160-A

50 kc. to 75 mc.

Radio frequency circuit design often requires the accurate measurement of Q, inductance and capacitance values. For this application the Type 160-A Q-Meter has become the uncompromising choice of radio and electronics engineers in this country and abroad.

Each component part and assembly used in the manufacture of this instrument is designed with the utmost care and exactness. Circuit tolerances are held to values attainable only in custom built instruments.

With the 160-A Q-Meter, as with other Boonton Radio Corporation instruments, the keynote in design is to embody accurate *direct reading* features which save time and simplify operation.

SPECIFICATIONS

Oscillator Frequency Range: 50 kc. to 75 mc. in 8 ranges.

Oscillator Frequency Accuracy: ±1%, 50 kc.—50 mc.
±3%, 50 mc.—75 mc.

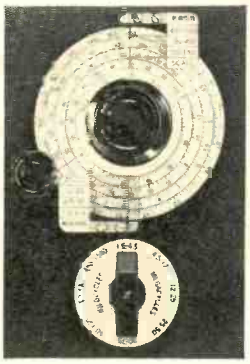
Q Measurement Range: Directly calibrated in Q, 20-250. "Multiply—Q—By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q range to 625.

Q Measurement Accuracy: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.

Capacitance Calibration Range: Main capacitor section 30-450 mmf, accuracy 1% or 1 mmf whichever is greater. Vernier capacitor section +3 mmf, zero, −3 mmf, calibrated in 0.1 mmf steps. Accuracy ±0.1 mmf.

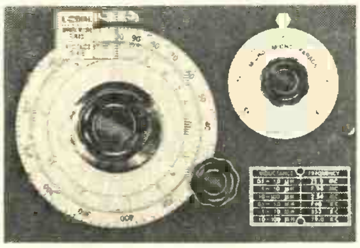
Catalog "H" containing further information available upon request.
(In Canada, direct inquiries to RCA Victor Co., Ltd., Montreal.)

1 OSCILLATOR FREQUENCY DIAL.



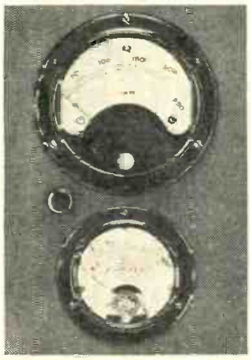
This large 4½" open faced dial has eight overlapping frequency ranges, each calibrated *directly* in kilocycles or megacycles, with scales conveniently divided for maximum readability. A vernier dial drive enables fine settings to be made with ease. All frequency ranges are accurate to within ±1% except the 50-75 megacycle range which is accurate to ±3%. The clearly marked range change switch located directly beneath the frequency dial facilitates rapid and positive selection of the desired frequency band.

2 Q-TUNING CAPACITANCE DIALS.



L-C dial serves twofold purpose of (1) conveniently and accurately indicating tuning capacitance *directly* in MMF, and (2) providing an effective inductance scale which also becomes *direct* reading at certain defined frequencies shown on frequency reference plate. Incremental capacitance dial at right calibrated from +3 MMF through zero to −3 MMF, accurate to ±0.1 MMF.

3 Q-VOLTMETER AND MULTIPLIER METER.



For the indication of Q values the 160-A Q-Meter employs a Weston Model 643 Meter calibrated *directly* in terms of Q over the range from 20-250. The damping of the meter movement is ideal for the rapid determination of exact resonance without sluggishness or overshoot. The lance type pointer enables Q readings to be obtained to the nearest unit. Located directly beneath the Q voltmeter is the "Multiply-Q-By" meter which provides Q multiplier factors of X1 to X1.5 in 0.1 steps, X2, and X2.5 thereby extending the useful range of Q indication to 625. This meter is carefully matched to a particular thermacouple element for maximum accuracy.

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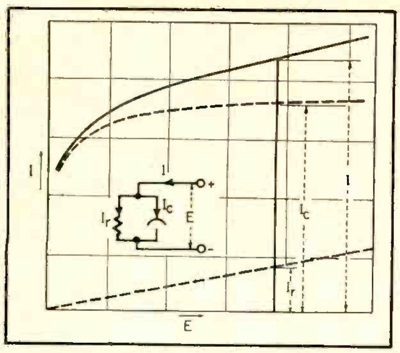

FIG. 1—Basic element required for magnetic saturation studies

each group, which may represent equal parameters of a system, can be varied simultaneously by changing the voltage across the exciting lamp. A master control is used for changing the voltage across all the exciting lamps and thereby can be used to adjust the excitation of all 60 of the cells simultaneously.

The photograph shows the cover removed from one of the units containing a group of ten cells excited from a single incandescent lamp. The cylinder of canvas Bakelite material, which is mounted on the inside of the cover, fits over the exciting lamp when the cover is in place. A screw shutter adjustable from the front of the cover passes in front of each of the ten openings in the cylinder to adjust for initial differences in the characteristics of the cells. Black plastic partitions separate the cells when the cover is in place and prevent the light intended for one cell from influencing the excitation of other cells.

Means are provided for cooling the exciting lamp by a blower which forces air around the lamp from the back and exhausts it through an opening in the cover.

The currents in the analog circuit are unidirectional and are not amplified. The values of current in different parts of the network system may cover a range from zero to approximately 125 microamperes. However, the current through individual cells seldom exceeds 15 microamperes.

There are 56 separate sources of unidirectional emf's available in the computer which may be connected anywhere within the analog circuit. These emf's are supplied by half-wave rectifiers and may be varied from zero to as high as 2,000 volts in some cases. As many as ten isolated voltages can be varied simultaneously.

A transformer of special design is used as a means of varying a group of isolated emf's simultaneously. The half-wave rectifiers of a group of emf sources are supplied by separate windings on the center leg of a three-legged core transformer. The single primary winding, also on the center leg, is connected to a source of alternating current supply through a continuously variable transformer, which is used to vary all of the ten unidirectional emf's simultaneously.

A second group of separate windings on an outer leg of the transformer supplies current to the heater filaments of the rectifiers. The single primary winding is connected directly to the alternating current source.

Since very small currents flow through the circuits with relatively high voltages impressed, special precautions were exercised in the construction of the instrument panels and the building of the control apparatus in order to avoid difficulties from leakage currents. The problem was alleviated to a great extent with the use of some of the more recent plastics. As a special precaution in guarding against future leakage currents, the computer apparatus was completely enclosed and air conditioned. With these precautions exercised there have been no leakage difficulties experienced.

Improved Microwave Spectroscope

MICROWAVE SPECTROSCOPY is based on sharp-line resonant absorptions that various gases exhibit throughout the microwave region. The simplest form of microwave spectroscope consists of a source of microwave energy, a section of waveguide in which the gas under study is placed, and a crystal detector. Constituents of the gas are identified by measuring frequencies of absorptions.

This system, while useful in some applications, leaves much to be desired in terms of sensitivity.

The Stark modulation system provides increased sensitivity in the detection and measurement of absorptions. The Stark system makes use of the fact that these absorption lines split up or change frequency when a d-c electric field is applied to the absorbing gas. Changes in output power (absorptions) as low as one part in 10^8 per centimeter of absorption path are possible.

In practice, a low-frequency oscillating d-c field is applied to an insulated metallic septum which extends the full length of the waveguide absorption cell. An amplifier tuned to the Stark modulation fre-

(Continued on p 214)

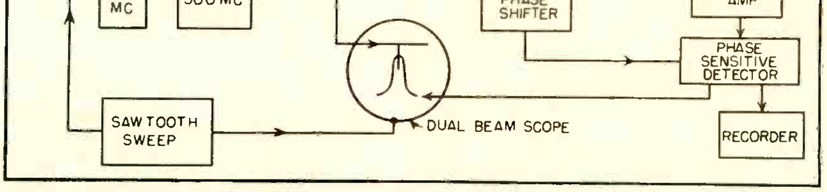

FIG. 1—Block diagram of components of 85-kc Stark-modulated microwave spectroscope

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with Kodapak Sheet

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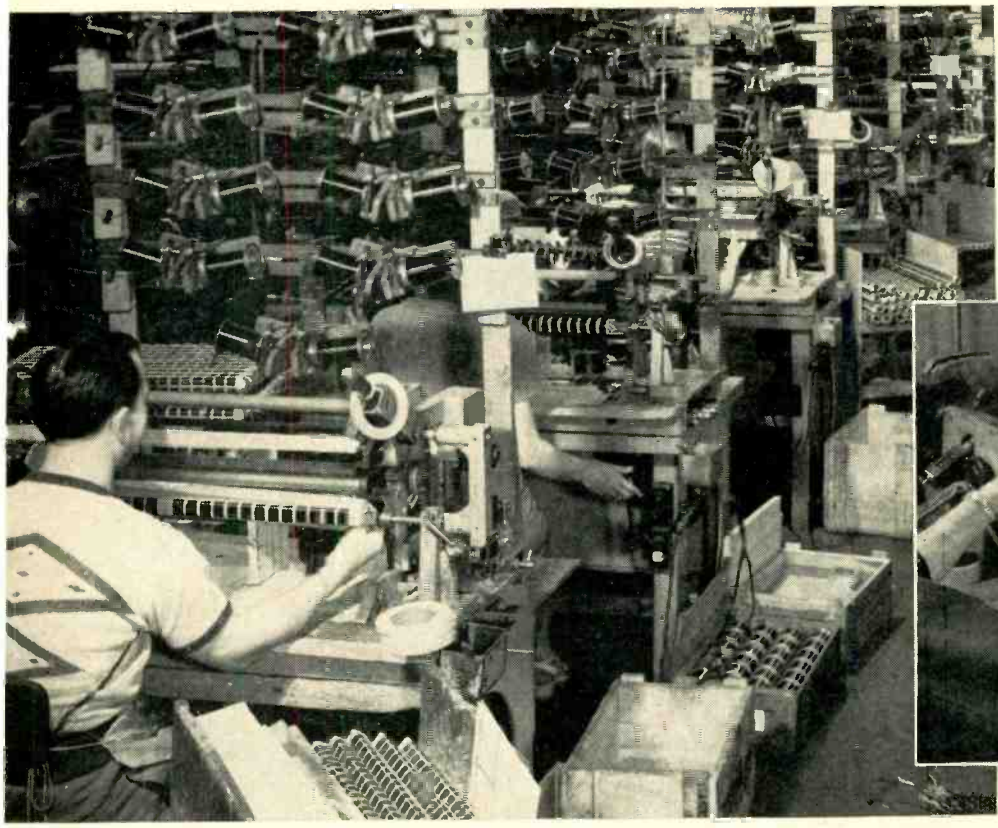

Gang layer insulation of transformer coils with .005-inch Kodapak I Sheet. Reproduced from photographs made in plant of Standard Transformer Company, Chiçago, Illinois, through the co-operation of the Insulation Manufacturers Corporation.

Feeding in .005-inch Kodapak I Sheet for coil-layer insulation.

Inserting sample preparatory to voltage breakdown test on Kodapak I Sheet.

UNIFORM COVERING: Because it has excellent strength, stretch, and toughness characteristics, Kodapak Sheet is particularly suitable for use on high-speed coil winding machines. It handles well at high speeds and it may be flexed or bent without danger of breaking.

UNIFORM PROTECTION: Kodapak Sheet gives a superior winding surface *plus* high dielectric protection with a minimum of bulk. Another advantage: lacquer and solvents may be used to form a continuous waterproof seal.

GENERAL INFORMATION: Kodapak Sheet is available in various forms, including Kodapak I Sheet, cellulose acetate, gauges up to 0.060″; Kodapak II Sheet, cellulose acetate butyrate, gauges up to 0.002″. For electrical applications where toughness and lower moisture absorption are required, Kodapak II Sheet is preferred, because of its physical toughness and high dielectric strength.

For further information, including other applications, write for free copy of the folder, "Kodapak Sheet for Electrical Uses."

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NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

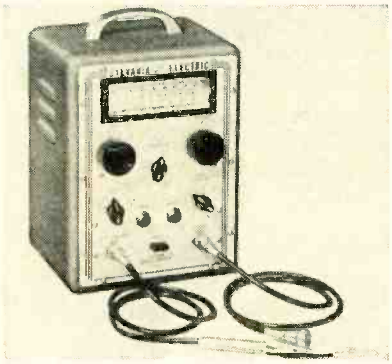
Variety of New and Improved Test Equipment Can Aid Manufacturer and Serviceman . . . Multipurpose Tubes and Components Are Offered . . . Twenty-five Literature Items Are Reviewed

Improved Phototube

RADIO CORP. OF AMERICA, Camden, N. J., has announced an improved 5819 head-on multiplier phototube. Spectral response covers the range from about 3,000 to 6,400 angstroms. Expressly designed for scintillation-counter work, the tube utilizes a head-on construction with a photocathode measuring 1½ in. in diameter on the inner glass surface of the face end of the bulb. Having a resolving time of only a small fraction of a second, the 5819 is capable of counting radioactive particles arriving less than one 100-millionth of a second apart.

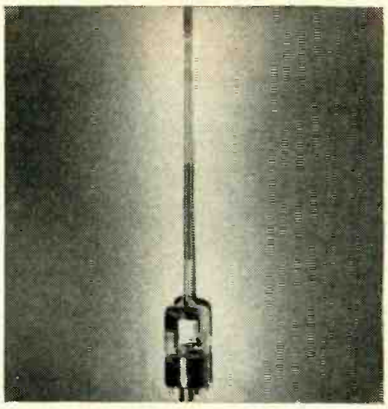
Power Level Meter

REED RESEARCH, INC., 1048 Potomac St., Washington 7, D. C. The Diotron power level meter uses a temperature limited diode and feedback loop. In the measurement of erratic or nonsinusoidal wave forms, it yields a true power reading on a linear scale. Full-scale measurements of 1 mw, 10 mw, 100 mw, 1 watt and 10 watts into 600 ohms are provided. Accurately corresponding rms voltage scales are also calibrated, and the instrument is within approximately ±2 percent from 50 cps to 10 mc.



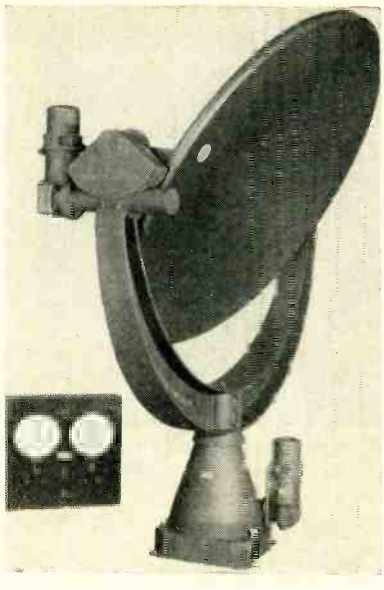
TV Marker Generator

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. Type 501 television marker generator provides a means of accurately marking frequencies on the ocilloscope trace of response curves while testing a tv receiver during manufacture or servicing. The tuned oscillator in the unit provides frequencies ranging from 15 to 240 mc in four bands: 15 to 30 mc, 30 to 60 mc, 60 to 120 mc and 120 to 240 mc. With an appropriate crystal inserted in the panel socket the oscillator will operate at any frequency between 2 and 20 mc, and will provide useful harmonic output up to the sixth for all-band calibration. A 4.5-mc crystal for use in servicing receivers with intercarrier sound circuits is available on special request.



Traveling-Wave Power Amplifier

FEDERAL TELECOMMUNICATION LABORATORIES, INC., 500 Washington Ave., Nutley 10, N. J., has announced a new traveling-wave power amplifier (model 5929) of the helix type, in the 4,000-to-5,000-mc frequency range. Constructed with particular attention to interchangeability, the tube will deliver a power output in excess of 10 w with a power gain of 20 db. The r-f terminals are arranged for waveguide circuit and the tube operates with an external electromagnetic field.

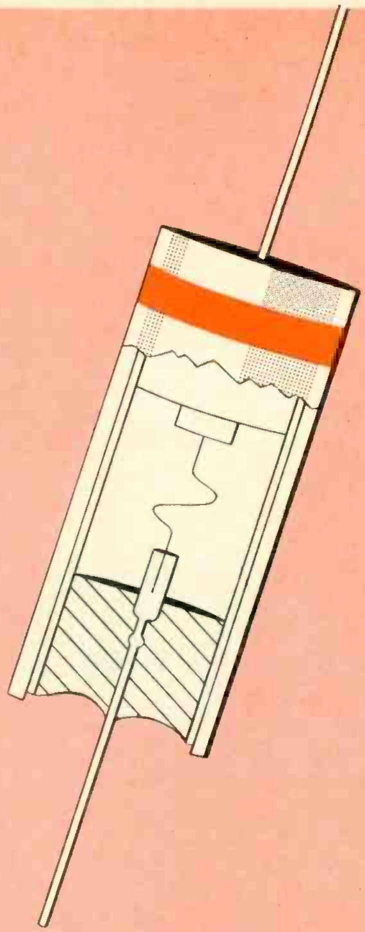


Remote Control of Microwave Antennas

RADIO CORP. OF AMERICA, Camden, N. J. A rotatable field mount and a remote control unit make up a new system for remote positioning of microwave parabolic antennas in the field at distances up to 1,500

RAYTHEON

GERMANIUM CRYSTAL DIODES



PERFORMANCE FEATURES:

Superior humidity characteristics

No wax or filler to affect operation even up to 100° C.

Improved Resistance-Temperature characteristics

Small size — 9/64" diameter, 25/64" length

Distinctive color coding

Smaller, more flexible leads for easier wiring

Completely insulated body for compact assembly

PERFORMANCE FACTS:

The following types are available in production quantities at Newton and Chicago, and in smaller quantities at our 310 Special Tube Distributors.

	CK705 General Purpose	CK706 Video Detector	CK707 50 V. dc Restorer	CK708 100 V. dc Restorer	CK710 UHF Mixer	1N66† General Purpose	1N67† High Back Resistance	1N68† 100 V. dc Restorer
MAXIMUM RATINGS (at 25°C.)								
DC Inverse Voltage (volts)	60	40	80	100	5	60	80	100
Average Rectified Current (ma.)	50	35	35	35	25	50	35	35
Peak Rectified Current (ma.)	150	125	100	100	75	150	100	100
Surge Current (for 1 sec.) (ma.)	500	300	500	500		500	500	500
Ambient Temperature for all types	— 50 to +100°C.							
CHARACTERISTICS (at 25°C.)								
Max. Inverse Current at — 2 volts (ma.)					0.5			
Max. Inverse Current at — 5 volts (ma.)			0.008				0.005	
Max. Inverse Current at — 10 volts (ma.)	0.05					0.05		
Max. Inverse Current at —50 volts (ma.)	0.8		0.10			0.8	0.05	
Max. Inverse Current at —100 volts (ma.)				0.625				0.625
Min. Forward Current at +1 volt (ma.)	5.0		3.5	3.0		5.0	4.0	3.0
Min. DC Reverse Voltage for Zero Dynamic Resistance (volts)	70	50	100	120		70	100	120
Shunt Capacitance (uuf)	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Rectification Efficiency at 54 mc (approx. %)		60						
Rectification Efficiency at 100 mc (%)						35 (min.)		
Oscillator injection current (ma.)					0.75*			

*Conversion loss at 500 mc. and noise factor comparable with 1N21B

†1N66, 1N67 and 1N68 must also pass humidity tests.

Other types are available for special applications.

RAYTHEON MANUFACTURING COMPANY

SPECIAL TUBE SECTION • Newton 58, Massachusetts

SUBMINIATURE TUBES • GERMANIUM DIODES and TRIODES • RADIATION COUNTER TUBES • RUGGED, LONG LIFE TUBES

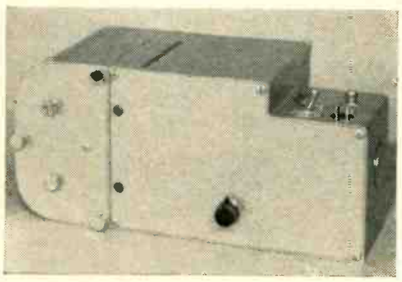
RAYTHEON

Excellence in Electronics

feet. The design of the field mount provides for both azimuth and tilt positioning of the parabola. The parabola is driven with 1/6-hp motors each providing a torque of 10,500 in. lb at 1 rpm. The reflector may be rotated 370 degrees in azimuth or tilted 15 degrees up and 30 degrees down. Magnetic brakes on each of the positioning motors aid in positioning the parabola to within ± 10 min of an arc. Power required for operation is 115 v, 60 cps, single phase, 6.8 amperes.

Signal Splitter

J. L. A. McLaughlin, P. O. Box 529, La Jolla, Calif., has announced the new Series 10 Signal Splitter, a selectable single-sideband converter for eliminating adjacent-channel and heterodyne interference. Either sideband can be rejected with high attenuation. The equipment is available in single, dual, and triple units. Models have information bandwidths of 200, 2,500, and 5,000 cps within ± 1 db and are suitable for reception of high-speed telegraphy, voice, and transoceanic broadcast reception. They can be employed with standard single or diversity communication receivers.

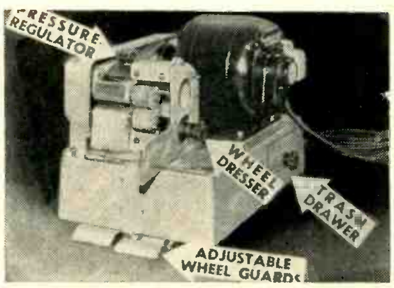


Adverse-Condition Oscillograph

Century Geophysical Corp., Tulsa, Okla. The Model 409 oscillograph has been designed especially for recording phenomena under the most adverse conditions. All parts and components have been selected in order that the oscillograph will withstand and record faithfully during accelerations up to 20 g's. The unit is especially desirable for use in instrumentation problems where space requirements are limited such as in parachute ejection tests and torpedo and missile studies. The magazine will accommodate a 50-foot roll of paper or film that is 3⅝ in. wide. Any speed from 2 to 12 in. per second may be selected by a calibrated dial control. The unit operates on 24 v d-c and full power current requirement is 3 amperes.

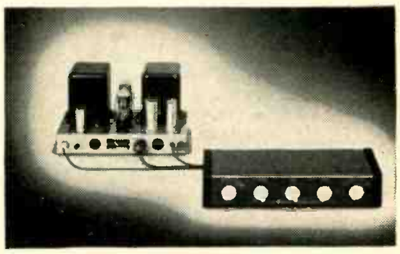
Transmitter Test Equipment

Radio Corp. of America, Camden, N. J. Type BI-11A transmission measuring set provides direct readings of transmitter system measurements with an accuracy conforming to FCC regulations. The new unit, which is particularly useful as a rack-mounted unit in the master control room or at the transmitter of a broadcast station, eliminates lengthy calculations and intricate setups for many transmitter measurements.



Wire Stripper

Rush Wire Stripper Division, The Eraser Co., Inc., 104 South State St., Syracuse 2, N. Y. Model DV wire stripper illustrated uses the principle of frictionally generated heat to melt enamel and Formex-type insulations. Through proper selection from a large number of different grades of stripping wheels, practically all kinds of insulations can be cleanly removed without damage to the wire. The model shown will strip wires, gages 48 through 25, including Litz wire up to 50/44. It measures 10 in. wide, 15 in. deep, and weighs 38 lb complete with motor and 6-ft lead. It is available for outright purchase or may be had on a rental-test basis.



Amplifier System

The Electronic Workshop, Inc., 351 Bleecker St., New York 14, N. Y. Model A-20-5 amplifier system has four input channels (including an equalizer-preamplifier for any of the available magnetic phono cartridges) with independent level adjustments. A four-position treble cutoff filter reduces high-frequency noise and distortion. The amplifier's 18 db of feedback affords excellent loudspeaker damping and long tube life. Distortion at 20 watts is less than 1 percent. Full power is delivered over the entire audio range.

Mixer Crystal Test Set

Airborne Instruments Laboratory, 160 Old Country Road, Mine-

(Continued on page 241)

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

...with the economy of thoriated-tungsten filaments

THESE SIX improved RCA power tubes are "musts" for designers of industrial electronic heating equipment where design and operating economies alike are important considerations.

Ranging in power input from 1.5 to 650 kw, these types successfully utilize thoriated-tungsten filaments which offer marked savings in filament power and the cost of associated power equipment.

The 5671 utilizes an effective lightweight radiator while the 5762 and 5786 have radiators designed to permit use of less-expensive blowers than have been required previously for similar tubes. The new and revolutionary RCA-5831 super-power beam triode with internal water cooling, is tested at one million watts input, and handles with high efficiency an input of 650 kilowatts in continuous commercial service.

Air jackets for the 5671 and 5762, and water jackets for the 5770 and 5771, are available from RCA.

. . .

RCA Application Engineers are ready to consult with you on the application of these improved tubes and accessories to your specific designs. For complete technical information covering the types in which you are interested, write RCA, Commercial Engineering, Section L42R, Harrison, N. J.

RCA

RADIO CORPORATION of AMERICA

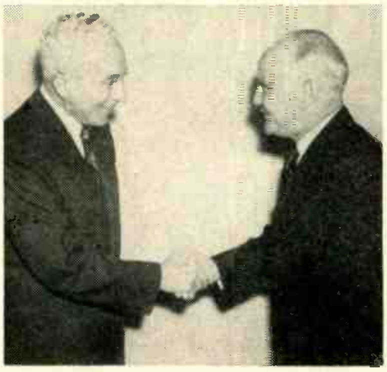
ELECTRON TUBES ***HARRISON, N. J.***

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

SMPTE Elects 1951 Officers, Confers Awards

MEETING at Lake Placid, N. Y. for its 68th Semiannual Convention October 16-20, the Society of Motion Picture and Television Engineers elected Peter Mole of the Mole-Richardson Co., Hollywood, president for 1951, Herbert Barnett of General Precision Labs., Pleasantville, N. Y., executive vice-president and John G. Frayne of the Westrex Corp., Hollywood, editorial vice-president. Other officers of the Society include Fred T. Bowditch, engineering vice-president, Ralph B. Austrian, financial vice-president, William C. Kunzmann, convention vice-president, Frank Cahill, Jr., treasurer and Robert M. Corbin, secretary.



Peter Mole (left), new president of the SMPTE, and retiring president Earl Sponable

The new board of governors, also taking office January 1, includes William B. Lodge of CBS, Oscar F. Neu of Neumade Products Co., Frank E. Carlson of GE, Malcolm G. Townsley of Bell & Howell, Thomas T. Moulton of 20th Century Fox, Norwood L. Simmons of Eastman Kodak and Lloyd Thompson of the Calvin Co.

Fellowship awards were made to Gerald L. Badgley, George L. Beers, Herbert E. Bragg, Fred W. Gage, Raymond L. Garman, Watson Jones, John P. Livadary, William B. Lodge, Boyce Nemec, Charles Rosher, John H. Waddell, Emerson Yorke and Frederick J. Kolb, Jr. Frederick J. Kolb Jr. received the Journal Award, Charles R. Fordyce the Samual L. Warner Memorial Award and Vladimir K. Zworykin the Progress Medal and a certificate of honorary membership. A certicate of honorary membership was also awarded Edward W. Kellogg.

Attendance at the meeting totalled just under 300.

EMPIRE STATE TELEVISION ANTENNA

Lines of a temporary television antenna atop the Empire State Building in New York City are shown being fastened by a steeplejack perched at 1,200 feet above ground. The new 222-foot tower now being completed will accommodate video transmitters for five New York television stations: WCBS-TV, Columbia Broadcasting System, Inc.; WABD, Allen B. Du Mont Laboratories, Inc.; WPIX, *The Daily News;* WNBT, National Broadcasting Co.; and WJZ-TV, American Broadcasting Co., Inc. Visible at the left is the needle-pointed Chrysler Building and at the right is the new United Nations Building near the East River

Priority System Announced

THE DEPARTMENT of Defense Munitions Board has announced that priority for defense contracts under NPA Regulation 2 is being handled as follows: Defense orders are identified as DO orders. This rating is the only one authorized under the regulation and all DO rated orders will have equal preferential status. The identifying digits which will be used in assigning DO numbers are: 0.1, aircraft; 02, guided missiles; 03, ships; 04, tank-automotive; 05, weapons; 06, ammunition; 07, electronic and communication equipment; 08, fuels and lubricants; 09, clothing and equipage; 10, transportation equipment; 11, building supplies and equipment for overseas (troop) construction; 21, miscellaneous; 22, Department of Defense construction (contract); 98, production equipment for certain contractors. All outstanding prime contracts now in effect and all new contracts will be rated with the exceptions of communications services, mineral aggregates, ores and scrap, and transportation services.

Rated orders must be accepted and filled regardless of existing contracts and orders except for such cases as when a delivery date on a rated order would interfere with the delivery date on a previous rated order, or if filling the order would cause a substantial loss of production.

The Board suggests that present prime contractors should check with contracting offices to make certain that all their defense contracts which are subject to rating are covered. In addition, subcontractors should begin immediately to iden-

tify those of their contracts which are with prime defense producers, who will have authority to extend the rating to them. The rating procedure in no way changes procurement practices. Contracts will be let in the same way they have in the past and those seeking contracts will follow the same procedure they have been following.

MEETINGS

JAN. 10-12; Second High Frequency Measurements Conference, sponsored by AIEE, IRE and NBS, Hotel Statler and Dept. of Interior Auditorium, Washington, D. C.

JAN. 22-26: AIEE Winter General Meeting, Hotel Statler, New York, N. Y.

MARCH 5-9: ASTM Spring Meeting and Committee Week, Cincinnati, Ohio.

MAR. 19-22: IRE Annual Convention, Hotel Waldorf Astora and Grand Central Palace, New York City.

MAY 23-24: Fifth National Convention, American Society for Quality Control, Hotel Cleveland, Cleveland, Ohio.

JUNE 18-22: ASTM Annual Meeting, Atlantic City, N. J.

JUNE 25-29: AIEE Summer General Meeting, Royal York Hotel, Toronto, Ontario, Canada.

CAA Approves Omnirange Flying

FOR THE FIRST TIME since the introduction of the omnirange technique a chain of these ranges has been designated by CAA as a controlled airway, over which qualified pilots in properly equipped planes may operate under instrument flight rules. The CAA has authorized Continental Air Lines to operate on this basis.

Extending through six states, they connect such important air traffic terminals as Kansas City, Denver, and Albuquerque. Also linked by the new type of facility are Omaha, Wichita, Tulsa, Oklahoma City, El Paso, Fort Worth and other cities en route.

The new routes cover approximately 4,380 miles and are formed by the signals of 41 CAA omniranges. In all, 271 omniranges have been commissioned by CAA in different parts of the United States.

The omnirange differs in two major respects from the conventional radio ranges which for 20 years have been the foundation of our air navigation system. It operates in the vhf band, thus eliminating most of the static and interference which occur in low-frequency transmission. In addition, the omnirange sends out courses in every direction, instead of just four. (Omnirange is a contraction of omnidirectional range.)

Flying the omnirange is relatively simple. Instead of listening continuously to dot-dash signals as on the four-course range, the pilot simply tunes in the omnirange and flies so as to keep a needle centered in a cockpit dial. Keeping that needle centered automatically crabs the plane into the wind just the right amount to fly a straight-line course to the omnirange.

Ultimately, CAA plans to install more than 400 omniranges for en-route flying of airways, blanketing most of the United States with their signals. They will make possible not only omnirange airways of the type just opened, but off-airway flying to hundreds of points not now served by air navigation aids. Omniranges also are used for low approach and let-down to airports under instrument conditions.

SUNSHINE MAKER IN ACTION

Palisades Amusement Park, N. J., was the scene of operation of Dr. G. A. Sykes, sunshine maker, while trying to outdo Dr. Howell, New York City's official rainmaker. Salary arrangement gave him $500 per sunny day with a forfeiture of $1,000 every rainy day. His method is to shoot electromagnetic waves into the clouds, with the hope of breaking them up and stopping rain

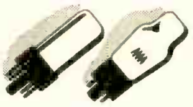
Signal Corps News

A NEW TYPE military field communications wire has been used successfully in Korea. Particularly suited to airborne operations, the wire can be laid at speeds up to 120 mph from planes. The wire consists of 2 conductors, each individually insulated and jacketed and twisted together to form a light, flexible, flat-lying twisted pair. A thin covering of nylon provides a tight waterproof container for the strands. Weight is about 46 lb per mile and talking range is approximately 12½ miles.

A companion item is an improved dispenser constructed of canvas and tape which will hold one-half mile of field wire. The wire can be

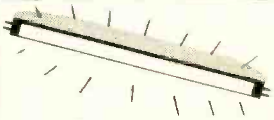
(Continued on p 274)

SYLVANIA TV Picture Tubes are natural-born leaders because . . . they come from a leading family



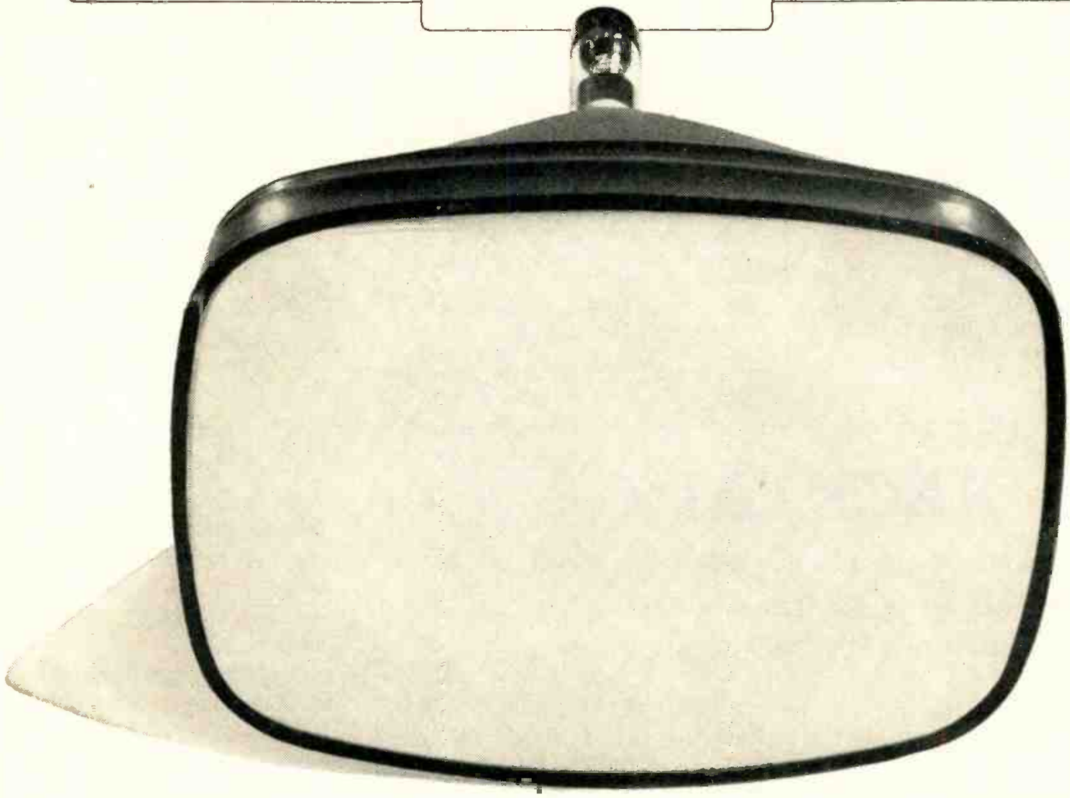
Radio Tubes . . . 25 years' experience in building high quality tubes for every radio and television need.

Electronics . . . wide experience in designing radar and electronic equipment for war-time and post-war commercial use.



Phosphors . . . production of white and colored phosphors for the "Finest in Fluorescent Lighting."

Lighting . . . half a century of research and manufacture of incandescent and fluorescent lamps to meet longest life and highest vision standards.



This unique combination of experience naturally fits Sylvania for top position in the TV Picture Tube field.

Maintaining this leadership is a continuing program of research and engineering. A Sylvania engineer, for example, invented the famous "Ion Trap," now licensed to numerous other picture tube makers.

Sylvania achievements in fluorescent powders, tungsten wire, and precision parts are some of the other reasons which lie behind the consistent color, greater clarity, and longer life of all Sylvania TV Picture Tubes.

Backing up each Sylvania advance is a rigid system of quality control . . . of checking and rechecking every step of every process . . . so that TV set owners everywhere will continue to look to Sylvania for the finest performance possible. New booklet gives information concerning the complete line of Sylvania Picture Tubes. Write for your copy today. Address Sylvania Electric Products Inc., Dept. R-2112, Emporium, Pa.

SYLVANIA ELECTRIC

TELEVISION PICTURE TUBES; RADIO TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

NEW BOOKS

Practical Television Engineering

By Scott Helt. *Murray Hill Books, Inc., New York* 1950, 708 *pages*, $7.50.

This volume, written by a member of the Research Division of the A. B. DuMont Laboratories and former chief engineer of the DuMont network, is the most comprehensive book on modern television equipment in print. Writing primarily from the standpoint of the equipment designer and operator, the author has constructed the book about 9 basic items of equipment: c-r tubes, c-r oscilloscopes, camera tubes, synchronizing generators, video amplifiers, regulated power supplies, television receivers, camera chains and transmitters, each of which is the subject of a separate chapter. The essential function of each is outlined in great detail, with full descriptions of components, circuits, and operating procedures taken from current practice. Nearly 100 pages are devoted, for example, to the circuits and functions of synchronizing generators, probably the most exhaustive treatment of the subject to appear anywhere. An introductory chapter outlines such fundamentals as picture transmission, scanning, optics and resolution, and a concluding chapter treats tv broadcast station operation from the engineering viewpoint. Throughout, the book is well-written, accurate and keyed to the essentials.

As the author states in his preface, even 700 pages are not sufficient to cover the whole subject as he would wish. Some readers may miss topics which, being remote from apparatus development, are not treated. These include vhf and uhf propagation, the analysis of transmission standards from a system point of view, and the fundamentals of color television. The book is not concerned with television systems themselves, but rather is geared directly to present equipment. As such, it is a very good book which will be welcomed by television engineers concerned with present-day problems.—D. G. F.

RELEASED THIS MONTH

Antennas; John D. Kraus; McGraw-Hill; $8.00.

Encyclopedia on Cathode-Ray Oscilloscopes and Their Uses; J. F. Rider and S. D. Uslan; John F. Rider Publisher; $9.00.

Photons and Electrons; K. H. Spring; Wiley; $1.75.

Pocket Encyclopedia of Atomic Energy; Frank Gaynor; Philosophical Library; $7.50.

Television, Volumes V and VI; RCA Review; $2.50 each.

Radio Engineering Handbook

Edited by Keith Henney. *McGraw-Hill Book Co., New York.* 1950, 4th *edition*, 1,197 *pages*, $10.00.

A completely adequate review of a handbook of nearly 1,200 pages would be a formidable task, and in this case cannot be attempted, so a

(continued on page 138)

BACKTALK

This Department is Operated as an Open Forum Where Readers May Discuss Problems of the Electronic Industry or Comment Upon Articles that ELECTRONICS has Published

Oscillator Radiation

Dear Sir:

In your issue of October under the heading, "Bloopers" on the *Cross Talk* page, you make reference to a letter written by me to a RTMA committee.

While I recognize the necessity of conserving space, it does seem to me that on these highly important and perhaps controversial subjects it would be better to have my letter speak for itself.

You have perhaps noticed how careful British technical journals are to reproduce verbatim the letters of their correspondents. While the Editor makes the point correctly that a letter was written by me on the subject of Radiating Receivers, my belief is that the letter that I wrote does not lend itself to the making of an abstract with the curtailment of its full meaning.

Edwin H. Armstrong
Department of Electrical Engineering
Columbia University
New York, N. Y.

Editor's Note: Here is the Major's letter.

Dr. W. R. G. Baker,
Director of Engineering,
Radio and Television
Manufacturers Association,
New York

Dear Dr. Baker:

The problem that is before this meeting today is only one of the many problems that have been created during the last five years by unsound engineering in the radio industry and in government and commercial circles responsible for radio matters.

The problem of radiating receivers has been a familiar one since the days of the single-circuit regenerative set and early superheterodyne set of over twenty years ago. That problem was solved and has been forgotten in the standard broadcast band for the last two decades. That we are now faced again with the same thing in the field of f-m and television broadcasting is a disgrace to the engineering profession. It is the result of the disregard of rules of engineering that were known twenty years ago. In both f-m and tv these rules have been and are now being flagrantly violated by a large part of the industry, perhaps to their immediate profit, but certainly to the ultimate

(continued on page 282)

Circuit Protection is Certain yet Flexible

with

HEINEMANN

MAGNETIC CIRCUIT BREAKERS

General Radio Company's Variac® Speed Control is protected against excess current damage by the HEINEMANN CIRCUIT BREAKER *shown here*

In explaining the type of protection enjoyed by this Speed Control for DC motors from AC lines, the manufacturer says: "The circuit breaker is of the inverse-time-delay type and its delay characteristics are approximately matched to the overload rating of the rectifier tube. With this protection, advantage can be taken of the short-period overload capabilities of the tube without risking destruction in the event of a stall or the application of a load of excessive inertia."

In the event of short circuit or dangerous overload, the breaker trips INSTANTLY, and any danger of arcing is eliminated by the high-speed magnetic Blowout.

An exclusive advantage of the Heinemann Magnetic Circuit Breaker is that, being entirely magnetic, nothing heats. No time is lost waiting for thermal elements to cool. After tripping, the breaker may be snapped "ON" at once. On the other hand if the overload condition persists, the contacts remain open even if the handle is held at "ON." Consequently, this breaker offers the most flexible, yet positive type of circuit protection obtainable. It provides continual service with no maintenance; all parts are cadmium plated to prevent corrosion.

Send for Bulletin No. 3100

EST. HECO 1888

HEINEMANN ELECTRIC COMPANY

97 PLUM STREET TRENTON, NEW JERSEY

NEW BOOKS (continued)

spot check system must be used. Keith Henney, who has had extensive experience in producing handbooks, has been assisted by 26 experts in the various phases. I am personally acquainted with more than half of them and know some of the others by reputation. In my opinion they are an unusually competent group of contributors. The editor has wisely omitted mathematical and mechanical tables, usually readily available, in order to include material of greater value, such as on waveguides. Despite the fact that emphasis is placed on practice rather than theory, a considerable amount of fundamental background theory is included, presumably to aid the engineer in using the practical material. Typical of this is the first chapter by Beverly Dudley on "Basis of Radio Communication" which is an excellent summary of the basic concepts, principles, and methods of radio engineering. Unfortunately, in paragraph 85, the implication seems to be that Kirchhoff's second law applies only to resistive circuits, and there appears to be some confusion regarding the particular solution of differential equations and the complementary function.

At the end of most of the chapters is an extensive list of references which will be of considerable value.

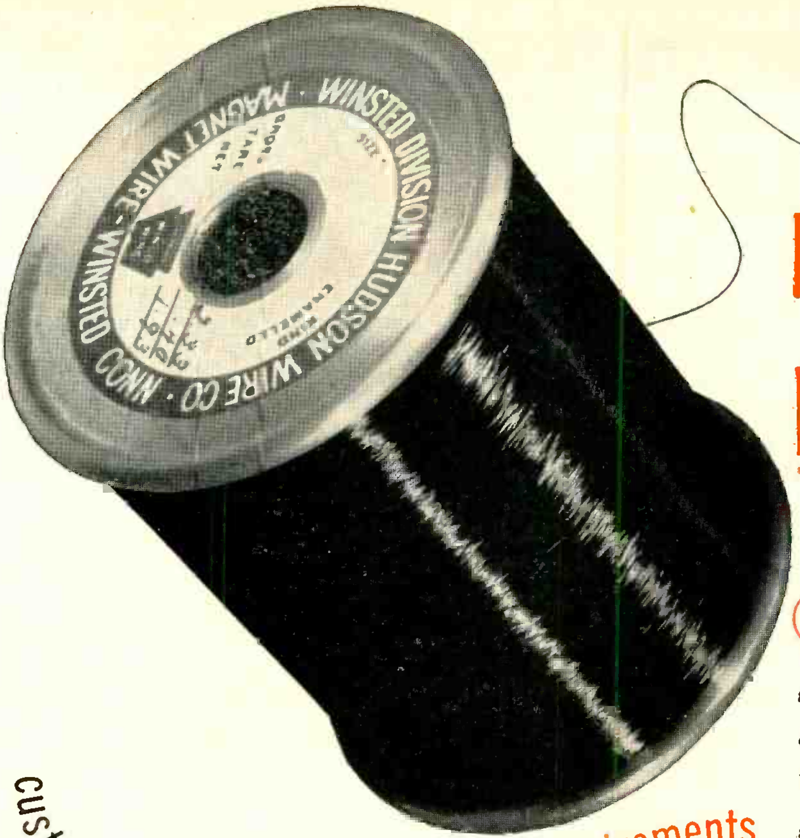
Chapter 2 on resistances would have been improved by emphasizing the merits of the Western Electric film resistors which are exceptionally good at high frequencies.

In Chapter 5, the curves shown in Fig. 19, 20, 21 do not correctly represent the phenomena and no mention is made of the effect upon the transient current of closing the circuit at different points on the electromotive force curve. The equation at the top of page 193 appears to be incorrect.

Chapter 6 provides an excellent discussion of electrical measurements; however, it should be noted that one side of equation 24 is inverted and equation 45 is dimensionally incorrect.

In Chapter 7 a notable omission is a discussion of regulating systems.

The format is quite satisfactory, the type legible, and the figures well done. Despite the fact that there



custom drawn ◎ custom insulated ◎ custom spooled

to your most exacting requirements

FINE WIRE
made finer

Custom-made fine wire! Just specify the electrical properties, flexibility, tensile strength, laying speed, uniformity and other characteristics you must have. Our Hudson and Winsted Divisions will meet and maintain your specifications.

Uniformity of product is guaranteed by our critical supervision which guards against variations in size, structure and electrical values. Yes, "Fine Wire Made Finer!" That is why Hudson-Winsted fine wires are the first choice of electrical, radio, television and electronic manufacturers whose products are noted for reliability and long life.

Tell us your wire problems and requirements. Our research, engineering and production facilities are at your disposal. Let us quote!

BARE WIRES
(HUDSON WIRE DIVISION)

Copper, Brass, Zinc, Tinsel, Tin, Nickel-Silver, Cadmium, Oxygen-free Copper, Silver-plated, Bronze, Phosphor-Bronze, Silver, Monel, Lead Wire, Fuse Wire, Specialty Wires

TEXTILE-COVERED WIRES
(WINSTED DIVISION)

Nylon, Celanese*, Silk, Cotton, Rayon, Fiberglas

All available on bare or enameled wire, single or double covered.

INSULATED WIRES (WINSTED DIVISION)

MATERIALS	TYPES	COVERINGS
Copper	Instrument Tubing	Plain and Heavy Enamel
Aluminum	Litz	Formvar
Iron	Multiplied and Twisted	EZsol (Liquid Nylon)
Copper-clad Steel		Cement-coated Enamel

FINE WIRES (HUDSON & WINSTED DIVISIONS)

Specializing in fine wires, custom-drawn and insulated, to critical needs—size, material, insulation. Your consideration is called particularly to the finest wire sizes—Nos. 44 to 50.

hudson wire company

general offices: ossining, n. y. winsted division: winsted, conn.

Every Alnico permanent magnet made by Carboloy Company is subjected to many quality checks like this flux test to assure you of outstanding uniformity and performance.

Look to CARBOLOY CO., INC. *for the finest in special metals*

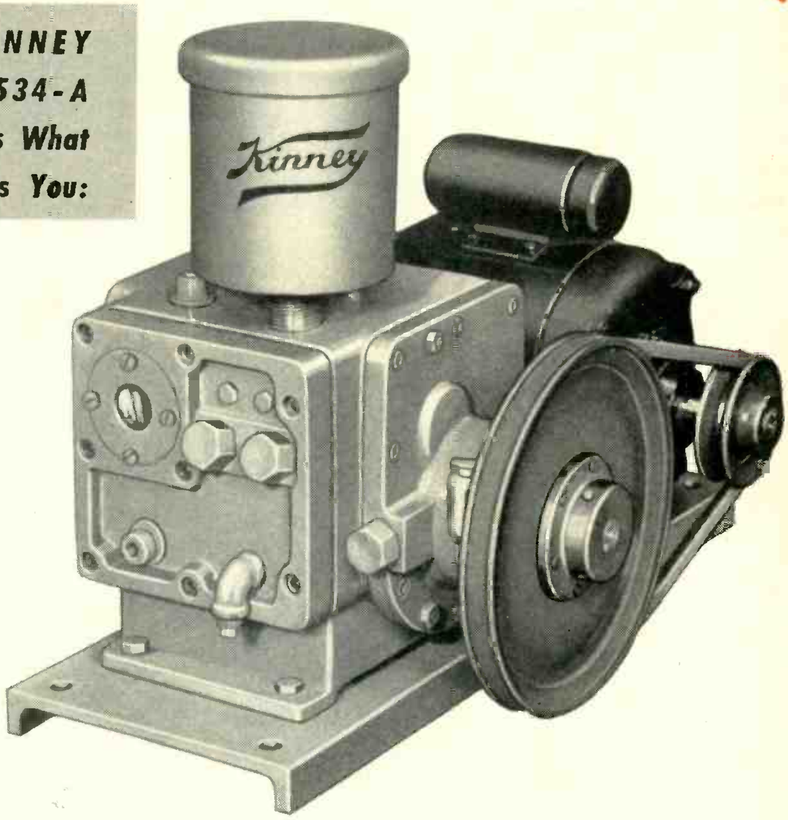
THE SAME principles of rigid quality control are being applied to the production of Alnico permanent magnets and special metals that have made "Carboloy" the leader in the field of cemented carbides for over 22 years. You are always assured of outstanding uniformity and performance in any product that bears the Carboloy Company name.

CARBIDES • **ALNICO** • HEVIMET

GOOD NEWS For VACUUM USERS!

A New Vacuum Pump

You're Looking At The NEW KINNEY VACUUM PUMP MODEL CVD 3534-A Small Pump For Big Results! Here's What This Compound Vacuum Pump Gives You:



★ — **Free air displacement of 4.9 cu. ft. per min. (139 liters per min.) . . . operates with ⅓ HP motor.**

★ — **McLeod gauge absolute pressure readings of 0.1 micron (0.0001 mm Hg.) or better.**

★ — **"Flick-switch" readiness . . . no hand starting or "warm-up" problems. Just flick the switch and Model 3534 is in operation.**

★ — **The same consistent performance and long-lived efficiency that have made Kinney Pumps famous in all phases of low pressure processing.**

See how Model CVD 3534 can save you money in power, processing time, and upkeep costs. Write for new Bulletin V50-A. Kinney Manufacturing Co., 3565 Washington St., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle.

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MAKING OLD THINGS BETTER
MAKING NEW THINGS POSSIBLE

KINNEY
Vacuum Pumps

are some errors in the book, it is a good reference for radio engineers. It contains a great deal of useful material. The majority of the chapters are exceptionally well done.—H. M. TURNER, *Assoc. Prof. of Elec. Eng., Yale University.*

Vacuum Equipment and Techniques

EDITED BY A. GUTHRIE AND R. K. WAKERLING. *National Nuclear Energy Series, Manhattan Project Technical Section, Division I, Vol. I. McGraw-Hill Book Co., New York,* 1950, 264 *pages,* $2.50.

A WELL-WRITTEN resume of work conducted by the Radiation Laboratory of the University of California in the field of high vacuum for the Manhattan District. These activities involved the testing and evaluation of pumps and gages designed for the electromagnetic separation process plant at Oak Ridge and the development of fundamental data and engineering concepts that were useful in the design of high-vacuum systems.

An excellent treatment is given of the fundamental theory of gas flow in vacuum systems. A complete treatment of problems of impedance, conductance and pumping speed is included together with both practical equations and tables for computing flow through pipes and various forms of apertures.

A description of mechanical pumps, diffusion pumps, traps and baffles includes data actually obtained as a result of the testing of representative commercial pumps and oils developed for the Y-12 diffusion plant. This data, although quite complete and indicative of problems to be encountered, in general is rather restricted to the specific 32-inch diffusion pumps studied.

The chapter on vacuum gages—ionization, Philips, Pirani, McLeod, Alphatron and others—is quite complete and includes data with respect to the theory and limitations of each type of unit.

The discussion of vacuum materials and equipment is a considerable improvement over earlier treatments of this subject. The suggestions, such as methods of construction for the design of vacuum-tight systems, are particularly

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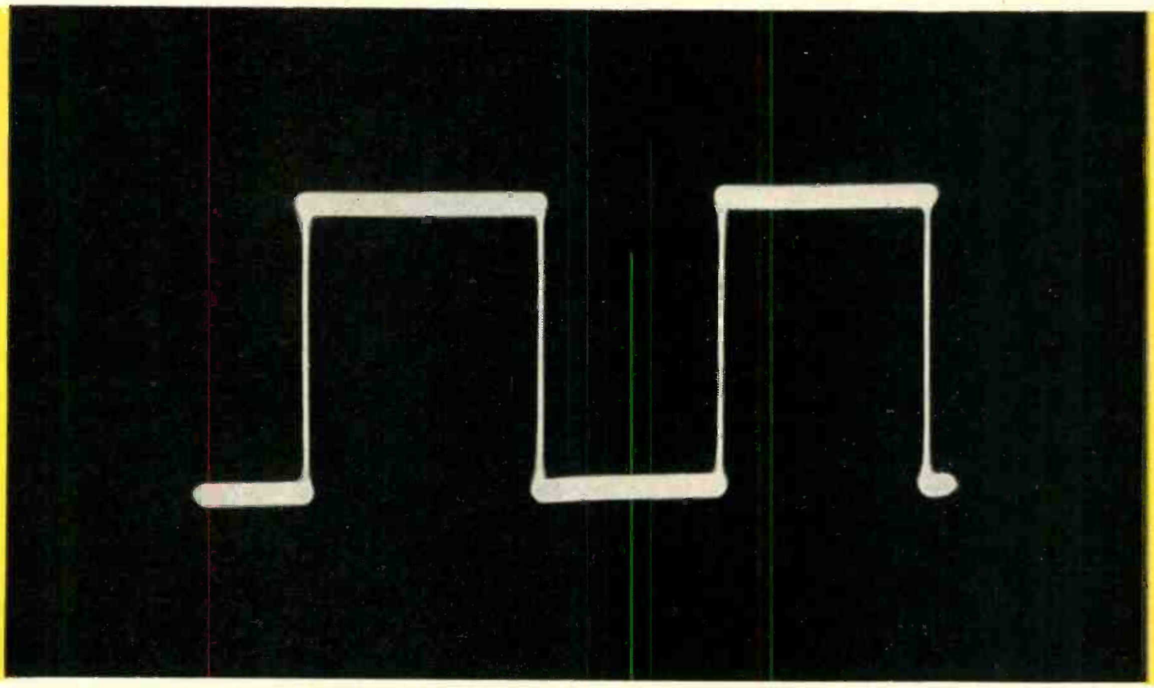
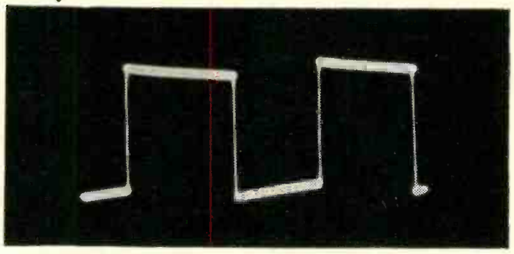
PHOTOGRAPHY

helps adjust an amplifier

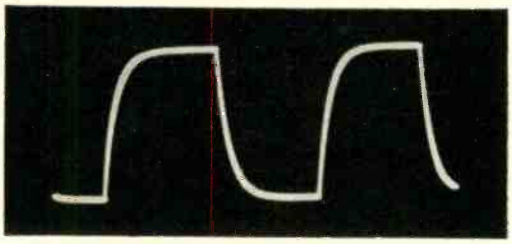


A perfect square wave, photographed by engineers of Allen B. Du-Mont Laboratories, Inc., at the output of a high-frequency amplifier. This is the result of repeated adjustment and readjustment of a compensated attenuator and peaking coils.

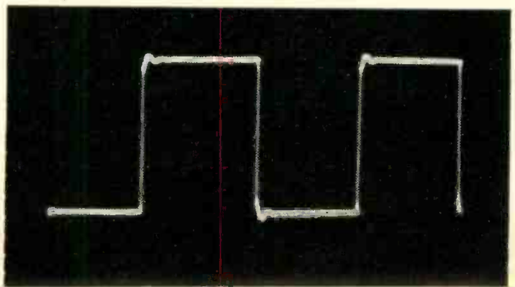
Improper adjustment results in poor low-frequency response. Note tilt in top and bottom flats. Percentage of tilt is a measure of low-frequency response and low-frequency phase shift.



Effect of "under peaking" of high-frequency compensating inductances. Note that rise time of square wave has been distorted so that the leading edge is rounded instead of sharp.



"Over peaking" with extremely fast rise. This produces "ringing" in the leading edge of the square wave.



Far subtler differences than shown here can have large effects on performance.

How can you remember the all-important details of wave form? How can you show improvements achieved in the course of design changes and adjustments? How can you prove that a circuit long since gone from your bench behaved in a certain way?

With photography, of course. It's simple, it's indisputable, and it's permanent!

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To photograph cathode-ray traces from almost any kind of screen—whether repetitive patterns or the fastest transients—just load your camera with 35mm. Kodak Linagraph Pan Film. Your Kodak Industrial Dealer carries it in 100-foot rolls and 36-exposure cassettes.

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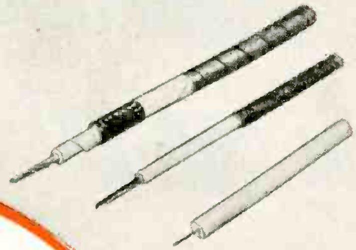
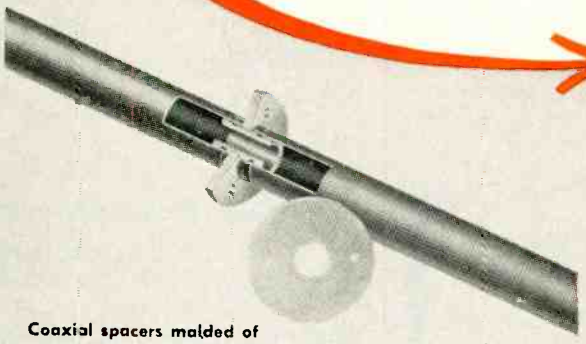
INSTRUMENT RECORDING
... a function of photography

For inserts in coaxial connectors, "Teflon" helps eliminate distortions in the circuit.



For high-frequency, high-voltage, high-temperature wires, the heat-resistance of "Teflon" makes it a superior insulator.

5 reasons why DU PONT "TEFLON"* gives unequaled efficiency in high-frequency transmission



Coaxial spacers molded of "Teflon" can boost transmission-line efficiency more than 10%.

In coaxial cables, "Teflon" is resilient and flexible and has high dielectric strength and low loss factor.

DU PONT'S NEW "TEFLON" tetrafluoroethylene resin is proving to be an excellent insulation for high-frequency wires and cables, coaxial transmission lines for FM radio and TV, and coaxial connectors. "Teflon" offers all these advantages:

1. **Low dielectric constant**—The dielectric constant of "Teflon" (2.0) is less than half that of ceramic! This new Du Pont plastic practically eliminates reflections and distortions in a transmission line when used as insulation in coaxial cables and connectors.

2. **Low loss factor**—The loss factor of "Teflon" is less than 0.0005 over the entire range of frequencies measured to date. Almost no power is lost through transmission-line spacers made of "Teflon."

3. **Heat-resistant**—The heat-resistance of "Teflon" is higher than that of any other thermoplastic (withstands up to 500°F.). And its electrical properties show little change up to 400°F.

4. **Tough and resilient**—"Teflon" withstands abuse—won't crack if dropped. It is resilient and flexible even at extremely low temperatures. Resists damage from vibration or bending when used as insulation on wires and cables.

5. **Zero moisture-absorption**—"Teflon" shows a moisture-absorption of 0.00% by A.S.T.M. D570-42. Hence its electrical properties are unaffected even after prolonged soaking in water.

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"TEFLON" is supplied by Du Pont in molding powders, tape, and water dispersions. We will gladly suggest molders or fabricators who can supply finished parts of "Teflon." Write today for more information. Our technical staff will be glad to help you. E. I. du Pont de Nemours & Co., (Inc.) Polychemicals Department, Sales Offices: 350 Fifth Ave., New York 1, N. Y.; 7 S. Dearborn St., Chicago 3, Ill.; 845 E. 60th Street, Los Angeles 1, California.

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useful for laboratory workers who operate in the range 10^{-4} to 1.0 mm.

Problems of leak detection are given in detail, including the theory of flow through small capillaries, the general technique of leak hunting, and the detailed operating characteristics of the helium leak detector.

This book will be found useful to any worker in the high-vacuum field. It represents a careful synopsis of the fine work done at the University of California during the war. These activities were restricted to studies of vacuum problems relating to the Manhattan District, and as might be expected, no attempt has been made to cover the broader industrial problems of high vacuum nor to include discussions of more recent industrial developments in the field.—RICHARD S. MORSE, *National Research Corporation*

Electronics in Engineering

BY W. RYLAND HILL. *McGraw-Hill Book Co., Inc., New York*, 1949, 274 *pages*, $3.50.

ALMOST all phases of engineering are in some way concerned with electronics today. Most colleges and universities are incorporating electrical engineering courses in their mechanical, chemical and other nonelectrical engineering curricula, and this book provides an excellent text for the electronics portion of any such course.

The general pattern of the book has been tried before, and met with varying degrees of success and failure. Hill seems to have hit the right combination throughout. No attempt has been made at completeness, but no sacrifice in clarity and understanding has resulted from his conciseness.

As a typical example of the thorough treatment of various subjects, a two-stage audio amplifier circuit is presented at the end of a chapter entitled "Practical Amplifier Circuits". The circuit shown is just what the author says it is—a practical amplifier circuit. All component values are given, and on the facing page, a part-by-part explanation of the function of each

These Three

ALLIED POWER RELAYS

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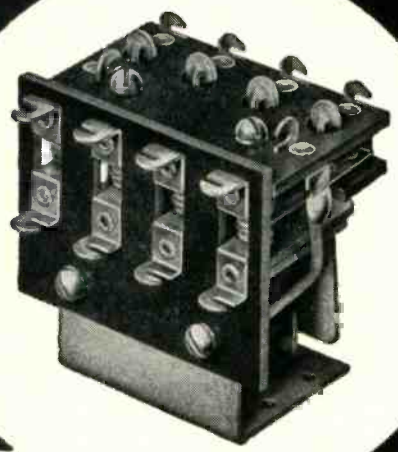
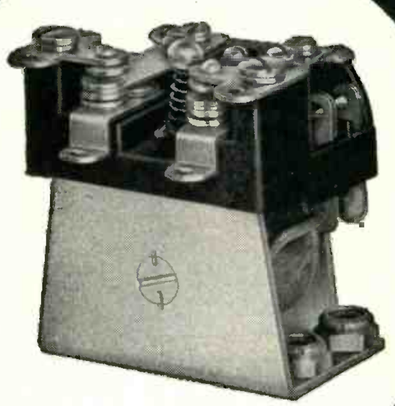
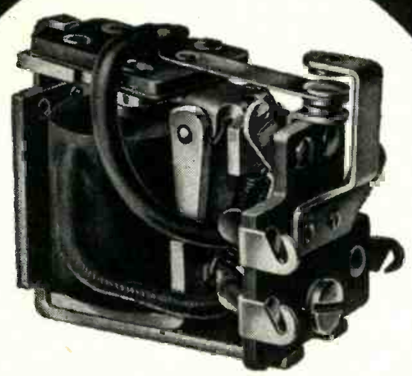




3-POLE & 4-POLE
"PO" TYPE RELAY

This medium power relay is supplied with contact arrangements up to 4-pole double-throw. Standard silver contacts rated at 15 amperes for 24 volts DC or 110 volts AC non-inductive. Coil rating 2.5 watts up to 112 volts DC and 10.5 volt-amperes up to 230 volts AC. Dimensions: 3-pole 2-1/4" x 1-7/8" x 1-5/8". 4-pole 2-1/4" x 1-7/8" x 2-3/16".



DOUBLE-POLE
"BO" TYPE RELAY

This all-purpose power relay is supplied with single or double-throw contacts. Molded insulation throughout. Standard silver contacts rated at 15 amperes for 24 volts DC or 110 volts AC non-inductive. Coil rating of 2.5 watts up to 112 volts DC and 4.5 volt-amperes up to 250 volts AC. Dimensions: 1-7/8" x 1-13/32" x 1-5/8".

SINGLE-POLE
"AS" TYPE RELAY

This small, light-weight power relay is supplied with single or double-throw contacts. Standard silver contacts rated at 5 amperes for 24 volts DC or 110 volts AC non-inductive. Coil rating 1 watt up to 95 volts DC and 3.5 volt-amperes up to 230 volts AC. Dimensions: 1-3/8" x 1-5/8" x 15/16".

Like all Allied Relays, types "AS," "BO" and "PO" may be had hermetically sealed, with choice of standard octal plug-in base or solder-type terminals.

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component is presented. Nothing is taken for granted. The mathematical approach is not avoided, but it is usually accompanied by a graphical analysis and an example computation employing typical circuit values.—J.D.F.

Electromagnetic Fields, Theory and Applications, Volume I—Mapping of Fields

BY ERNST WEBER. *John Wiley and Sons, Inc., New York*, 1950, $10.00.

THIS BOOK presents a comprehensive account of the theory of mapping static electric and magnetic fields, with numerous examples of the application of the basic theory to engineering problems. Perhaps the most noteworthy feature is its method of presentation of the subject material. Rather than divide the material into the two usual broad categories, electrostatics and magnetostatics, the author has chosen to establish all of the basic physical relationships first, then show their use in mapping actual field distributions. Worthy of praise here is the manner in which the fundamental physical differences between electric fields and magnetic fields are carefully established.

Two chapters deal with experimental and graphical methods used to obtain the distribution of more complex fields. Here is an excellent treatment of the method of electric and magnetic images.

The last two chapters of the book lead the reader into an extensive account of the advanced analytic solution of complex field problems. The methods of conjugate functions and conformal mapping, utilizing the theory of functions of a complex variable for solution of two-dimensional problems, are described. The mathematics of three-dimensional potential distribution is formulated, with an extensive discussion of orthogonal coordinate systems.

Appendices include complete lists of letter symbols, quantities, and units used, together with reviews of vector analysis, Bessel functions, Legendre functions, and an excellent general bibliography.

The book has been excellently

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"Q" is of the order of 250 and up, as against 80 for average small loop mounted inside receiver. The Croloy Radio Rod fits anywhere — only 8″ long by ½″ diameter, or smaller. Pivoted and rotated for additional selectivity, or mounted vertically for omni-directional reception. On the production line, the magnetic antenna can be mounted on chassis for complete assembly and test, before placement in cabinet.

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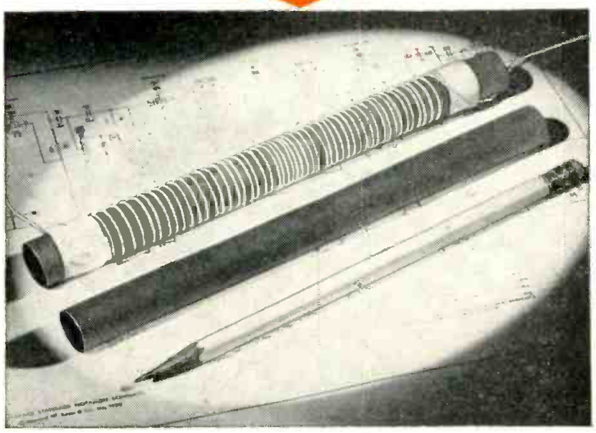

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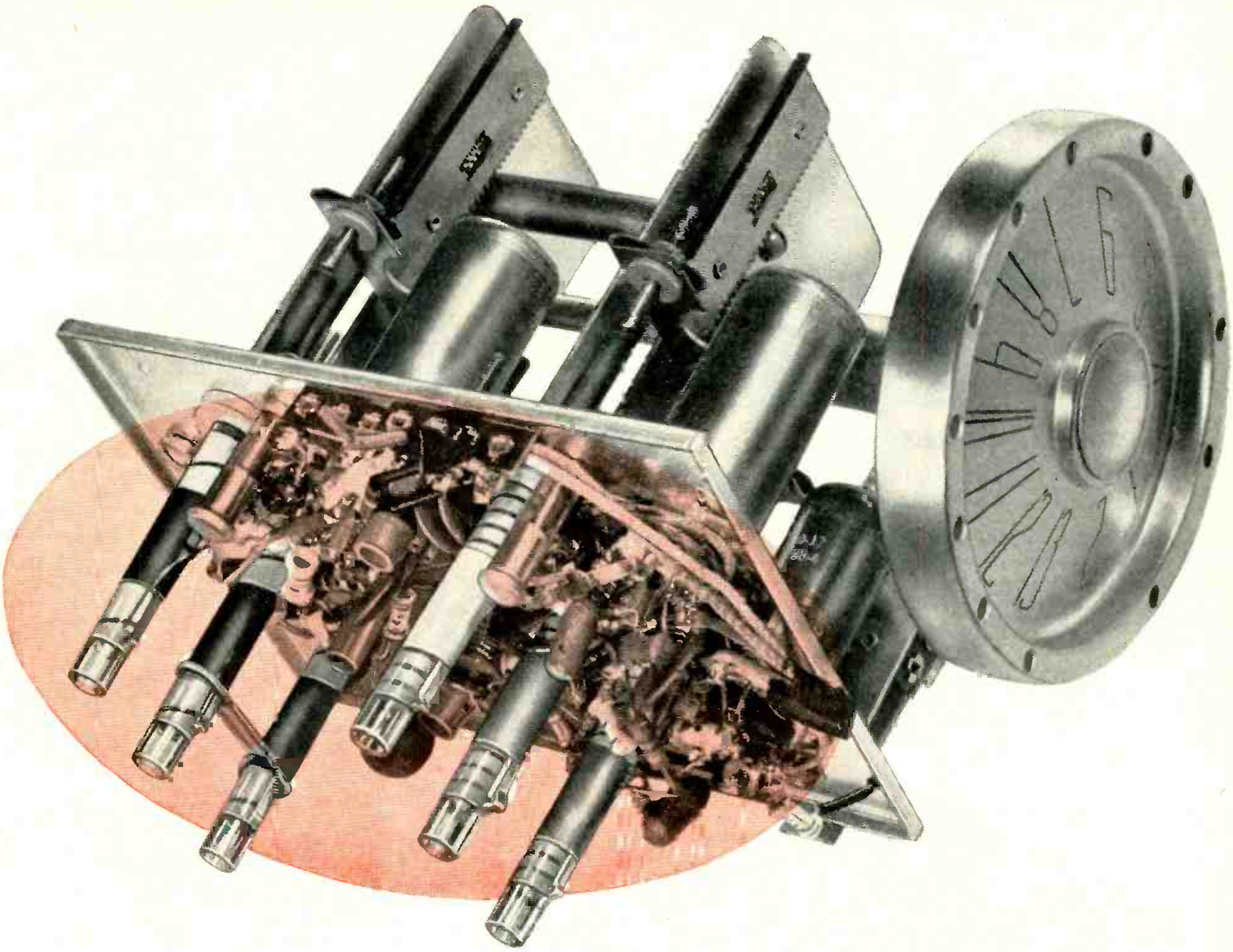

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In high frequency tuning applications, stability is extremely important, both for ease of alignment and customer satisfaction. That is one of the reasons why the Stromberg-Carlson Company specifies Corning Metallized Glass Inductances. With Corning Inductances drift is negligible even under unusually variable ambient temperatures. Why? Because the integral contact of the fired-on metallizing with the dimensionally stable glass coil forms results in high temperature stability. High Q is inherent.

The inductance characteristics of the coils cannot be changed by rough handling or vibration. This is because the integral contact between the fired-on metallizing and the glass coil form eliminates voids between conductor and form. When used with powdered iron cores, the accuracy and rigidity of the glass insures stable, noiseless tuning.

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Design versatility is another characteristic of Corning Inductances. They can be manufactured to the most exacting specifications in uniform, variable or double pitch windings. Fixed tuned, permeability tuned or permeability tuned inductance-trimmer combinations are available with standard cores and fittings. Let Corning help you increase performance at lower costs. Our engineers will be glad to discuss your inductance problems with you.

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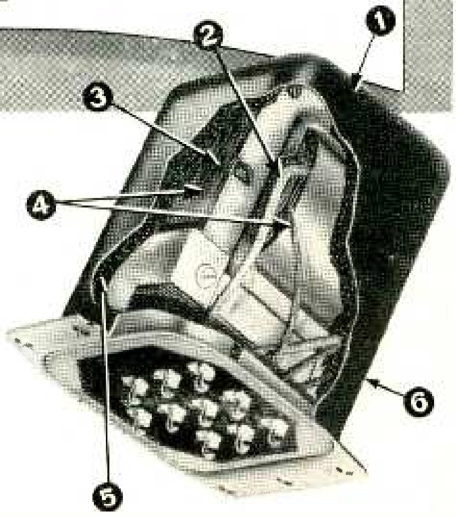


written, is extremely well organized, and is thorough in its coverage of the subject material. It is intended primarily for use as a textbook in graduate courses in electromagnetic theory. It provides an ideal choice for such use. Numerous illustrative problems follow each chapter, and throughout the book the rationalized MKS system of units is utilized. The book is recommended for inclusion in the reference library of every practicing radio engineer and electronic physicist. It is believed that the readers of this volume will eagerly await publication of the second volume in this series covering the dynamic electromagnetic field.—JOSEPH W. KEARNEY, *Airborne Instruments Laboratory*

Voltage Stabilizers

BY F. A. BENSON, *Electronic Engineering*, 28 *Essex St., Strand, London*, 1950, 125 *pages*, 12/6.

A CONCISE monograph dealing entirely with the stabilization or regulation of electrical voltages, this book will be an extremely handy reference for an engineer or technician. The author has compiled circuits and statistics from both British and American periodicals and presents methods for applying different degrees of regulation to a wide range of voltages.

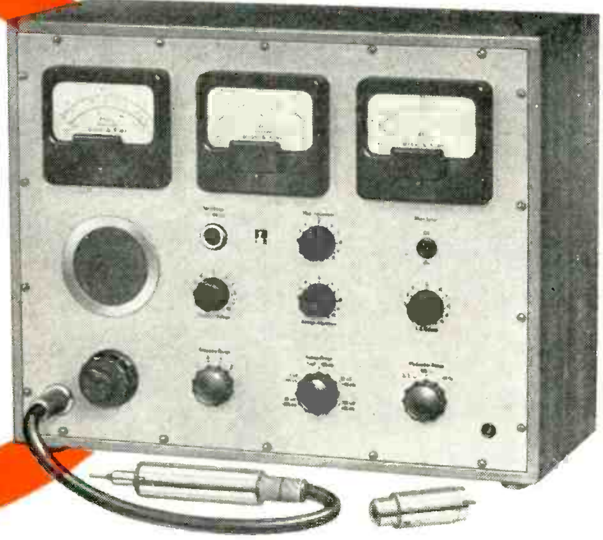
The material is divided into four main categories: stabilizers employing magnetic saturation devices, glow-discharge tubes, thermionic tubes and a catch-all chapter describing specialized stabilizers, such as those for use with high-voltage r-f supplies, various bridge-type systems and so on. In every case, the treatment is thorough and all pertinent information is presented.

Some engineers might rebel against one particular portion of the book. In describing the design of VR-tube circuits, the author goes slightly off the deep end in applying formulas, where plain and simple common-sense engineering is really needed.

An extensive table showing different types of regulating tubes is presented. This reviewer was interested and amazed to find that glow-discharge tubes are available new instruments for

Quality Control

and electronic research



HETERODYNE VOLTMETER

MODEL BL 2002

The Heterodyne Voltmeter Model BL 2002 is a selective tube voltmeter for the measurement of alternating current voltages in the high frequency range. The instrument is particularly designed for use in radio laboratories for measurements on radio receivers, Radar IF-circuits, for the control of signal generators, co-axial carrier frequency systems, etc. The high sensitivity makes the instrument very suitable for measuring small alternating current voltages, for example from aerials. The instrument has a meter for modulation measurements.

SPECIFICATIONS

Frequency Range: 20 kilocycles per second – 27 megacycles per second in 4 ranges.
Voltage Range: Full scale deflection for 10–100–1000 microvolts, 10 and 100 millivolts, and for 1 and 10 volts.
Input Impedance: 5 megohms in parallel with 12 micromicrofarads. With attenuator: Several thousands megohms in parallel with 3 micromicrofarads.
Bandwidth: –3 db at ±3.5 kilocycles per second, –10 db at ± 6 kilocycles per second, 40 db at ± 13 kilocycles per second, –80 db at ± 25 kilocycles per second. Intermediate frequency is 1650 kilocycles per second.
Frequency Accuracy: About 2% ± 2 kilocycles per second.
Voltage Accuracy: ± 0.5 db in the broadcast frequency range and ± 1 db in the short-wave range.
Reference Voltage: A built-in oscillator delivering exactly 1 millivolt, 100 kilocycles per second.
Modulation Meter: Two ranges from 0 –30% and from 0 –100%.
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Tubes: Three 6J6, three 6AU6, two 6BA6, 6AL5, 7S7, six 4 and one OA2.
Power Supply: 115 volts alternating current, 40 –120 cps, 65 watts.
Dimensions: 16" (height) x 20" (width) x 9" (depth).
Weight: 42 lbs.

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MODEL BL 1502 AND BL 1507

The Deviation Test Bridge indicates on a large illuminated scale the percentage deviation of a test component from a standard component. The bridge is particularly suited for checking resistors, capacitors and inductors in industrial plants, but has proved useful in many special measurements based on comparison between two impedances. Up to 4000 resistors or 2000 transformers may be checked per hour.

SPECIFICATIONS

Deviation Measurement Ranges: Model BL 1502: Resistance 10 ohm-10 megohm, capacitance 50 micromicrofarad – 10 microfarad, inductance 2 millihenry – 100 Henry. Frequency: 1000 cps.
Model BL 1507: Capacitance 25 micromicrofarads – 0.1 microfarads, inductance 100 microhenry – 0.3 Henry, resistance 20–100,000 ohms.
Frequency: 50 kilocycles per second.
Instrument: Large moving-coil instrument to permit easy readings, and illuminated scale with zero point in the center. The instrument is safeguarded against overloads. Full scale deflection at 7% and 25%.
Accuracy: Comparison better than 0.1% at zero point, and the tolerance accuracy better than 5% at full scale deflection. No sensitivity to hum voltages.
Power Supply: 115 volts alternating current 40-120 cps. 40 watts.
Tubes: Three 6AU6, six V6GT, six 4 and one OA2. For Model BL 1507 additional 6AL5.
Dimensions: 13" (height) x 11" (width) x 8" (depth excluding dials).
Weight: 15 lbs.

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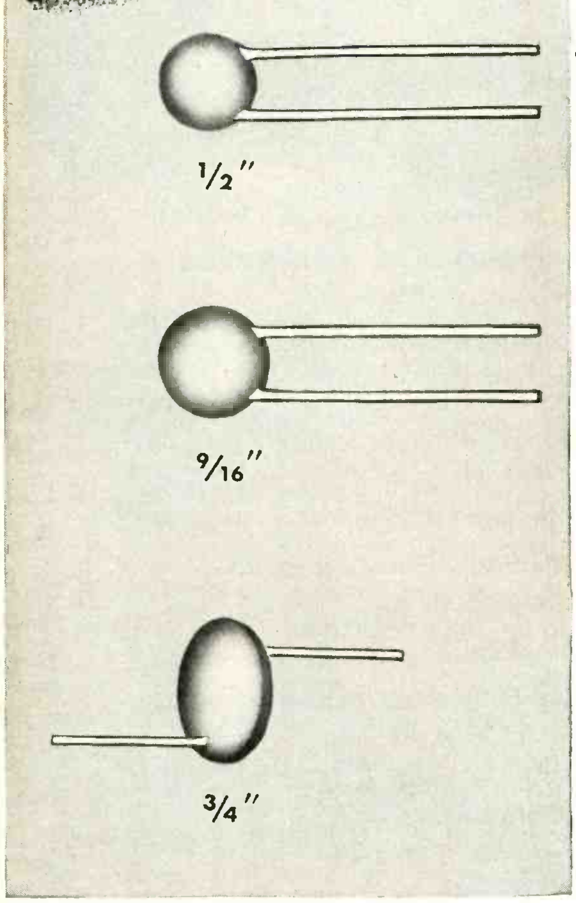

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Rated at 3000 Volts

Negative 1400TC – available in capacities between 75-180 MMF. in tolerances of ±5%, ±10%, ±20%. Tested at 6000 V.D.C.

RMC Type 6K DISCAP

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RMC Type B-GMV and Type C Temperature Compensating DISCAPS

RMC DISCAPS are approved by leading makers of TV sets, tuners and high frequency electronic equipment. Type B-GMV DISCAPS are available in the following capacities: .001, .0015, .002, .005, 2x.001, 2x.0015, 2x.002, 2x.004, 2x.005 MFD. Type C temperature compensating DISCAPS are available in a range between NPO and N2200TC and in capacities from 5 to 150 MMF.

Every DISCAP is 100% Tested for Capacity, Leakage Resistance and Breakdown

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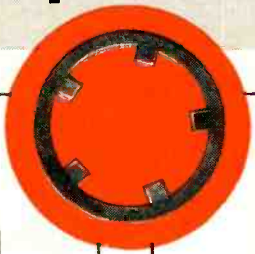
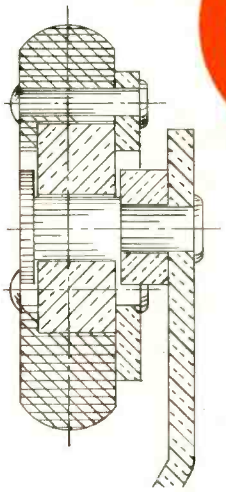
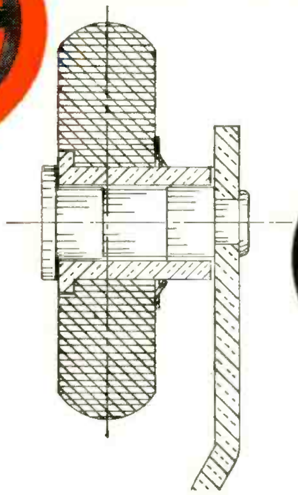


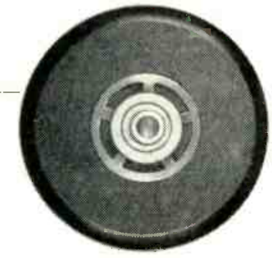
Old Way



WASHER AND 3 RIVETS HELD BUSHING IN WHEEL. Difficulty in accurate positioning of rivet holes caused rejects. Also rivets loosened in use.

New Way





SINGLE TRUARC RING LOCKS BUSHING—STAYS SECURE. Self-locking ring (type 5105) needs no groove. Replaces washer, 3 rivets, separate spacer.

Redesign with one Waldes Truarc Ring cuts cost of wheel used in Har-Vey Rolling Door Hardware (for residential doors) from 26.1¢ to 14.5¢—a 44% saving for Metal Products Corporation, Miami. Use of Truarc cuts manufacturing time 76%. Eliminates 5 separate parts, 3 press operations. And gives a product that stands up better in use!

Redesign with Truarc Rings and you too will cut costs. Wherever you use machined shoulders, bolts, screws, nuts, cotter pins, snap rings, there's a Truarc Ring that does a better job of holding parts together. Truarc Rings are precision engineered. They make assembly and disassembly quick and easy.

See what Truarc Rings can do toward cutting overall costs for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

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	saving
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eliminates riveting washer	.0111
eliminates punching washer	.00033
eliminates washer, spacer, rivets	.02236
cuts cost of inserting bushing	.00037
cuts cost of inspection	.0032
cuts cost of wheel, bushing, rivet	.0797
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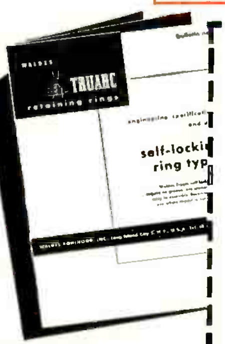

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for regulating practically any voltage between 50 and 160 volts. This table gives type numbers and complete characteristics for VR tubes whose operating voltages are as follows: 50, 55, 60-63, 70, 75, 83-87, 90-110, 85, 97.5, 100, 105, 115-120, 120, 150, and 160. A bibliography with 292 entries, all referring to voltage-regulating circuits, is presented for further reading.—J.D.F.

THUMBNAIL REVIEWS

ELECTROMECHANICAL AND ELECTROACOUSTICAL ANALOGIES. By Bent Gehlshoj. Available from Scandinavian Book Service, 620 W. 158, New York, 1947, 142 pages, $2.50. Use of admittance and impedance, whichever seems more appropriate in each case, to compute performance in mechanical and acoustical systems as well as in electromechanical transducers such as the moving-coil transducer, moving-armature transducer, capacitor transducer, piezoelectric transducer and piezoelectric resonator. Includes comprehensive bibliography.

ELECTRONIC ENGINEERING MASTER INDEX 1949. Electronics Research Pub. Co., 480 Canal, New York, 1950, 296 pages, $17.50. Subject index to contents of almost 400 electronic and allied engineering publications issued in 1949, including some 4,000 patents. Total number of entries is over 12,000.

TV INSTALLATION TECHNIQUES. By Samuel L. Marshall. John F. Rider Publisher, Inc., New York, 1950, 336 pages, $3.60. Written for the television receiver installer, whether serviceman, experimenter or engineer. Chapters cover: nature of television; radio propagation; antennas; transmission lines and special antenna systems; materials and methods used in installations; high masts and tower installations; problems arising in television installations; receiver adjustment and service in the home; municipal regulations. Summaries and questions follow each chapter. Includes antenna design equations and procedures, calculation of forces on mast and antenna due to wind pressure and ice loading, and design of wave traps and filters for tvi.

ELEMENTS AND PRACTICE OF SOUND RECORDING. Audio Engineering Society, care of F. Sumner Hall, 153 W. 33, New York, 117 pages, $3.00. Compilation of lecture course notes, with illustrations, on 32 lectures presented by the Society in 1949 and 1950. Six lectures deal with disc recording, six with magnetic recording and ten with film recording, with the remainder covering other aspects of recording systems.

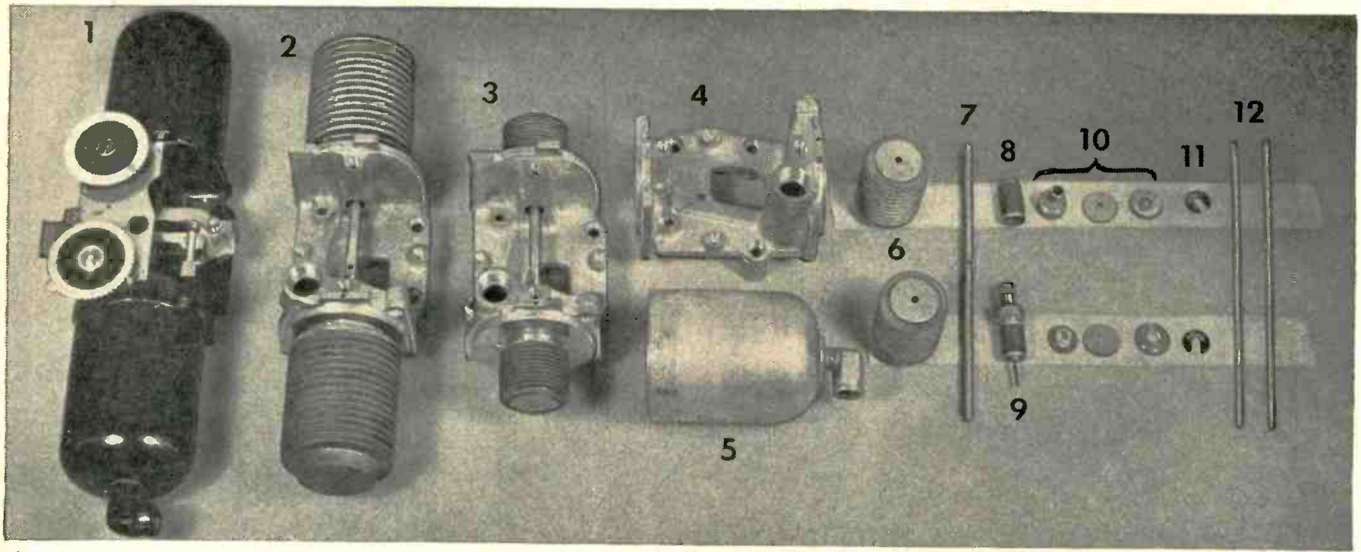
HIGH-FIDELITY TECHNIQUES. By James R. Langham. Gernsback Library Book No. 42. Radcraft Publications, New York, 1950, 112 pages, $1.00. Practical and usable engineering and construction data, interspersed with human-interest comments and anecdotes with which audio enthusiasts will heartily sympathize. The seven chapters cover: distortion; speakers and baffles; power amplifiers; amplifier design; power supplies; phonographs; some last words about high fidelity.

A.S.T.M. STANDARDS ON GLASS AND GLASS PRODUCTS. American Society for Testing Materials, 1916 Race St., Philadelphia, Pa., second edition, 1950, 116 pages, $1.50. Includes specifications for glass spool insulators and pin-type lime-glass insulators, with a method of testing these products. Woven glass tapes, tubular sleeving and braids are also covered.

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by BRIDGEPORT BRASS COMPANY "Bridgeport" Headquarters for BRASS, BRONZE and COPPER



Component parts of air control unit used in such instruments as a pyrometer: 1. Control unit; 2. Covers, nozzle, mechanical motion parts removed; 3. Outer bellows removed; 4. Forged body; 5. Cover shell; 6. Inner bellows; 7. Bellows rod; 8. Valve sealing bellows; 9. Needle-valve assembly; 10. Machined washers and small parts; 11. Spring lock washers; 12. Copper tubes. Courtesy Brown Instruments Division, Minneapolis-Honeywell Regulator Company, Phila., Pa.

Copper Alloys Insure Long Life, Reliability of Air Control Unit

Varied atmospheres in oil refineries, chemical plants, heat treating rooms, pumping stations, etc., necessitate the use in sensitive control instruments of alloys capable of withstanding a wide range of corrosive conditions.

From a functional standpoint, the precision needed in various components of instruments requires alloys which can be speedily machined to close tolerances and also drawn into deep cups and shells.

The illustrated air control unit, which is employed in the Brown line of controllers, uses a wide range of copper alloys.

Penetrating Liquid Used

The body of the unit (No. 4) is a brass forging. Accurately machined diameters with clean facings are necessary in this part to accommodate sealing units. Since a hydrocarbon of low viscosity is used, even microscopic porosity would cause leakage. The forging is accurate enough dimensionally so that much machining is eliminated and at the same time no problems in holding the piece are encountered. Forging alloys containing lead are exceptionally easy to machine.

The two end covers (No. 5) are drawn shells of cartridge brass (70% copper and 30% zinc). This alloy has high ductility and is excellent for deep drawing.

Fatigue Resistance Desired

Phosphor bronze grade A (95% copper and 5% tin) was selected for the bellows as long life is essential for a quality product. This alloy has great resistance to fatigue and a low modulus of elasticity compared to steel which makes the bellows very sensitive. In addition, phosphor bronze has excellent corrosion resistance. This bronze can be coldworked to a high degree.

The washers and small parts (No. 10) are made from free machining brass rod in screw machines, as is the shaft (No. 7).

This metal has the highest machinability of all the copper-base alloys. Turning, milling, drilling, threading and tapping operations are speeded up through the use of this alloy.

Copper tubing (No. 12) is used for conducting the hydrocarbon fluid from one chamber to another.

Clogging Danger Eliminated

Corrosion resistance in this tubing, as well as the body and other parts in contact with the hydrocarbon, is not only essential from a non-destructive standpoint but if any rust or scale were carried through the system blocking of the small orifices would occur.

The fittings are also forged brass.

Another important factor in favor of copper, brass and bronze in sealed units is the ease in which it may be soldered. Non-acid fluxes are used and only a minimum of heat is necessary to produce tinning, forming air and liquid-tight joints.

The excellent bearing qualities of the copper alloys also help to make instruments sensitive and to reduce wear to a minimum.

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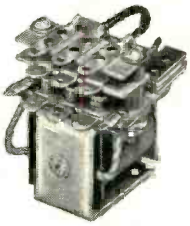
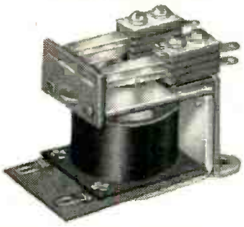


SERIES 335 RELAY

THE A. N. CONNECTOR TYPE

SERIES 595 RELAY

THE OCTAL PLUG TYPE



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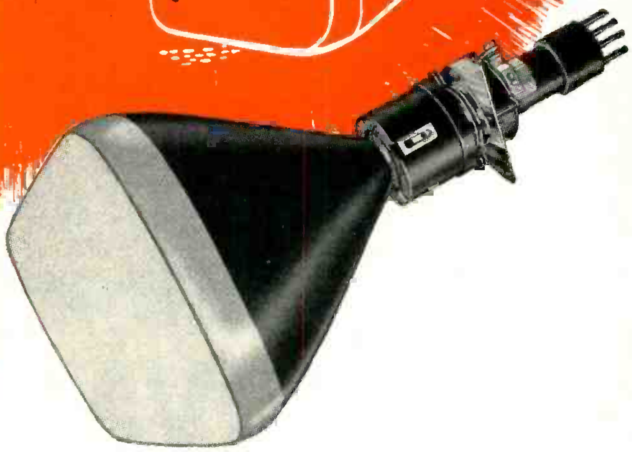

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TUBES AT WORK

(continued from page 122)

sitivity is adjusted by means of the 290-ohm feedback resistor R_N. The last two stages are triode-connected, while the first stage is pentode-connected.

There are two rules of thumb for obtaining stability in a feedback system: keep the number of reactive components to a minimum, and maintain the widest possible disparity in bandwidth between the different stages. By observing these rules, a margin of about 10 db against oscillation is realized. There are no peaks at the edges of the pass band. In circuits of this general type, incidentally, the greatest tendency toward oscillation is at low frequencies, rather than high.

A vtvm of this same type has been built that was flat to 700 kc, with a full-scale sensitivity of 100 millivolts. Three 1L4 stages were employed in pentode connection, with 22,000-ohm plate load resistors, and each screen connected directly to the 90-volt B supply.

The circuit shown is particularly tolerant of aging of the batteries. The insertion of a 1,000-ohm resistance in series with the B battery produced a change in calibration of less than 2 percent.

(1) L. Fleming, VTVM For Built-In Applications, ELECTRONICS, p 154, Sept. 1950.

Stable Electronic Voltage Regulator

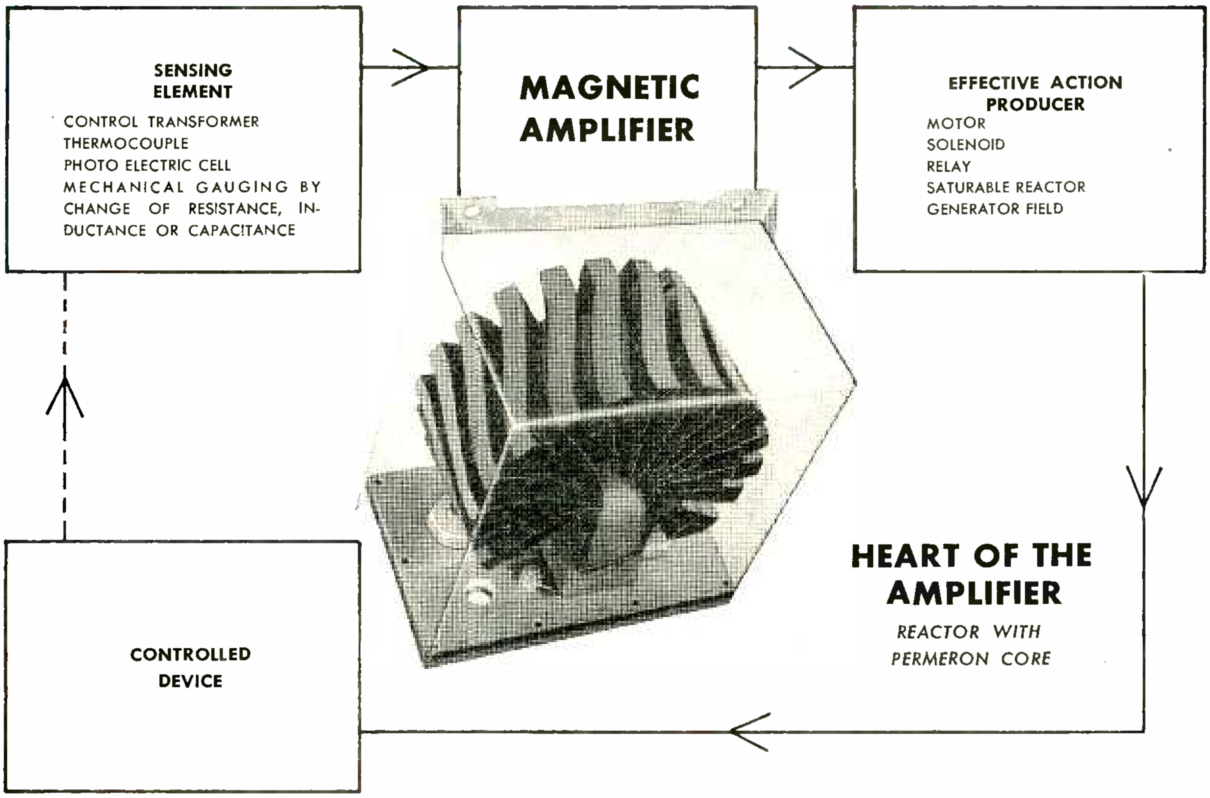
BY PETER G. SULZER

*National Bureau of Standards
Washington, D. C.*

ELECTRONIC VOLTAGE REGULATORS have been employed when a d-c supply having excellent regulation and stability is required. It is the purpose of this paper to describe a circuit which produces a substantial improvement in performance with but little increase in complexity.

The regulator under consideration consists of a voltage-control tube, a d-c amplifier, a stable voltage standard, and a means for comparing the controlled voltage with the standard voltage. A popular scheme[1,2] is that of Fig. 1 A, which contains a control tube, V_1, a volt-

Here's the ideal amplifier for control applications



Why? Well, for one thing it's a *magnetic* amplifier. The advantages are obvious: there are no moving parts — hence, there's nothing to wear out. It's shock-proof and vibration-proof.

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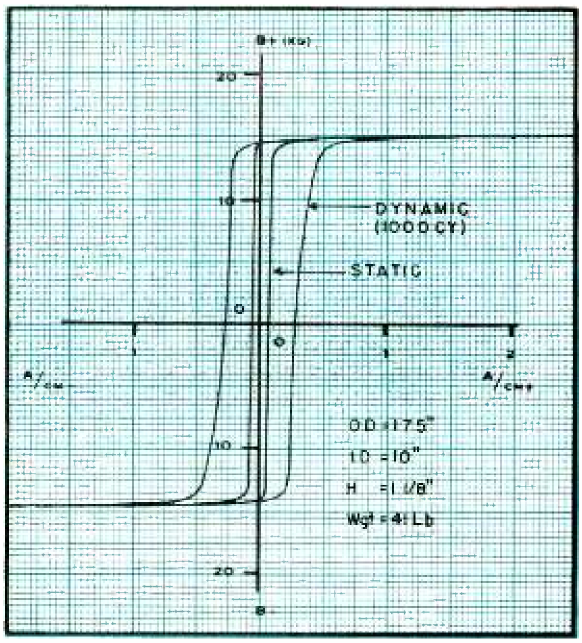
Magnetic amplifiers with PERMERON cores are now being produced by several large electrical manufacturers for an ever-expanding field of uses. These cores, with their amazing characteristics, have helped make magnetic amplifiers practical for many new uses and better for many old ones.

If *your* business is amplifiers, or controls, it will pay you to take another look at PERMERON!



For additional information write—I-T-E Rectifier Division, or consult your local I-T-E Representative

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NMA - 5

Commercial equivalent of TS-587/U.
Sensitivity as two-terminal voltmeter, (95 ohms balanced) 2 microvolts 15-125 MC; 5 microvolts 88-400 MC. Field intensity measurements using calibrated dipole. Frequency range includes FM and TV Bands.

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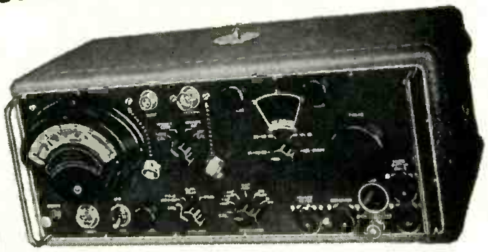
NM - 10A



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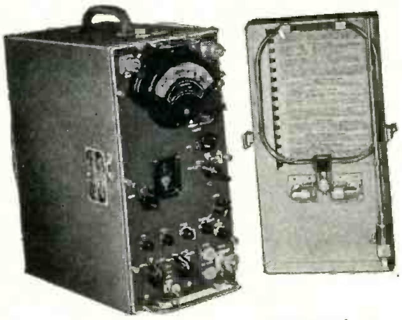

HF!

150 KC to 25 MC

NM - 20A

Commercial equivalent of AN/PRM-1.
Self-contained batteries. A.C. supply optional. Sensitivity as two-terminal voltmeter, 1 microvolt. Field intensity with ½ meter rod antenna, 2 microvolts-per-meter; rotatable loop supplied. Includes standard broadcast band, radio range, WWV, and communications frequencies.

UHF!

375 MC to 1000 MC

NM - 50A

Commercial equivalent of AN/URM-17.
Sensitivity as two-terminal voltmeter, (50-ohm coaxial input) 10 microvolts. Field intensity measurements using calibrated dipole. Frequency range includes Citizens Band and UHF color TV Band.

Since 1944 **Stoddart RI-FI*** instruments have established the standard for superior quality and unexcelled performance. These instruments fully comply with test equipment requirements of such radio interference specifications as JAN-I-225, ASA C63.2, 16E4(SHIPS), AN-I-24a, AN-I-42, AN-I-27a, AN-I-40 and others. Many of these specifications were written or revised to the standards of performance demonstrated in Stoddart equipment.

The rugged and reliable instruments illustrated above serve equally well in field or laboratory. Individually calibrated for consistent results using internal standard of reference. Meter scales marked in microvolts and DB above one microvolt. Function selector enables measurement of sinusoidal or complex waveforms, giving average, peak or quasi-peak values. Accessories provide means for measuring either conducted or radiated r.f. voltages. Graphic recorder available.

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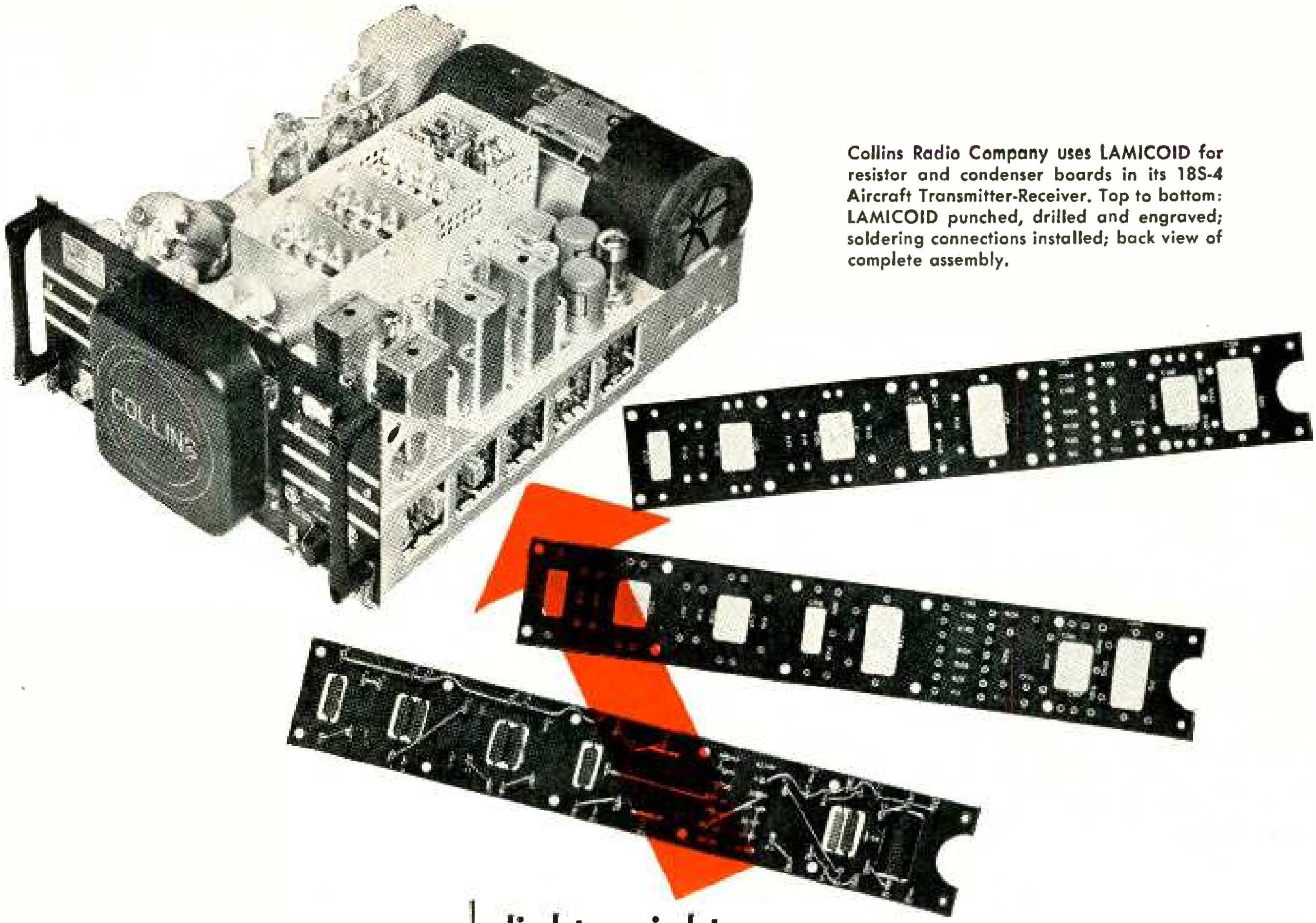

Collins Radio Company uses LAMICOID for resistor and condenser boards in its 18S-4 Aircraft Transmitter-Receiver. Top to bottom: LAMICOID punched, drilled and engraved; soldering connections installed; back view of complete assembly.

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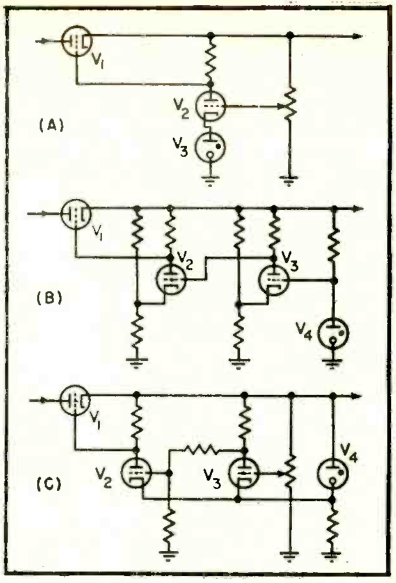

FIG. 1—Basic voltage regulator circuit diagrams

age amplifier, V_2, and a constant-voltage glow tube, V_3. Comparison occurs in the grid-cathode circuit of V_2. Analysis has shown[3] that one requirement for good regulation is high gain in the voltage amplifier. Thus a pentode is usually employed for V_2, or the cascode amplifier[4] has been used. Higher gain may be obtained with the cascade amplifier[5] of Fig. 1B. It will be noted, however, that cathode degeneration occurs in V_2 and V_3. In order to realize the full gain capabilities of the two-stage amplifier the circuit of Fig. 1C has been devised. Here both cathodes see a low impedance through the glow tube V_4, which is used as the voltage standard. The control grid of V_3 is connected to a voltage divider connected across the output of the regulator. Therefore the output-voltage variations are applied to both cathodes, and it can be seen that, as a result, the effective voltage gain of V_3 is decreased by unity. This, however, is of little consequence when high-μ tubes are employed.

Performance

To calculate the performance of the regulator, consider the equivalent circuit shown in Fig. 2A, where e_i and e_o are the input and output voltages respectively, R_p and μ refer to the control tube (V_1 in Fig. 1C), e_s is the standard voltage, A_o is the voltage-amplifier gain, $1/N$ is the voltage-divider attenuation, and R_L is the resistance presented by the


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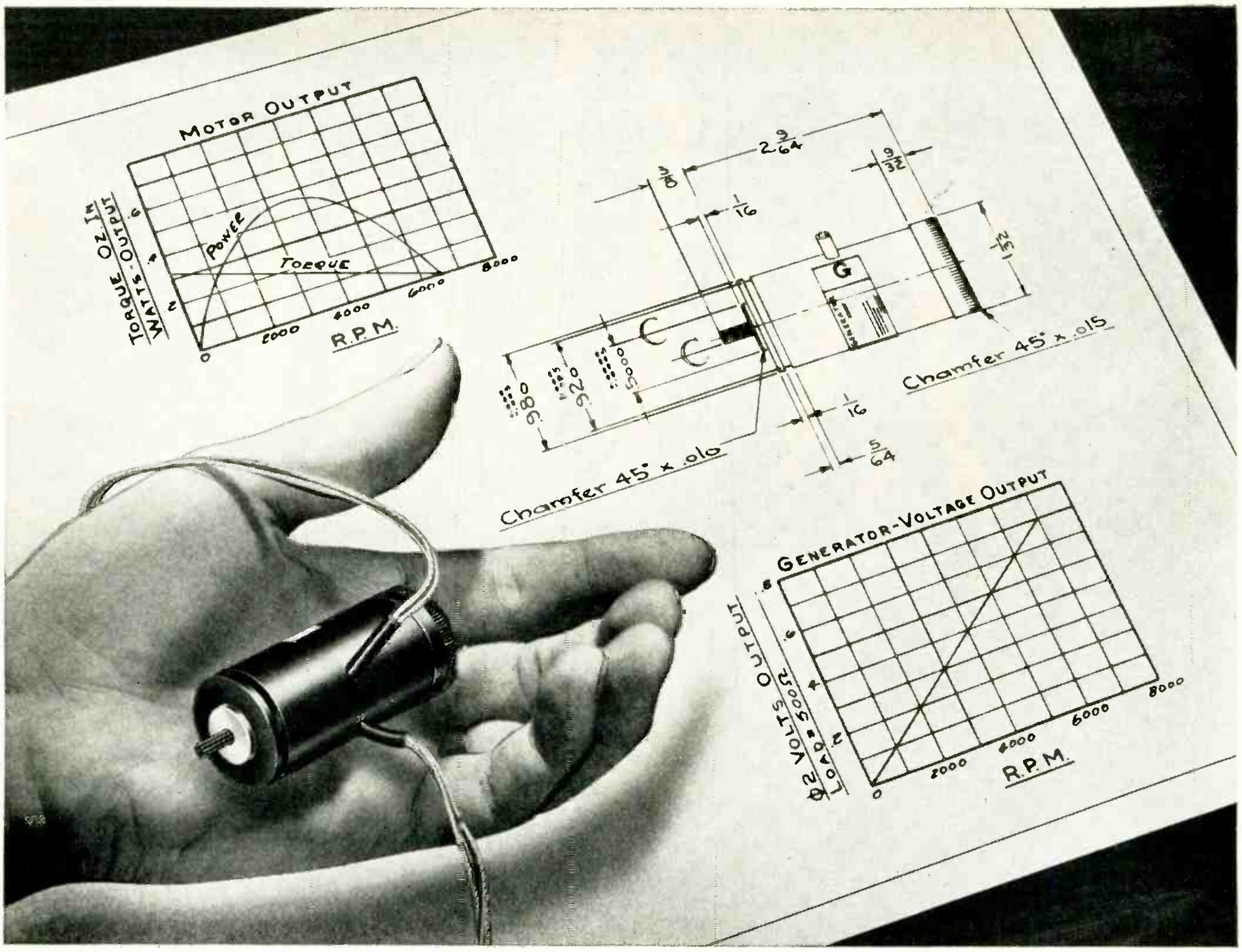

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For further information on the 1623 and others in the complete Kollsman group of miniature special purpose AC motors—or if you require a unit to your own specifications—write: Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, N. Y.

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Motor characteristics: Maximum torque at stall—smooth-running (will not "cog")—fast-reversing—operates from two-phase source, or from single-phase with phase-shifting condenser—available for 60 or 400 cycle operation.

Generator characteristics: Low residual voltage and voltage "spread"—constant frequency output—amplitude directly proportional to speed.

Unit characteristics: Both rotors mounted on same shaft, assuring positive alignment—stainless steel housing—hardened beryllium copper shaft—corrosion-resistant nickel steel laminations—high temperature insulation (up to 200° C. total temperature)—stainless steel precision ball bearings—weight: 4.2 ounces.

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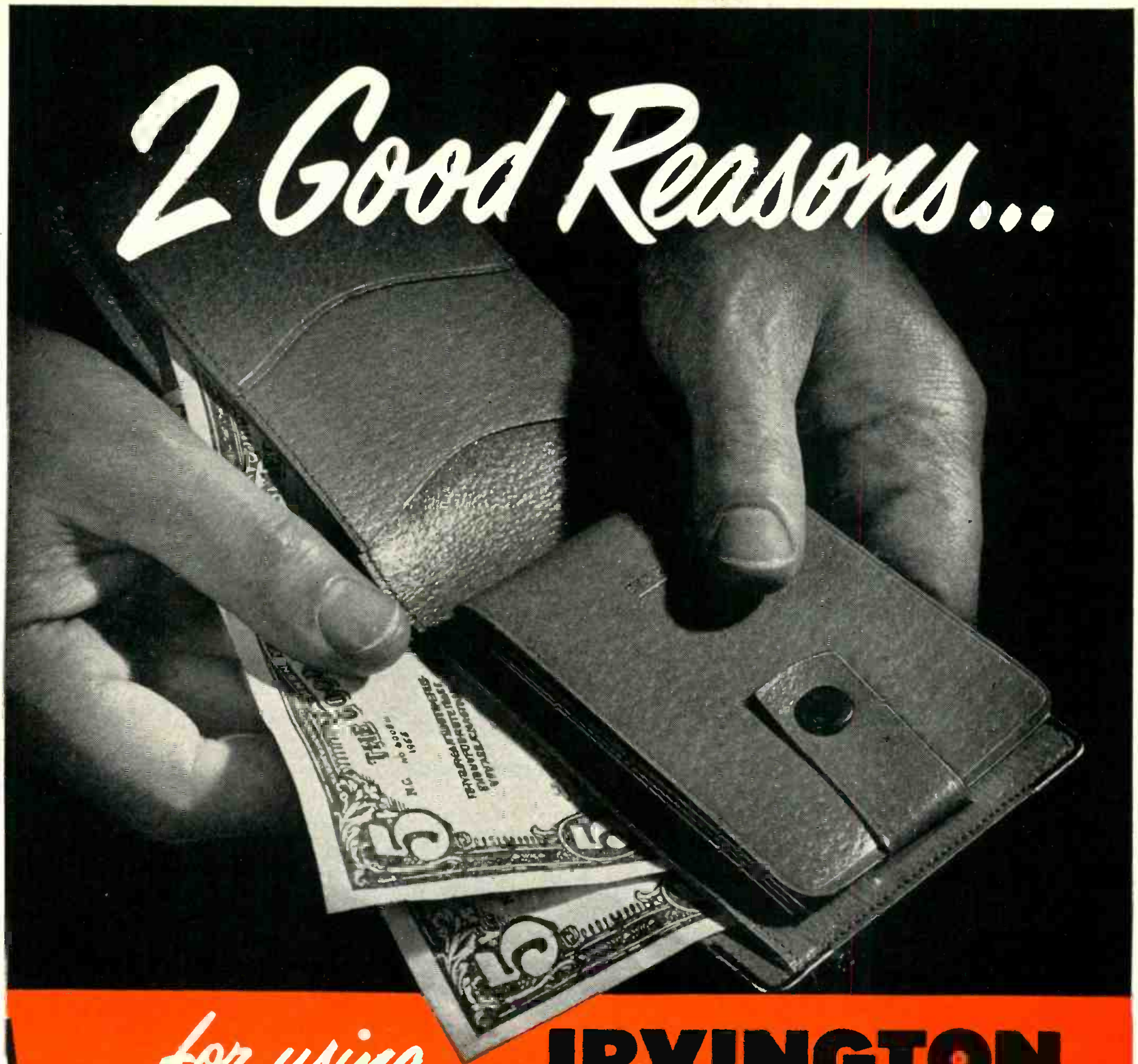

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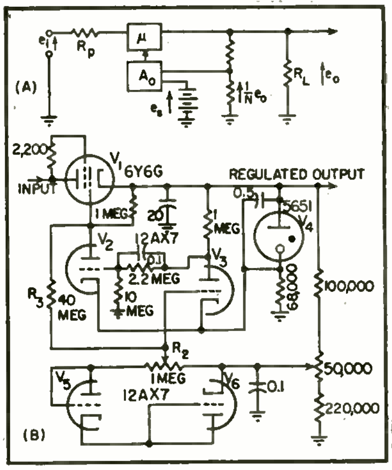


FIG. 2—Stabilized voltage regulator circuit maintains constant output voltage for ten-percent line-voltage fluctuations and load variations from 0 to 80 ma

load. Considering incremental voltages,

$$\frac{\Delta e_i - \mu\left[A_o\frac{\Delta e_o}{N} + \Delta e_o\right]}{R_p + R_L} = \frac{\Delta e_o}{R_L} \qquad (1)$$

Rearranging, it is found that

$$\frac{\Delta e_o}{\Delta e_i} = \frac{1}{1 + \mu + \frac{R_p}{R_L} + \frac{\mu A_o}{N}} \qquad (2)$$

where $\Delta e_o/\Delta e_i$ is defined as the input regulation. It is desired to minimize this quantity, which can be accomplished conveniently by increasing A_o.

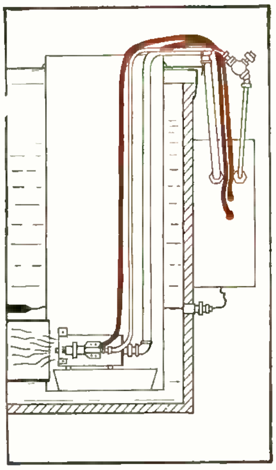
The output regulation can be specified in terms of the equivalent source resistance R_i. Considering the regulator as an amplifier having negative voltage feedback, it can be shown[6] that the source resistance

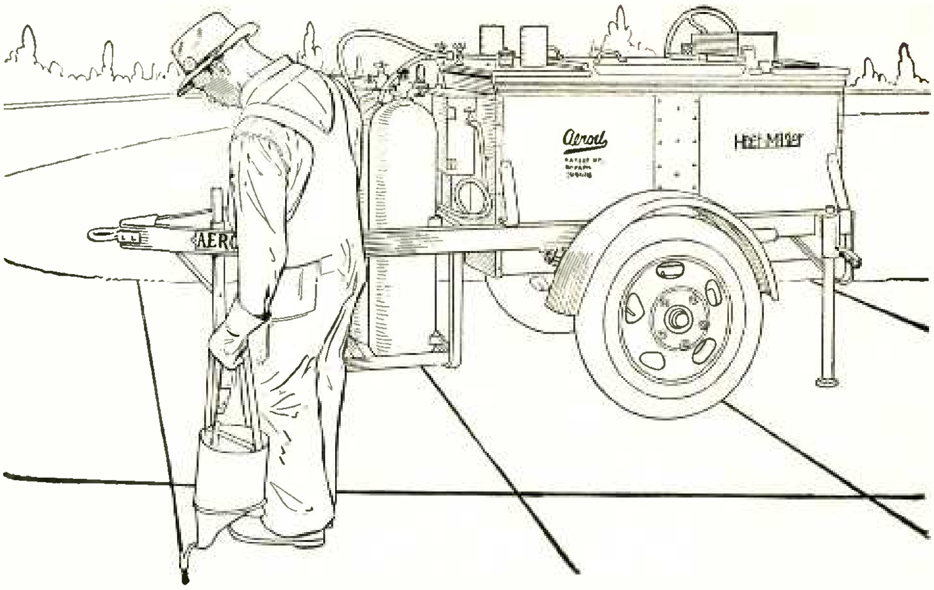
$$R_i = \frac{R}{1 + A\beta} \qquad (3)$$

where R is the output resistance of the amplifier in the absence of feedback, A is the amplifier voltage gain for the same condition, and β is the fraction of the voltage fed back. In the circuit of Fig. 1C, V_1 can be considered as a cathode follower of output resistance $\frac{R_p}{\mu + 1}$ and voltage gain $\frac{\mu R_L}{R_p + (1+\mu)R_L}$. Substituting,

$$R_i = \frac{\frac{R_p}{\mu+1}}{1 + \left(\frac{A_o}{N}\right)\left(\frac{\mu R_L}{R_p + (1+\mu)R_L}\right)} \qquad (4)$$

For the practical circuit of Fig. 2B, where A_o = 4,000, $N \approx 2$, $\mu = 5$, and R_p = 750 ohms, one obtains





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"BH Fiberglas Sleeving is used inside the burner wells (see sectional view above) to protect the LPG gas lines and thermostatic control lines against very high temperatures and open flames from the gas-fired torches. It affords complete protection and plays a very important part in the efficient, breakdown-free operation of this equipment."

BH Fiberglas Sleeving is as flexible as string because no hardening varnish or lacquer is used. It is heat resistant to 1200°F, if required. Won't split, crack or deteriorate. Resists grease, oils, and moisture. Use it profitably in your product or in your plant equipment. Write us today about your insulation problems.

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☐ BH "649" Fiberglas Tubing and Sleeving from Eq. 2 and 4, $\Delta e_o/\Delta e_i \approx 1/10{,}000$, and $R_i \approx 0.06$ ohm. These calculations were made for a 50-ma load ($R_L = 5{,}000$). Thus a 50-volt input change would appear as a change of but 0.005 volt at the output, while the output voltage will change 0.003 volt as the load current is increased from 0 to 50 ma.

An improvement in the performance of the circuit can be obtained by increasing A_o through regeneration. A resistor connected between the plate of V_2 and the grid of V_3 will accomplish the desired result. In this manner A_o can effectively be made infinite, with resulting perfect regulation.

Circuit

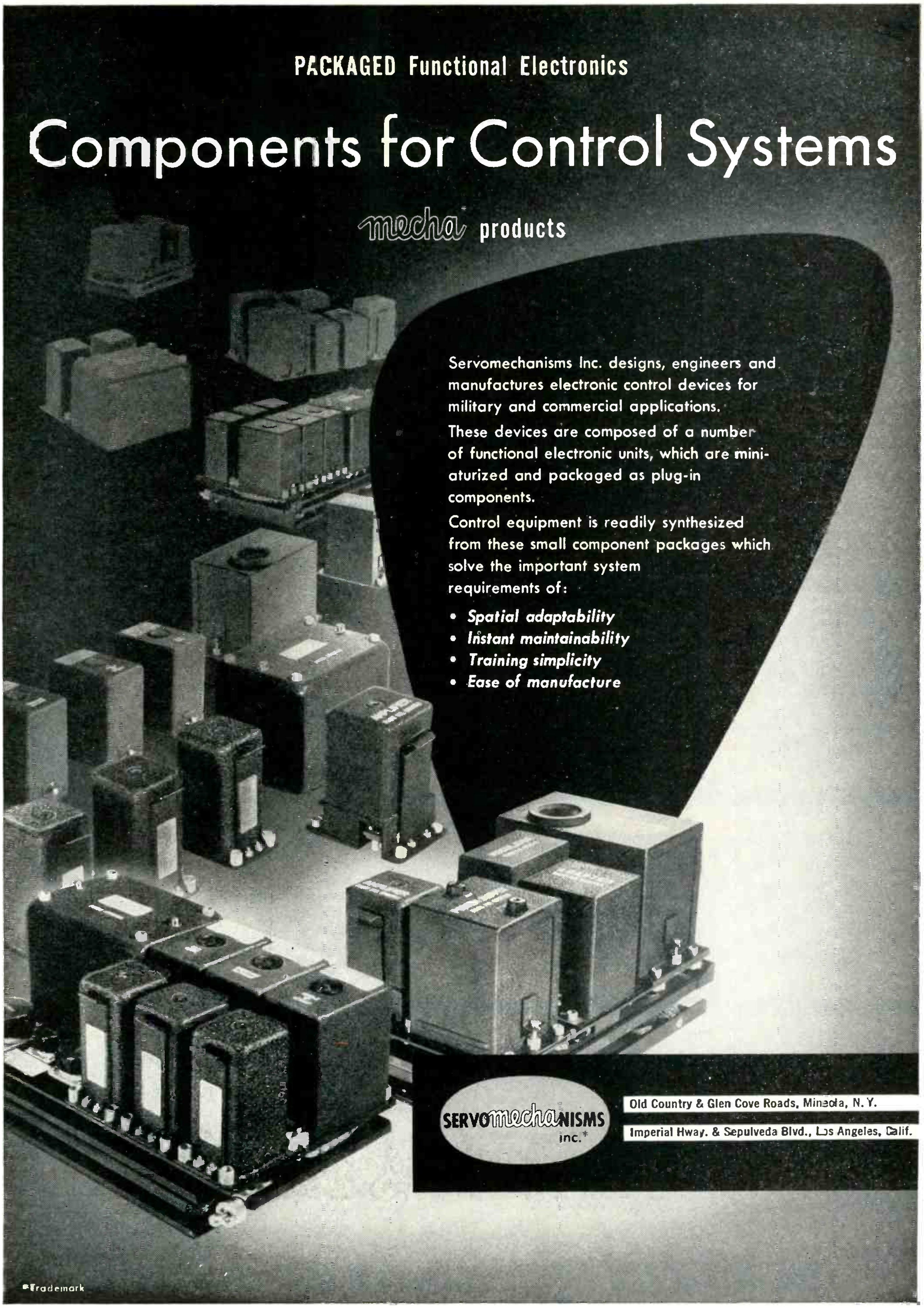
If the circuit given above is incorporated into a power supply, it is found that the output voltage will still vary as the line voltage is changed. This is caused by heater-voltage variations changing the effective bias on the control grid of V_3. A simple method of compensation [7] consists of inserting diodes V_5 and V_6 in Fig. 2B, in series with the control grid of V_3. If the tubes are operated from a common heater supply it is possible to obtain almost complete compensation over the normal range of heater-voltage variations.

Adjustment

In aligning the regulator, R_3 was disconnected, and R_2 was set for zero diode compensation. The control R_1 was set for the desired output (between 225 and 275 volts). The d-c input of the regulator was then varied over a range of 50 volts, and R_3 was selected for zero output-voltage variation. The diode-compensation control was next set for minimum output-voltage change as the line voltage was changed $\pm$ 10 percent.

Performance

A final check of performance showed the output voltage to be constant within 0.02 volt for $\pm$ 10 percent line-voltage variations and for load currents from 0 to 80 ma, the maximum current for the 6Y6G. The output voltage was constant within 0.025 volt (with fixed load current) over a period of one day. The output impedance was less than


PACKAGED Functional Electronics
Components for Control Systems
mecha* products
Servomechanisms Inc. designs, engineers and manufactures electronic control devices for military and commercial applications.
These devices are composed of a number of functional electronic units, which are miniaturized and packaged as plug-in components.
Control equipment is readily synthesized from these small component packages which solve the important system requirements of:
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• Instant maintainability
• Training simplicity
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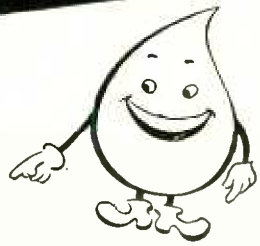
G.E.'s New All-Purpose* Insulating Varnish G-E 9574



J. L. Hughes, owner of the J. L. Hughes Electric Company, Columbus, Ohio, says:

"We have found from test and practical experience that General Electric general-purpose varnish 9574 is tops for our work."

J. Lindborg, owner of AAA Electric Motor Service, Atlanta, Ga., says:

"Our experience has been that this varnish is as good as G.E. claims. It gives a good coat on every type of wire, bakes easily and dries to a tough coating that stands up perfectly in service."

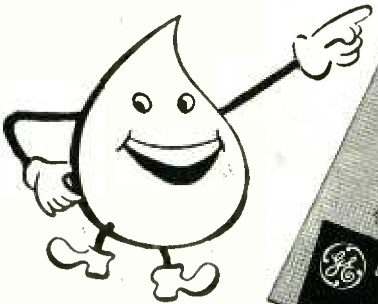
Guy W. Probst, owner of Lockhaven Electric Repair Co., Lockhaven, Pa., says:

"I find that I only use about half as much 1201 Glyptal as a cover coat on 9574 as I had to use over the varnish I had been using, and I get higher gloss and better bonding."

These statements indicate the success of the new G-E 9574. If you are looking for an insulating varnish which bakes at low temperatures, penetrates deep coils easily, and requires no special thinner, investigate G-E 9574.

**G-E 9574 gives excellent results on all types of coils except extra-high-speed armatures. It is one of G.E.'s complete line of electrical insulating materials, including wedges, adhesives, cements, compounds, cords and twines, sleeving, wire enamels, mica, papers and fibers, permafils, tapes, tubing, varnished cloths, and varnishes.*

Here's A Bulletin You Should Have! If you haven't yet tried G-E 9574 get in touch with your local G-E Distributor, or write for our new bulletin to Section K3, Chemical Department, General Electric Company, Pittsfield, Massachusetts.



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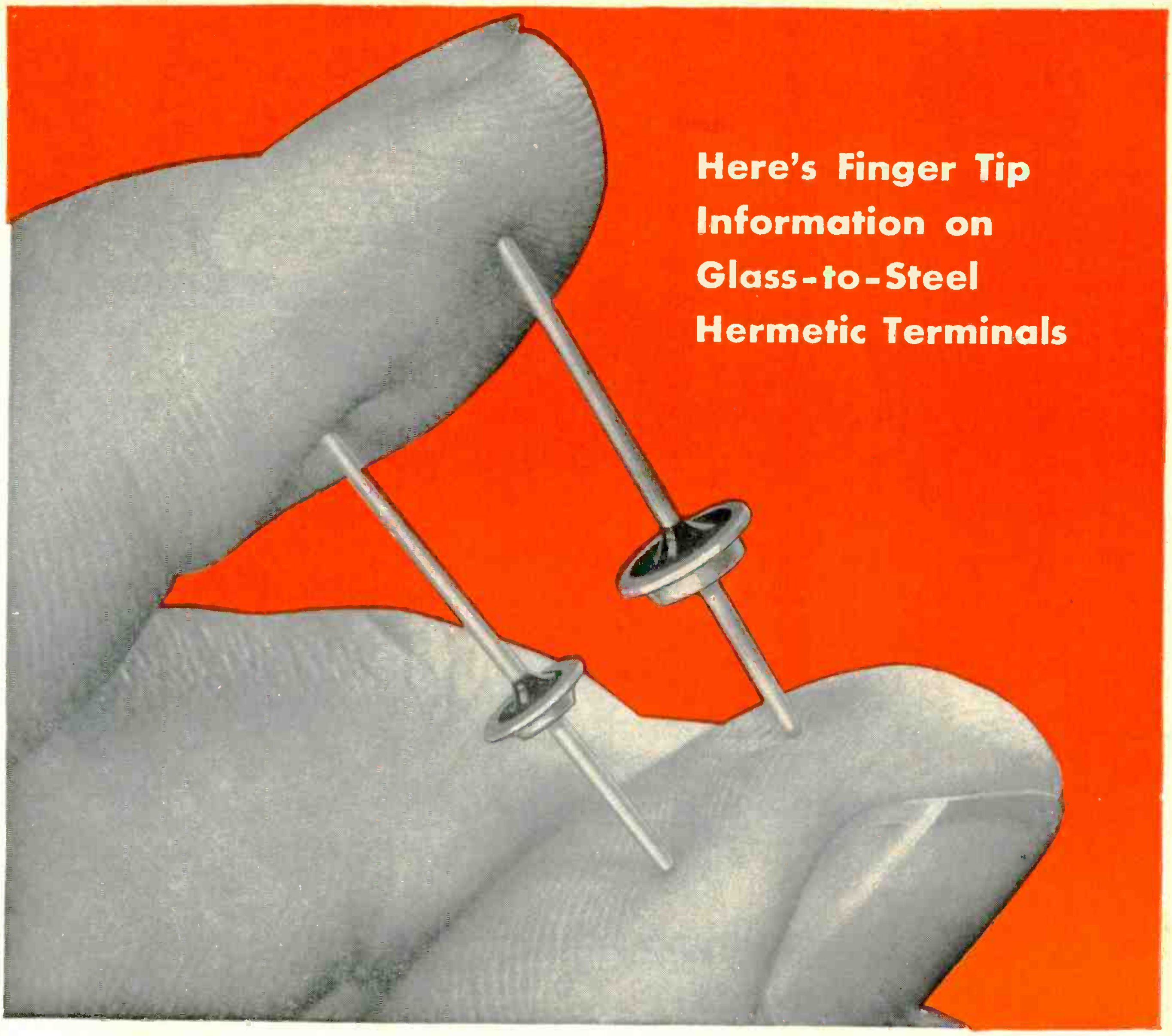

• The trend toward hermetic sealing in all phases of electrical manufacturing is gaining impetus. Fusite has pioneered in the field of glass-to-steel hermetic terminals for use in fusion sealing—the only truly hermetic process.

• We have prepared a brochure crammed full of illustrations, specifications, diagrams, and facts about the Fusite wide line of single and multiple electrode terminals.

• We assure you that regardless of your present level of knowledge concerning glass-to-steel terminals, you do not have a complete or accurate picture of the production possibilities of fusion sealing until you know the Fusite story.

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TERMINALS ILLUSTRATED: 104SW, Left, 105SW, Right.
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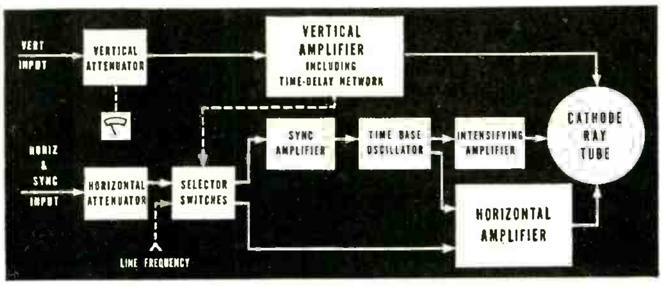
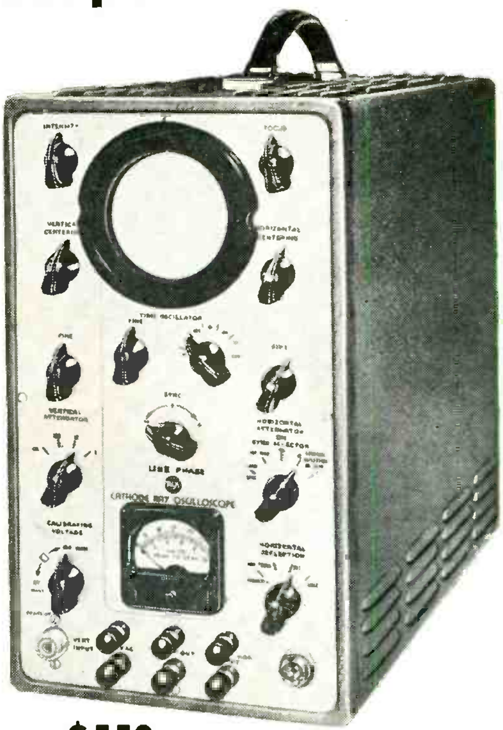
CARTHAGE AT HANNAFORD, NORWOOD, CINCINNATI 12, OHIO

A WIDE BAND laboratory 'scope for pulse measurement and square-wave analysis

RCA WO-79B



BLOCK DIAGRAM OF WO-79B



$550 SUGGESTED USER PRICE
(Includes direct probe and low-capacitance probe and cables.)

Unique facilities for

- Manufacturing Applications
- TV Station Monitoring
- TV Equipment Design

FEATURING...

- ✓ Frequency response flat to 5 Mc
- ✓ High-speed triggered time base with built-in delay line
- ✓ Intensifying amplifier with blanking
- ✓ High-speed sawtooth with trace expansion
- ✓ Calibrating meter for instantaneous voltage measurements
- ✓ Also internally available—extra-high anode voltage

The RCA WO-79B Cathode-Ray Oscilloscope is a precision laboratory-type instrument of compact, portable design. With its outstanding features, this versatile instrument will handle a wide range of jobs in research and manufacturing applications.

The WO-79B is particularly useful for the observation and measurement of TV synchronizing and deflection voltages, ignition waveforms, pulses, and radar signals. It will display waveforms having a duration as short as one microsecond. Leading edges of steep-fronted, narrow pulses, such as are encountered in TV sync generators and electro-mechanical relays, can readily be observed.

One of the unusual features is an "intensifying amplifier" which serves to blank out the return trace and intensify the brilliance of the forward trace. Also, the 'scope has a special sync amplifier and phase-polarity control which allow the instrument to sync on extremely weak signals of either positive or negative polarity.

For further information on features of the WO-79B, see your local RCA Test Equipment Distributor, or write to RCA, Commercial Engineering, Section K42Y, Harrison, N. J.

SPECIFICATIONS

Frequency Range:
Vert. Amplifier..Flat within ±20%, 10 cps to 5 Mc/sec
Horiz. Amplifier..Flat within ±10%, 10 cps to 500 kc
Deflection Factor: (vert. amplifier)
0.18 RMS volt/inch (for 1100 volts sec. anode)
0.27 RMS volt/inch (for 1500 volts sec. anode)
Sawtooth Time Base............20 cps to 250 Kc/sec
Triggered Time Base
Max. Writing Speed...........1 inch per microsecond
Max. Repetition Rate......................50 kc/sec
Tube Complement—3-6AC7; 4-6AG7; 3-6SN7GT; 1-6SH7; 1-6H6; 1-2X2A; 1-5U4G; 1-OD3; 1-3KP1 CRT; 1-6C4
Note: Type 3KP11 CRT interchangeable with 3KP1

Available from your RCA Test Equipment Distributor

RADIO CORPORATION of AMERICA
TEST EQUIPMENT HARRISON, N.J.

0.2 ohm at all frequencies below 200 kilocycles.

References

(1) U. S. Patent No. 2,075,966 (A. W. Vance).
(2) RCA Application Note No. 96, August, 1938.
(3) F. V. Hunt and R. W. Hickman, On Electronic Voltage Stabilizers, *Rev. Sci. Instr.*, **10**, p 6, Jan. 1939.
(4) ibid. (3).
(5) RCA Tube Handbook HB-3. Listed under tube-type 5651.
(6) H. F. Mayer, Control of Amplifier Internal Impedance, *Proc. IRE*, **27**, p 213, Mar. 1939.
(7) G. E. Valley, Jr., and Henry Wallman, "Vacuum-Tube Amplifiers", McGraw-Hill, N. Y., 1948.

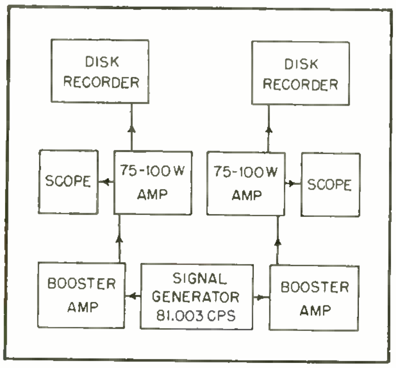
Adapt 2-Speed Tables to 3-Speed Operation

By Leon A. Wortman
New York, N. Y.

Numerous recording companies and broadcast stations would like to be able to record and play back the 45-rpm discs. Many of them have avoided buying adaptors for their 2-speed turntables, or buying new 3-speed turntables, because of the extra costs involved. However, most studios and stations already have the gear necessary for 3-speed operation without in any way altering the turntable itself.

Reeves Sound Studios, New York City, is using the 2-speed (33⅓ and 78 rpm) Fairchild Unit 524 transcription playback turntable and the Fairchild Unit 523 studio model disk recorder, and they make 45-rpm masters for pressings. The setup shown in the block diagram is all that is required.

A stable audio signal generator feeds a booster amplifier to drive a power amplifier. Through experimentation, and with a disk strobe, it was learned that if the frequency



System for recording at 45-rpm using a 33-78 rpm turntable

Federated ROSIN CORE SOLDER

Look for the orange package . . . the universally popular solder for use in electrical applications where bonding must be secure and free from corrosion.

The flux is in the solder . . . all you need is heat! Federated Rosin Core Solder is available in 1, 5, and 20-pound sizes.

Federated makes *every* commercial solder . . . Asarco Body Filler Metal, acid-core, solid wire, spray-gun, and bar . . . purity and composition guaranteed by the world's leading supplier of solder.

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120 Broadway, New York 5, N. Y.

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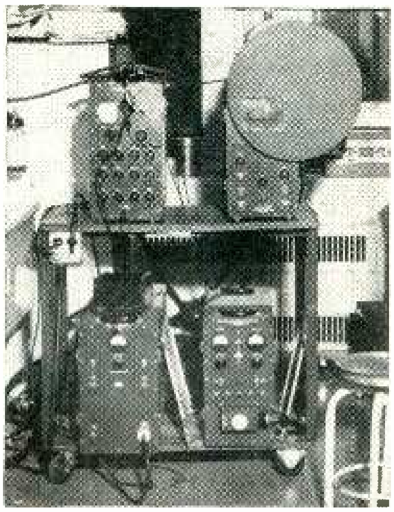
federated first in the non ferrous field FMD of the line voltage feeding the turntable drive motor were made 81.003 cycles per second, the speed of rotation of the turntable would be exactly 45 rpm. That is with the Fairchild drive set for $33\frac{1}{3}$-rpm operation. This results in synchronous 45-rpm operation.

The scopes read the phase difference between the signal generator and the built-in scope sweep oscillator. A change in the pattern on the scope screen indicates a shift in the frequency of the controlling signal generator and a resultant change in 45-rpm turntable speed.

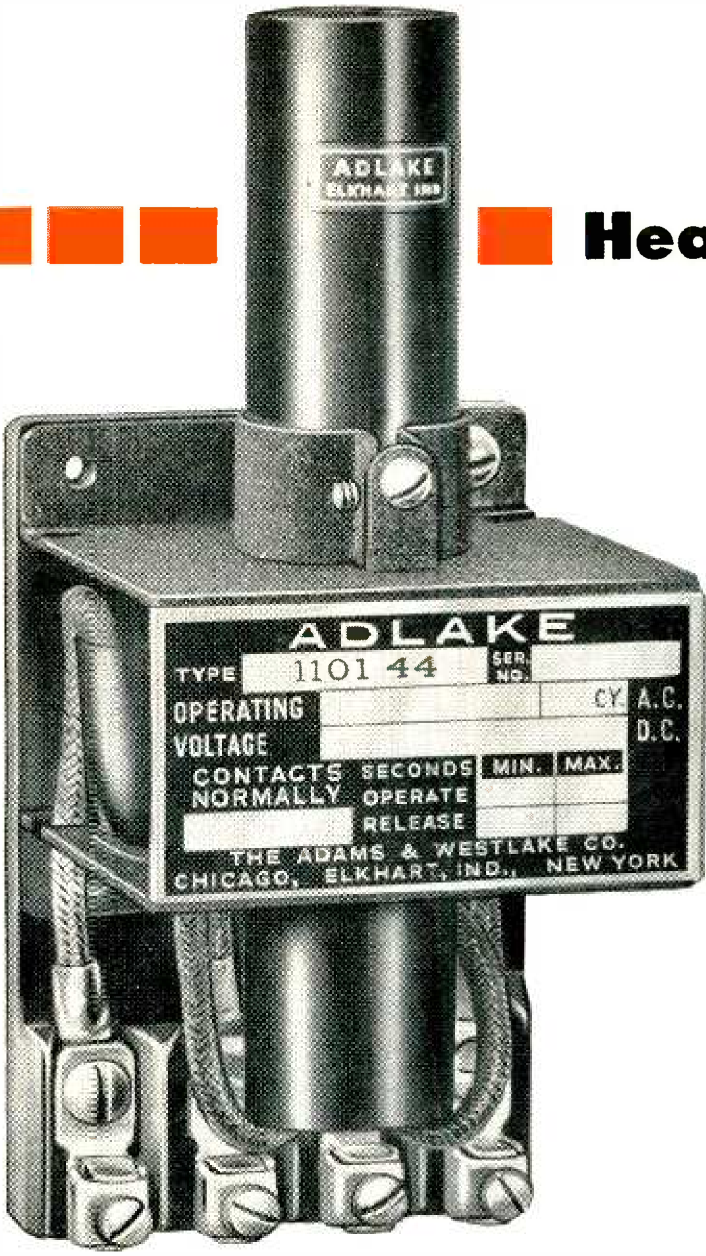
Reeves uses duplicate power amplifiers driven by one signal generator to operate two Fairchild disk recorders, one for original and the other for safety recording. The power amplifiers must be capable of delivering adequate power to the drive motors. To properly drive the motors, the amplifiers should deliver an output power of from 75 to 100 watts, with good wave form, at 81 cycles. Because of the new line frequency applied to the drive motors, the drive motors require individual retuning to maintain good torque. This is easily done by the capacitor substitution method, substituting new values for the 4-μf motor starting capacitor supplied by the manufacturer.

18-Mc Telecolor for Surgical Training

INDUSTRIAL color television equipment using an 18-mc bandwidth



Color television camera used in operating room. Spotlight on top of camera was the only additional illumination needed for the image orthicon even though color wheel was used



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TRADE MARK

Heavy-Duty Relay No. 1101

Now Available with or without Compression-Type Terminal Block

For the first time, the rugged and versatile ADLAKE No. 1101 Mercury Relay may be had with or without a compression-type terminal block. Either style is available as a time delay or a load relay, with contact normally open or closed, for A.C. energization.

The No. 1101 Relay offers a time range of from .15 of a second to 20 minutes. Time characteristics are fixed and non-adjustable, and each relay is tamperproof. The standard finish is black enamel, wrinkled, and construction is sturdy, to withstand heavy shocks and vibrations.

The No. 1101 proved its value in such varied applications as radio transmission, timing power circuits, production line time control, voltage regulation, liquid level controls and solenoid valves. Every day, new applications for this economical relay are being discovered.

For the full story on the No. 1101 Relay, as well as the many other important Adlake Relays, drop a card to The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana. No obligation, of course.

Every Adlake Relay Offers You These Advantages:

HERMETICALLY SEALED—dust, dirt, moisture, oxidation and temperature changes can't interfere with operation.

SILENT AND CHATTERLESS

REQUIRES NO MAINTENANCE

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Established 1857 ELKHART, INDIANA New York • Chicago

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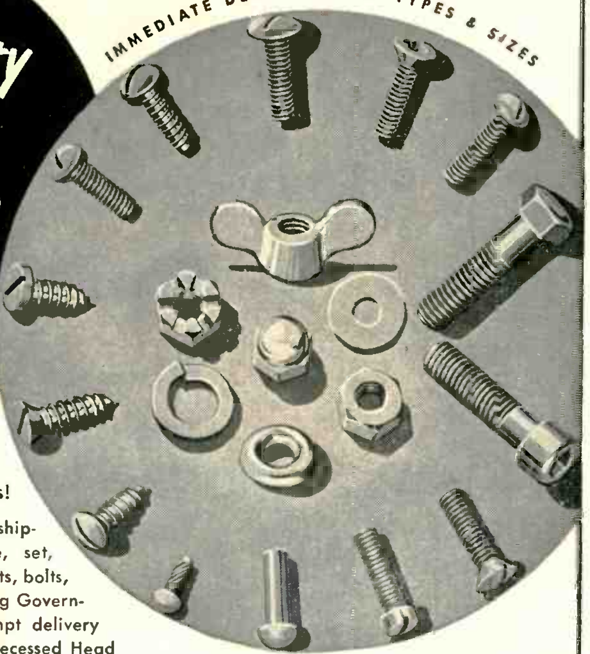

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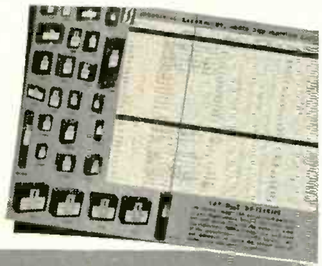

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MODEL 60

Bolometer Amplifier

- Self Contained Metering
- Pull Out Meter
- AC and DC Recorder Output
- Panel Selection of 3 Frequencies
- Adjustable and Metered Bolometer Bias

USES

The Model 60 Bolometer Amplifier is a band pass amplifier designed to amplify the output of crystal or bolometer probes used in RF measuring equipment. The amplifier is suitable for all occasions where extremely low audio voltages must be amplified. The recorder output makes the unit particularly useful for antenna pattern recorders requiring either AC or DC input voltages.

DESCRIPTION

The Model 60 Bolometer Amplifier is an audio amplifier incorporating parallel 'T' null networks in a feed back circuit to provide a narrow band pass at any desired frequency within specified limits. The amplifier includes a meter amplifier and an output meter which may be removed from the panel opening for use at remote locations. The recorder output provides a choice of impedances for AC outputs as well as a DC output for those recorders requiring such an input. Input circuits are designed for operation with crystals or 300 ohm bolometers.

CHARACTERISTICS

FREQUENCY RANGE—400 cycles to 5000 cycles (choice of 1, 2, or 3 frequencies within these limits) ±2% frequency tolerance.

BANDWIDTH—(1/2 voltage points) 8% of bandpass center frequency.

INPUT VOLTAGE RANGE Meter—10^{-2}—10^{-7} volt. Recorder (AC)—10^{-2}—10^{-6} volt.

INPUT IMPEDANCE—250 ohm to 350 ohm.

METER—Logarithmic meter scale (0—20 db) with 100 db decade.

RECORDER OUTPUT—AC .01—100 volts 50,000 ohms. Additional output impedances of 5000 ohms, 500 ohms, and 250 ohms. DC—0.01—0.75 volts.

BOLOMETER BIAS—Adjustable in steps of 2% current change over a range 2:1—metered directly.

POWER SUPPLY—115 volts 50/60 cycles 40 watts.

DIMENSIONS—19" wide, 8¾" high 10" deep.

WEIGHT—27 lbs.

FINISH—Blue grey wrinkle panel and mahogany cabinet (unit may be rack mounted without cabinet if desired.)

Ask for Bulletin L-60

PICKARD & BURNS, Inc.

240 Highland Ave.
Needham 94, Mass.

FOR ARMED SERVICES COMPONENT REQUIREMENTS—1N69 AND 1N70

SPECIFICATIONS

Max Ratings at 25°C	1N69	1N70
Peak Inverse Voltage	75	125
Max Continuous Inverse Voltage	60	100
Average Rectified Current (ma)	40	30
Peak Rectified Current (ma)	125	90
Surge Current (ma)	400	350
Temp. Range °C	−50 to +70	−50 to +70
Characteristics at 25°C		
Max Inverse Current at −50v(ma)	.85	.41
Max Inverse Current at −10v(ma)	.05	.01
Min Forward Current at +1v(ma)	5.0	3.0
Average Shunt Capacitance (mmfd)	0.8	0.8

Welded

GERMANIUM DIODES

GENERAL ELECTRIC germanium diodes must meet the most rigid specifications, yet volume production continues to drive their prices steadily downward. Compare new G-E prices with all others . . . then check the following reasons for this ever-widening acceptance among electronics designers, engineers, and equipment makers:

Dual Mounting—For Convenience— Versatile G-E diodes can be mounted two ways: *clip them into place* by means of their husky, non-oxidizing nickel pin terminals . . . or use each diode's well-tinned, copper-clad steel leads to *solder* it into the circuit. These special leads are strong and flexible conduct less heat than ordinary types, and thus prevent damage during soldering.

Platinum Whisker—For Strength— To assure stability and long life, the G-E diode's pigtail whisker is of platinum, which, unlike tungsten, can be strongly welded to germanium.

Moisture Resistant Insulating Case—For Protection— A special insulating case of molded, mineral-filled phenolic protects this unique welded contact. The case is also tapered to assure correct polarity mounting. These diodes are so easy to handle—you can install 'em in the dark!

Looking For A Long Life Diode? We've got 'em! The complete G-E line includes four general purpose diodes, two JAN types, two TV types (more than half a million of these have already been supplied to TV receiver manufacturers), one u-h-f model and the high quality quad of four balanced diodes. For product and application engineering service, inquire at the G-E electronics office near you, or write: *General Electric Company, Electronics Park, Syracuse, N. Y.*

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Now in 2nd Printing! Here are 68 pages of facts on characteristics, advantages, and circuitry of diodes. Charts, curves, diagrams, typical applications. Leatherette bound, loose-leaf style. Supplementary sheets furnished free as published. Worth many times its modest price of \$1.25. Send check or money order to: *General Electric Company, Section 4120 Electronics Park, Syracuse, New York.*

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GENERAL ELECTRIC

with 500-line horizontal resolution was demonstrated by DuMont to surgeons attending sessions of The New York Academy of Medicine at St. Clare's Hospital in New York City. Ample light for bright and clear color pictures was obtained by supplementing operating table illumination with one spotlight mounted on top of the camera, even though the image orthicon had to work through the rotating color

Visiting doctors watching surgical operation in full color on 12½-inch screen. Fidelity is sufficient to show individual nerves and veins, and camera right alongside operating table gives better view than if looking over shoulder of surgeon

wheel of the sequential scanning system employed.

The only equipment in the operating room was the camera and a microphone for commentary by the surgeon. In an adjacent scrub-room were the four portable units needed for producing the complete picture signal—the low-voltage supply, sync generator, camera control and color mixer, and a 7-inch color monitor. The large color monitor, providing a 12½-inch picture bright enough for viewing by up to 40 persons, was located in a downstairs auditorium of the hospital and connected to the control point upstairs

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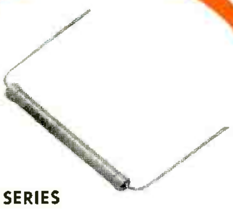
YOU CAN COUNT on performance exactly as rated with Bradley rectifiers — whether your requirements involve one unit or a hundred thousand units. Our exclusive vacuum process—as applied to selenium and copper oxide rectifiers — provides the highest type of quality control. You get the rectifier you need, predictably accurate, true to rating and long-lived even under extreme operating conditions.

SPECIAL POWER CONVERSION PROBLEMS — the kind that get you shrugs elsewhere — are challenges that we accept and handle with speed and competence. Bradley has helped many leading manufacturers use rectifiers in new ways that have led to improved product performance. We can help you, too, on either standard or special requirements. If your product involves a rectifier — see Bradley to get the performance desired.



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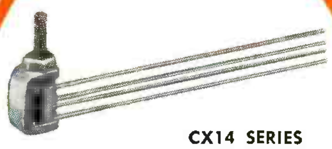
Selenium for high voltage uses.



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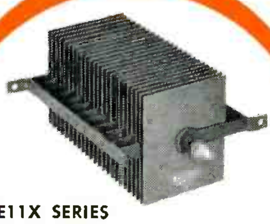
Copper oxide for instruments.



SE11X SERIES
Selenium for high current uses.

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Bradley Luxtron* photoelectric cells convert light directly into electrical energy without external power source. Wide range of models, sizes and shapes available.

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BRADLEY LABORATORIES, INC.
82 MEADOW STREET NEW HAVEN 10, CONNECTICUT

Control point for DuMont telecolor installation at St. Clare's Hospital in New York City. Camera control and 7-inch color monitor are on top shelf, with power supply and sync generator below

with coaxial RG-11/U cable. Use of 180 fields per second gave stable, flickerless images in the closed-wire system.

Cloud Base and Top Indicator

THEORETICAL STUDIES at Evans Signal Laboratory in 1945 indicated that radar operating at approximately one centimeter should detect clouds. An experimental radar set operating at 1.25 centimeters was built at the Fort Monmouth, N. J. Laboratory and the results were encouraging.

Clouds have been detected as high as 46,000 feet and several layers of clouds have been detected and the height of the bases and tops of the layers determined. The accuracy of height information has been checked by means of test flights and found to be exceptionally good.

An A-scope indicator showing intensity of cloud echo versus height was used originally as the only indicator. Later a facsimile-type recorder was adapted to print the video information and thereby obtain a permanent record of the height of bases and tops of cloud layers.

Development models of the AN/TPQ-6 are being built by Bendix Radio for the Signal Corps. Three systems are being made with fixed vertical beam and one system

give your sets *extra* sales appeal

Television purchasers need no introduction to Stainless Steel . . . they've become acquainted with its light weight and superior strength in hundreds of home products. Used for picture tube cones, it gives salesmen an extra talking point in favor of your set.

Customers will be pleased to hear that Stainless cones weigh at least one-third less than all-glass cones, yet they are stronger and less susceptible to the dangers of implosion and breakage.

The weight reduction that Stainless makes possible is highly important from the manufacturing standpoint. It materially reduces the cost of handling, packing and shipping picture tubes and sets.

A new grade of U·S·S Stainless Steel—U·S·S 17-TV—has been developed especially for television applications. The unique characteristics of this new Stainless grade make possible the fusing of glass faceplate and neck to the metal cone with an airtight seal.

If you are interested in Stainless Steel for picture tubes, take advantage of the information assembled during development of U·S·S 17-TV. Send your request to United States Steel Corporation Subsidiaries, 2210 Carnegie Building, Pittsburgh 30, Pennsylvania.

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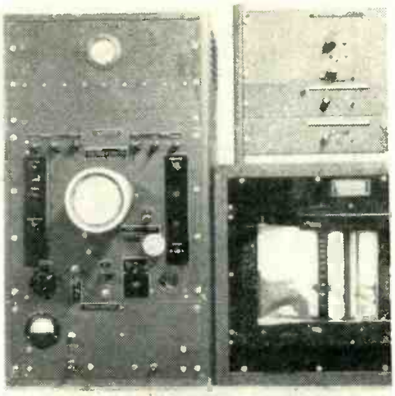
UNITED STATES STEEL



Radar indicator, recorder, and amplifier used for recording height of cloud bases and top

with the antenna positionable in azimuth and elevation. The chief difference between the experimental and development models is the wavelength. The development models operate at 0.86 cm (about 34,000 mc) and are the first Signal Corps radars to operate at this wavelength.

A few of the chief characteristics of the systems are noted below:

	Experimental Model	Development Models
Wavelength	1.25 cm	0.86 cm
Frequency	24,000 mc	34,000 mc
Magnetron	3J21	X7107
Antenna	60-in. Parabola	7 ft. Metallic Lens 7 ft. Parabola (4th System)
Range	50,000 feet	60,000 feet 100,000 feet (4thSystem)
Pulse Length	1 μsec	1 and 0.2 μsec
Pulse Rate	400 cps	492 and 2,460 cps
Beamwidth	0.6 deg	0.3 deg

Cloud information obtainable by radar can be of value both in aviation as a flying aid and in meteorology for the study of cloud structure. Development is continuing with the aim of standardizing on the best type of radar cloud detector for eventual field use by the Joint Services.

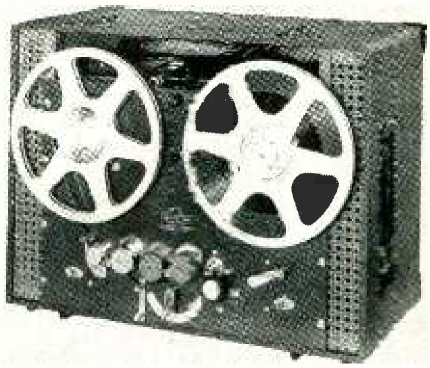
Capacitance-Controlled Recorder

FOR MANY INDUSTRIAL and laboratory processes, an indication of minute current is not sufficient and a graphical record is required. Most of the existing systems suffer from limitations, the majority of which are associated with the difficulty of operating a pen over a paper surface with the small power available

if it's TAPE...it's PRESTO
if it's PRESTO...it's the BEST

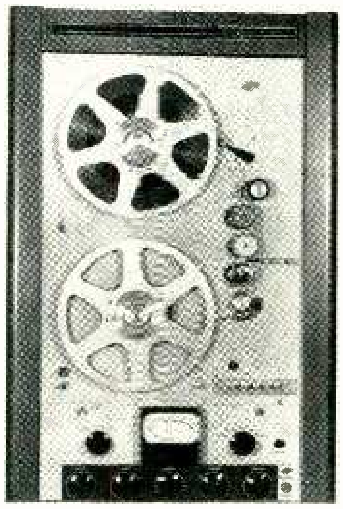
PRESTO PORTABLE RECORDER PT-900

Combining the features of machines costing hundreds of dollars more, the PT-900 answers the need for a recorder of ultra-high fidelity in a completely portable, compactly designed unit. Equipped with separate amplifiers for recording and monitoring; individual heads for erase, record, playback; three microphone input; dual speed (15" and 7½/sec.). Frequency response from 50 to 15,000 cps.



PRESTO PORTABLE RECORDER RC-10/14

This machine is identical to the RC-10/24, except for panel size and selector control. With a panel 19"x14", the RC-10/14 is shown mounted in a durable, leatherette carrying case. Weighing just 68 pounds, this tape transport mechanism has all the audio quality, speed regulation and reliability of a fine console type unit, at a cost far below a studio recorder. PRESTO amplifier (model 900-A2), as shown with model PT-900, is recommended.



PRESTO RACK MOUNTED RECORDER RC-10/24

The number one choice of engineers seeking the finest tape machine for relay rack mounting. Rugged construction and precision engineering combine to bring almost faultless operation. Push-button control, three magnetic heads, speeds of 15" and 7½"/sec.; fast-forward and rewind speed of 250"/sec.; frequency response to 15,000 cps. Accommodates reels up to 10½" in diameter. Panel size: 19"x24½". Constant tape tension assured by torque motors. Illustrated with the PRESTO 900-A2 amplifier, recommended for use with this recorder.

AMERICA'S MOST COMPLETE SELECTION OF FINE TAPE RECORDERS

PRESTO

RECORDING CORPORATION

Paramus, New Jersey

In Canada: Walter P. Downs, Ltd., Dominion Square Bldg., Montreal, Canada
Overseas: M. Simons & Son Company, Inc., 25 Warren Street, New York, N. Y.

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

Transformer Space-saving problem

SOLVED

Here's a space-saving problem . . . and another example of how Westinghouse applies engineering experience to handle all types of transformer problems.

The problem: To build a more compact filament transformer for use with Phanotron rectifier tubes.

First, the transformer case, core and coils had to be made smaller.

Second, the large standoff insulator between the transformer case and tube socket had to be eliminated. Because the previous case was metal, a large standoff insulator had been used to keep the tube socket, mounted on top of the transformer case, 11,000 volts from ground.

The Westinghouse solution: MOLDARTA and Type C HIPERSIL cores, two Westinghouse engineered products.

Westinghouse Type C HIPERSIL cores, ⅓ smaller than ordinary cores, easily fit the smaller MOLDARTA transformer case.

MOLDARTA, a low power factor, low loss material, also served as the perfect insulator. Thus the large standoff insulator was eliminated . . . the desired compactness was attained . . . and a difficult space-saving problem was solved.

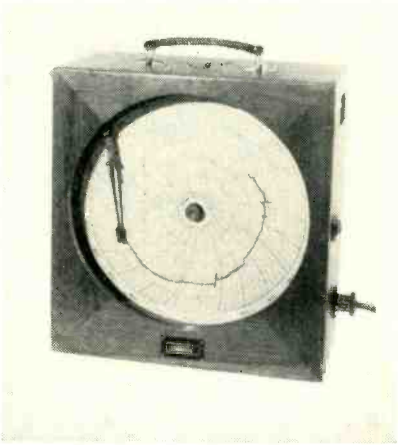
If you have a tough transformer problem, take advantage of the facilities of Westinghouse for quick, practical solutions. Transformers specially designed for all types of electrical and electronic circuits, as well as a wide selection of standardized designs . . . produced in quantity . . . with quality. Call your nearby Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-70569

Westinghouse

SPECIALTY TRANSFORMERS

from low-current circuits. It is claimed that a new instrument overcomes these difficulties and provides a robust and accurate recorder which will operate in any circuit where an indicating instrument can be used.

The instrument developed by Fielden (Electronics) Ltd. of England, and described in *Electronic Engineering*, consists of a servo-operated mechanism which is positionally controlled by a moving coil, moving iron vane or dynamometer movement. The pointer of the normal meter movement is replaced by a light vane which acts as one plate of a variable capacitor, another similar vane, arranged to be



Any current that deflects a normal meter movement can be recorded by the Fielden Servograph

turned by the servo mechanism, moves in the same arc as the meter-operated vane. The two are maintained at a constant spacing by an electronic capacitance relay which controls the servo motor. The current to be measured has to provide only enough energy to deflect a normal meter movement and the servo mechanism locates the pen arm with precision at the resting place of this movement.

The capacitance relay employed consists of an oscillator in which the feedback circuit is arranged as a capacitance-dividing network, of which the meter capacitor forms one arm and an internal preset capacitor another. When one capacitor is larger than the other the feedback is positive, and when one is smaller than the other the feed-

WILCOX ...**FIRST CHOICE of HAWAIIAN AIRLINES**

VHF AIR-BORNE COMMUNICATIONS

Hawaiian Airlines selected the WILCOX TYPE 361A COMMUNICATIONS SYSTEM for all aircraft. This consists of a 50 watt transmitter, a high sensitivity receiver, and a compact power supply, each contained in a separate ½ ATR chassis. Transmitter and receiver contain frequency selector with provisions for 70 channels . . . ample for both present and future needs.

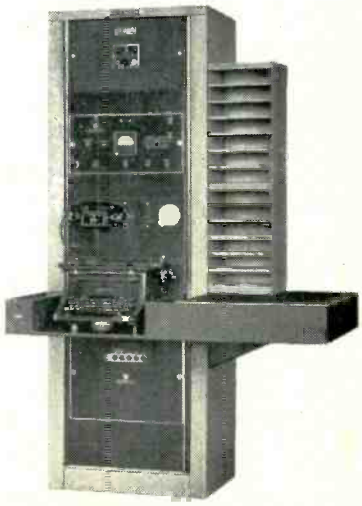
VHF GROUND STATION PACKAGED RADIO

Hawaiian Airlines selected the WILCOX TYPE 428A FACTORY PACKAGED STATION for all ground stations. This consists of the WILCOX 406A fixed frequency 50 watt transmitter, the WILCOX 305A fixed frequency receiver, the WILCOX 407A power supply, the WILCOX 614A VHF antenna, telephone handset, loudspeaker, desk front, typewriter well, and message rack.

DEPENDABLE COMMUNICATIONS FOR THE WORLD'S AIRLINES

During recent months, many of the world's foremost airlines, UNITED, EASTERN, TWA, MID-CONTINENT, BRANIFF, PIONEER, ROBINSON, and WISCONSIN CENTRAL have placed volume orders for similar communications equipment. No greater compliment could be paid to the performance, dependability, and economy of WILCOX equipment than to be **"FIRST CHOICE"** of this distinguished group.

Write Today for complete information on the Type 361A VHF Air-borne Communications System and the Type 428 Packaged VHF Ground Station.



Type 428 Packaged VHF Station

WILCOX ELECTRIC COMPANY

KANSAS CITY 1, MISSOURI, U.S.A.

NO OTHER TESTER

does so much... so well!

In the shop . . . 28 ranges *in one case* to locate circuit troubles on production equipment.
On the bench . . . 28 ranges *in one case* for checking electrical equipment during manufacture.
In the lab . . . 28 ranges *in one case* immediately available for research and development work.

28 Instrument Ranges

D-C VOLTS: 100 mv, 1/10/50/200/500/1000 volts (20,000 ohms per volt).
A-C VOLTS: 5/15/30/150/300/750 volts.
D-C CURRENT: 50 microamps; 1/10/100 milliamps; 1/10 amps.
A-C CURRENT: .5/1/5/10 amps.
RESISTANCE: 3000/30,000/300,000 ohms; 3/30 megohms.

Stock Accessories Available for Extending Above Ranges

It does *so* much, *so* well, for *so* little. Check your Weston Representative for full details or see your local jobber. Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark 5, New Jersey . . . manufacturers of Weston and Tagliabue Instruments.

WESTON *Instruments*

Albany • Atlanta • Boston • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Houston • Jacksonville • Knoxville • Little Rock • Los Angeles • Meriden • Minneapolis • Newark • New Orleans
New York • Orlando • Philadelphia • Phoenix • Pittsburgh • Rochester • San Francisco • Seattle • St. Louis • Syracuse • Tulsa • Washington, D. C. • In Canada, Northern Electric Company, Ltd., Powerlite Devices, Ltd.

back is negative. The circuit is so arranged that it is in oscillation when the meter capacitor is the smaller, and any conditions which cause the meter-operated vane and the servo-operated vane to close up together put the circuit out of oscillation.

The capacitance relay controls the direction of rotation of the servo motor, which is suitably geared to the pen arm of the recorder, and to the servo-operated vane in the instrument. The whole arrangement thus provides a system which maintains the two capacitor plates at constant spacing and where any electrostatic attraction between two vanes has no effect on calibration accuracy.

Operation

Let it be assumed that some increment in current has changed the position of the indicating movement. If its movement is downward, its vane leaves the servo-operated vane. Conversely, if its movement is upward, it moves up to and rests against the servo-operated vane. In either event the motor starts to rotate in one direction or the other, moving the servo vane to the new position.

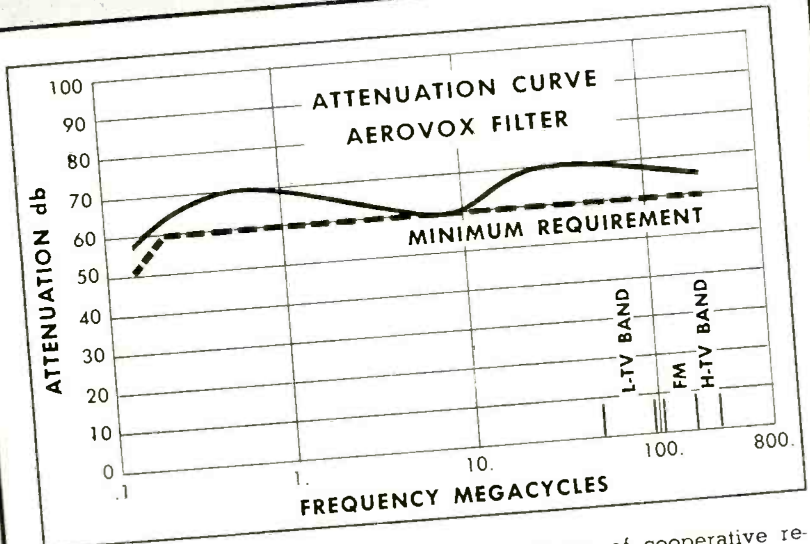
The circuit is so adjusted that when the two plates are positioned 0.01 inch from one another the voltage present at the servo vane pulls the meter vane towards it, but in doing so switches off the oscillator and the electrostatic attraction. The meter vane starts to return to its original position, but in doing so switches on the oscillator, and the cycle is repeated. The result is that the meter vane is maintained in oscillation at several cycles per second in a very small arc of about 0.001 inch at its periphery and the servo vane remains stationary.

The meter vane takes up a mean position slightly towards the servo vane, but this disturbance is constant over the whole scale and, consequently, does not affect calibration accuracy. The fact that the meter movement is in oscillation overcomes any tendency to pivot sticking, and the accuracy is equal to that of a movement which is being very gently tapped throughout the readings.

By arranging the capacitor plates in the vertical plane the circuit

Uncle Sam's latest jeep as quiet as proverbial mouse, because of AEROVOX

Interference Filters



● The chart sums it up. Note how radio interference generated by the ignition system and other electrical equipment is suppressed well in excess of requirements.

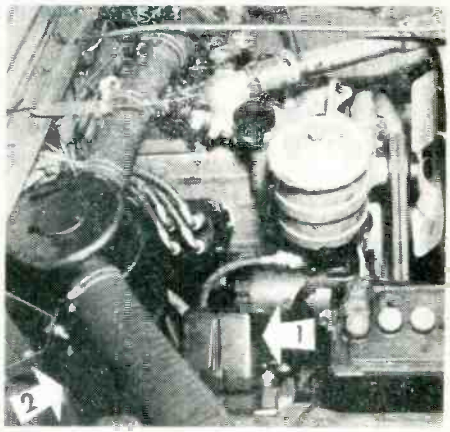
Uncle Sam's new jeep includes The Electric Auto-Lite Company's 24-volt waterproof electrical equipment. It must operate efficiently even under water. And radio interference must be minimized in the interests of dependable military communications.

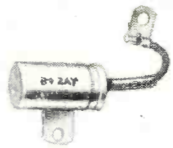
Long hours of cooperative research and engineering were spent on this noise-suppression problem. The main considerations were filters to minimize interference originating with the voltage regulator, the generator and the ignition system. Aerovox finalized the complete answer based on the three major units here presented.

• • •

And thoroughly waterproof, weatherproof and shockproof, of course.

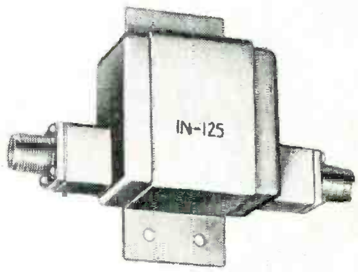
● Capacitance applications such as this are all in the day's work for Aerovox engineers. Whatever your capacitance problems and requirements may be, Aerovox will fit the right capacitors to the right applications. Address Dept. FE.





Aerovox Type 89ZAY using a metallized paper capacitor and mounting inside voltage regulator case to work in conjunction with IN-127.

Aerovox Type IN-127 mounted inside voltage regulator (Arrow No. 1) and acting as interference eliminator for voltage regulator and generator systems.



Aerovox IN-125 which mounts on bulkhead of jeep (Arrow No. 2) and suppresses interference originating in ignition system.

AEROVOX capacitors

FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A.

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offers a complete line of standard RESISTORS that meet practically every requirement

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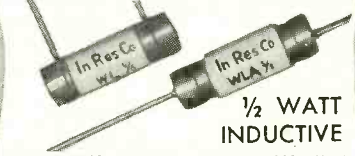
Economical in Cost

IN-RES-CO WL series resistors were designed to meet increasing demands for a compact resistor of high accuracy priced for general use. They meet the most critical requirements — close tolerance, ability to withstand overload, long life. Write for catalog.

TYPES WL 5/8 and WLA 5/8



½ WATT INDUCTIVE

MAX. RES: .01 to 7,500 ohm (331 Alloy)
.01 to 4,000 ohm (Nichrome)
.01 to 1,250 ohm (Manganin)

BODY SIZE: 5/8" lg. by 3/16" diam.

TOLERANCE: STANDARD 1%

TYPES WL and WLA

1 WATT INDUCTIVE

MAX. RES: .01 to 15,000 ohm (331 Alloy)
.01 to 8,000 ohm (Nichrome)
.01 to 2,500 ohm (Manganin)

BODY SIZE: 1" lg. by 3/16" diam.

TOLERANCE: STANDARD 1%

Can be supplied non-inductive with one-half indicated maximum resistance.

IN-RES-CO APPLICATION-DESIGNED RESISTORS

IN-RES-CO

INSTRUMENT RESISTORS CO., 1036 COMMERCE AVE., UNION, N. J.

CONTINUOUSLY VARIABLE DUAL-HEAVY DUTY REGULATED DC SUPPLIES

✓ FEATURES

- ✓ DUAL regulated outputs, continuously variable, 0 to 600 volts.
- ✓ Maximum current 200 milliamperes each, or 400 combined.
- ✓ Regulation better than .5%.
- ✓ 6.3 volts AC at 10 amperes center-tapped.
- ✓ Ripple voltage less than 10 millivolts.
- ✓ Stabilized bias supply.

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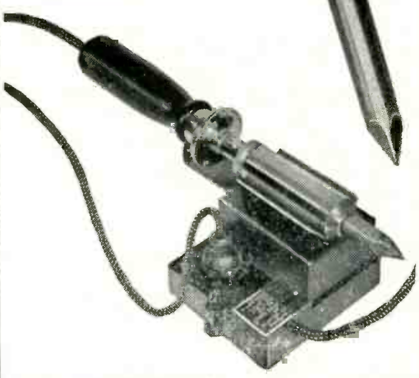
American Beauty

ELECTRIC SOLDERING IRONS

are sturdily built for the hard usage of industrial service. Have plug type tips and are constructed on the unit system with each vital part, such as heating element, easily removable and replaceable. In 5 sizes, from 50 watts to 550 watts.

TEMPERATURE REGULATING STAND

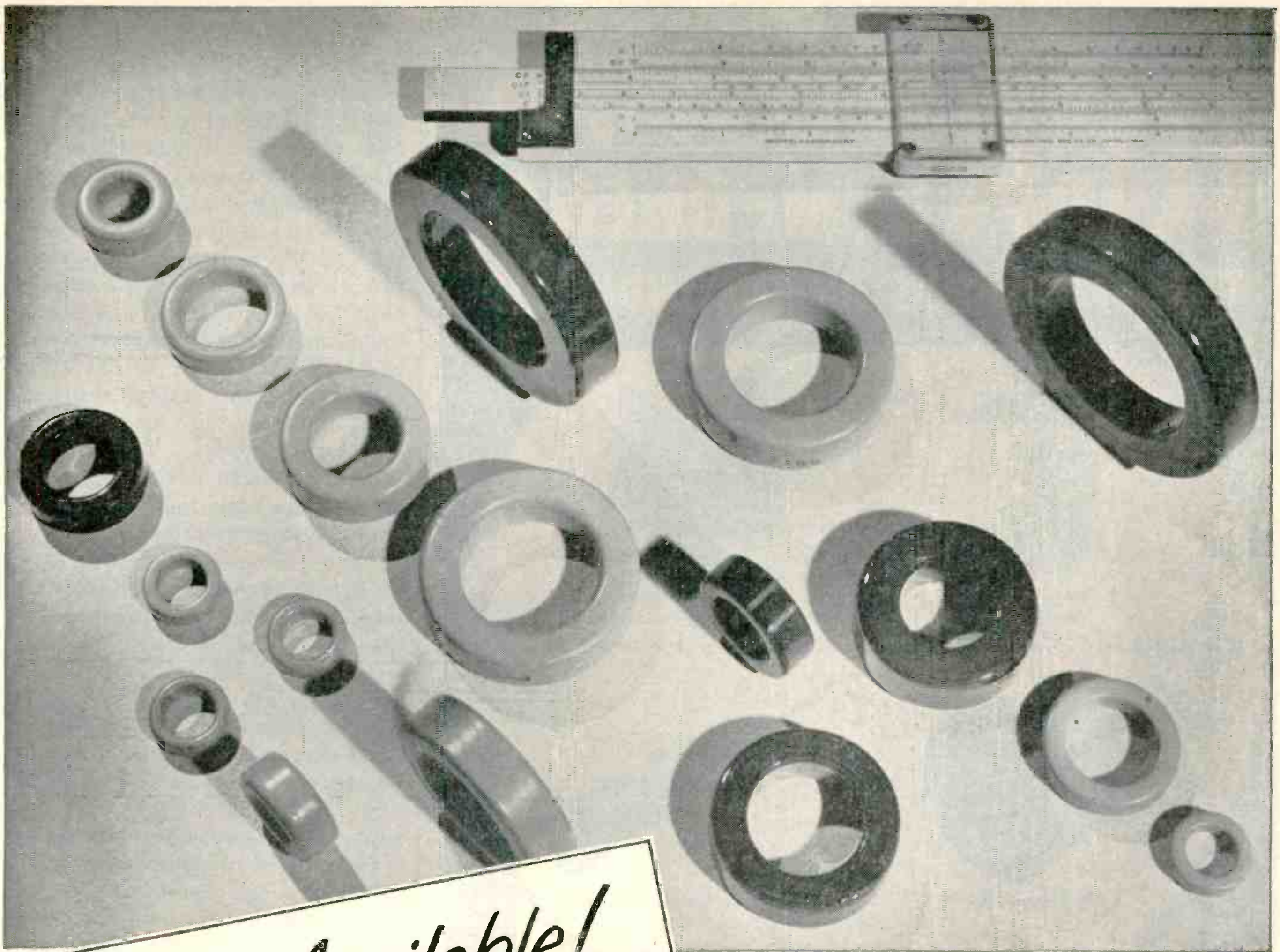
This is a thermostatically controlled device for the regulation of the temperature of an electric soldering iron. When placed on and connected to this stand, iron may be maintained at working temperature or through adjustment on bottom of stand at low or warm temperatures.



For descriptive literature write 110-1

AMERICAN ELECTRICAL HEATER COMPANY

DETROIT 2, MICH., U. S. A.



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MOLYBDENUM PERMALLOY POWDER CORES*

HIGH Q TOROIDS for use in Loading Coils, Filters, Broadband Carrier Systems and Networks—for frequencies up to 200 KC

COMPLETE LINE OF CORES TO MEET YOUR NEEDS

★ Furnished in four standard permeabilities—125, 60, 26 and 14.

★ Available in a wide range of sizes to obtain nominal inductances as high as 281 mh/1000 turns.

★ These toroidal cores are given various types of enamel and varnish finishes, some of which permit winding with heavy Formex insulated wire without supplementary insulation over the core.

For high Q in a small volume, characterized by low eddy current and hysteresis losses, ARNOLD Moly Permalloy Powder Toroidal Cores are commercially available to meet high standards of physical and electrical requirements. They provide constant permeability over a wide range of flux density. The 125 Mu cores are recommended for use up to 15 kc, 60 Mu at 10 to 50 kc, 26 Mu at 30 to 75 kc, and 14 Mu at 50 to 200 kc. Many of these cores may be furnished stabilized to provide constant permeability (±0.1%) over a specific temperature range.

**Manufactured under licensing arrangements with Western Electric Company.*

W&D 2930

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS

operates on a change of spacing of a capacitor with a very narrow gap, and the increment in capacitance is relatively large. This factor enables the equipment to be preset and eliminates external controls. Any slight change in the performance of the capacitance relay due to tube ageing or renewal appears as a minute change in the operational distance of the capacitor gap, which if readable at all, would be taken up by the natural readjustment of the set zero on the pen of the graph recorder. The accuracy of the completed device is just as good as the basic meter movement used for its construction.

The instrument does away with flimsy pen movements and their attendant constant ink troubles. Inaccuracies due to change in pen weight as the ink pot level changes are completely eliminated. Another feature is the fact that owing to the servo-operated mechanism there is no tendency for the pen to stick, and vertical transients are recorded with accuracy. The servo-operated mechanism provides ample power for the operation of cam switches which can be set to operate at any level. The instrument is capable of giving a control switching action on a differential of 0.1 percent of scale reading which, in the case of a 0-50 μa movement, allows a control switching action on 0.05 μa.

Portable Geiger Counter

By Edward Reible
Sales Engineer
Nuclear Instrument and Chemical Corp.
Chicago, Ill.

An extremely compact Geiger counter weighing less than two pounds and operating from standard flashlight batteries is shown in the photograph. Detection of nuclear radiations is indi-

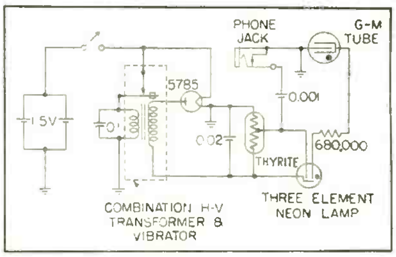
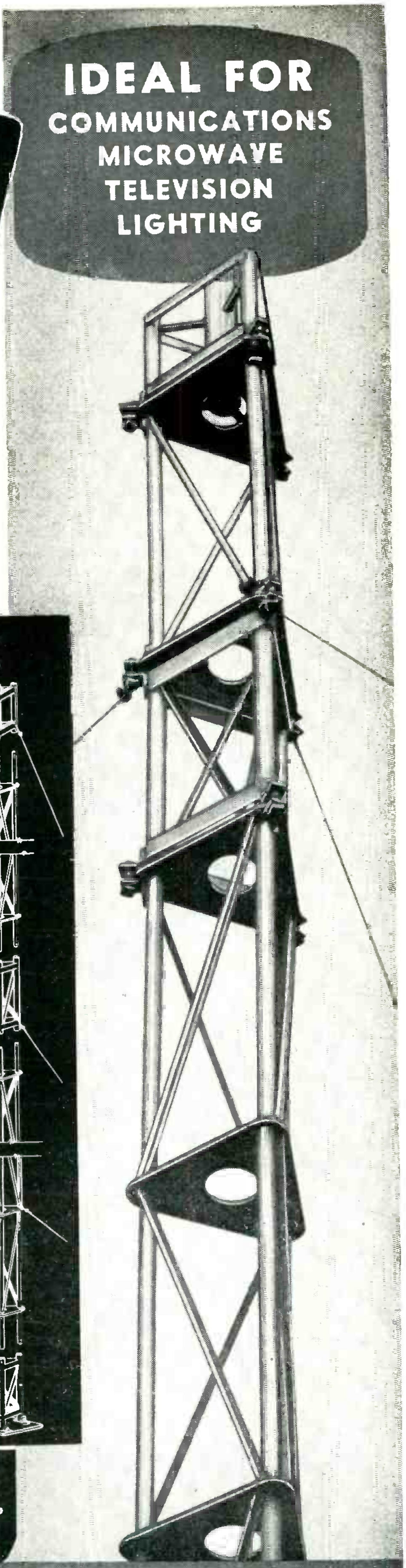


FIG. 1 — Flashlight-battery-powered Geiger counter provides both visible and audible indications of nuclear radiations

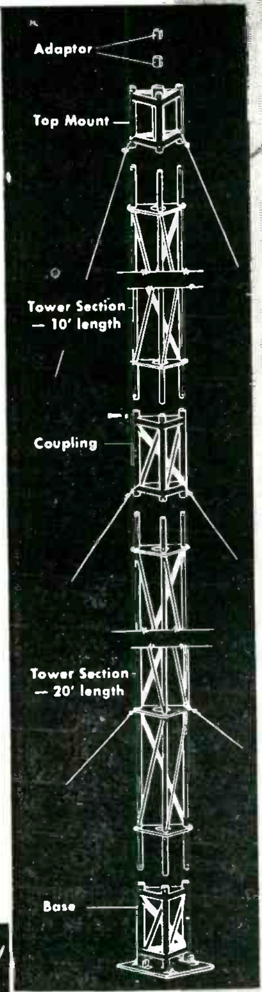
THE TOWER OF STRENGTH



Superior construction features give LOW COST Vee-D-X sectional towers the highest safety factor of any tower in its price class.

If you have an elevated installation problem, absolute permanency of your installation is assured when you use a VEE-D-X sectional tower. Strength is a major factor. Don't take chances with structural failure. Be sure with VEE-D-X!

- *Rugged, all-welded construction diagonally laced with angle iron for maximum rigidity.*
- *Can be erected on ground or on flat or peaked roof.*
- *Patented plate spaced at two foot intervals prevents twisting and affords rigidity found in no other tower.*
- *Safe and easy to climb.*
- *Completely galvanized, light weight tubular steel . . . 20 ft. section 72 lbs.*

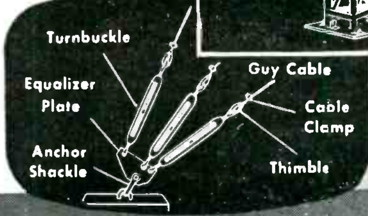


PRE-ASSEMBLED
for fast, inexpensive installation

VEE-D-X towers are designed for use at any height from 10 to 140 feet. They are self-supporting up to 20 feet and, where space is limited, *semi-guyed** type installations may be used at 30, 40, and 50 foot heights. Sketch at right shows the basic parts and necessary accessories for a complete installation. Three types of top mount are available. VEE-D-X towers may be ordered in separate units or as a complete package for a specific height. (Either guyed or semi-guyed.) Write the LaPointe-Plascomold Corporation of Unionville, Conn. for complete information.

*Semi-guyed towers employ one set of guy cables attached at a height of 10 ft. up the tower and anchored at a 6 ft . radius from the base.

VEE-D-X



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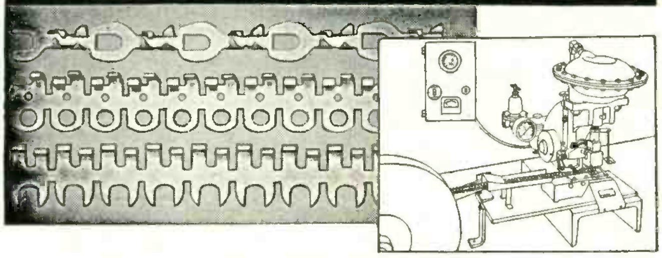
Now Terminals Can Be ATTACHED & SOLDERED *in ONE Automatic Operation!*



New Terminal Attaching Machine—

attaches and solders various sizes and types of pre-soldered tandem terminals (supplied on reels) at rates up to 1200 per hour. Machine cuts off, clinches and solders terminals in one instantaneous operation. Eliminates handling of loose terminals, solder and flux to increase production and lower costs on long runs. Standard types available. Strong, perfectly soldered joints are assured, as absolute control of heat is maintained. Send for detailed information, enclose sample of wire and terminal now used. Address Dept. E.

For ordinary runs in moderate quantity we continue to produce

SEPARATE TERMINALS for ELECTRIC WIRES

We also make SMALL METAL STAMPINGS, exact to Customer's Prints. Modern Plant, Equipment and Methods. Precision Work. Moderate Die Charges. Prompt, Dependable Service.

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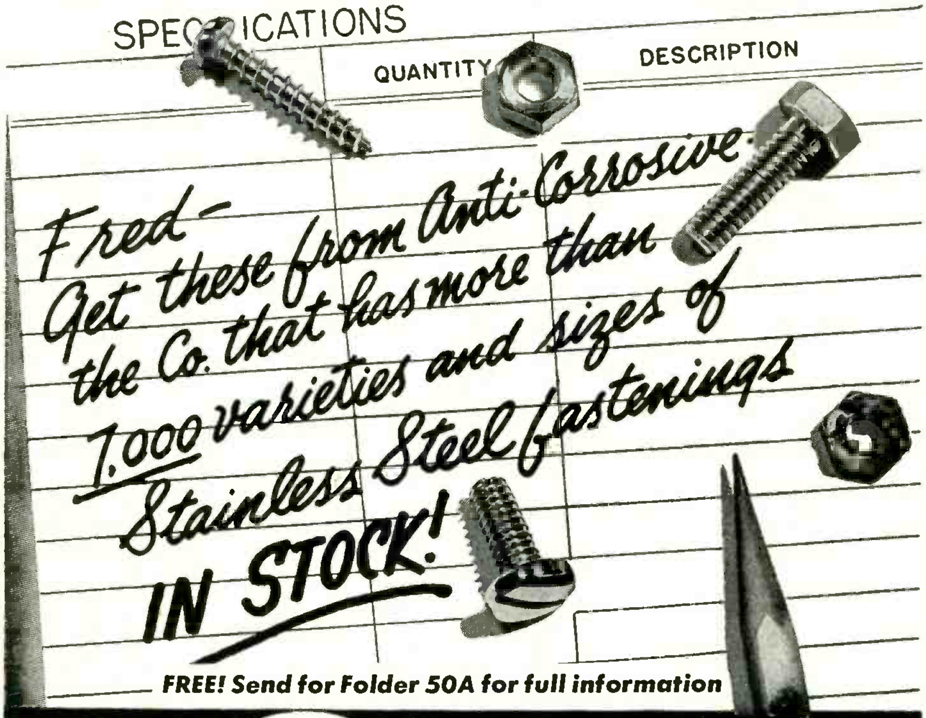

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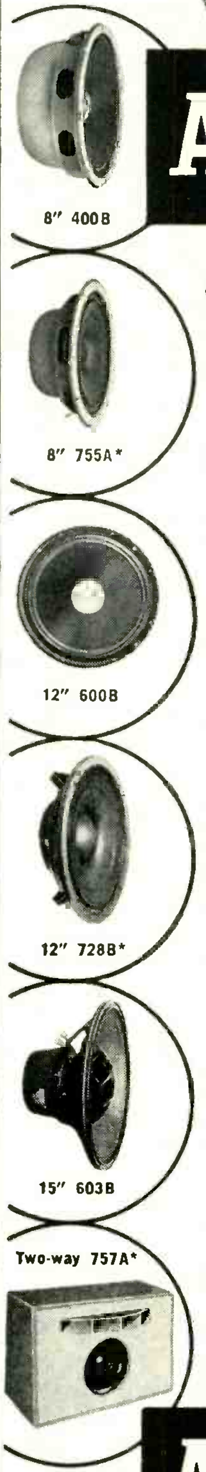

8" 400B

8" 755A*

12" 600B

12" 728B*

15" 603B

Two-way 757A*

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for every speaker need ...

Regardless of restrictions or special requirements an ALTEC speaker can do the job better... ALTEC speakers have many "exclusive" design features, resulting in a superior product... with smoother extended frequency response... higher efficiency... finer full-range tonal qualities... greater listening pleasure... more ruggedness and trouble-free operation. Investigate further why ALTEC speakers are chosen on direct listening comparison... write for complete technical information.

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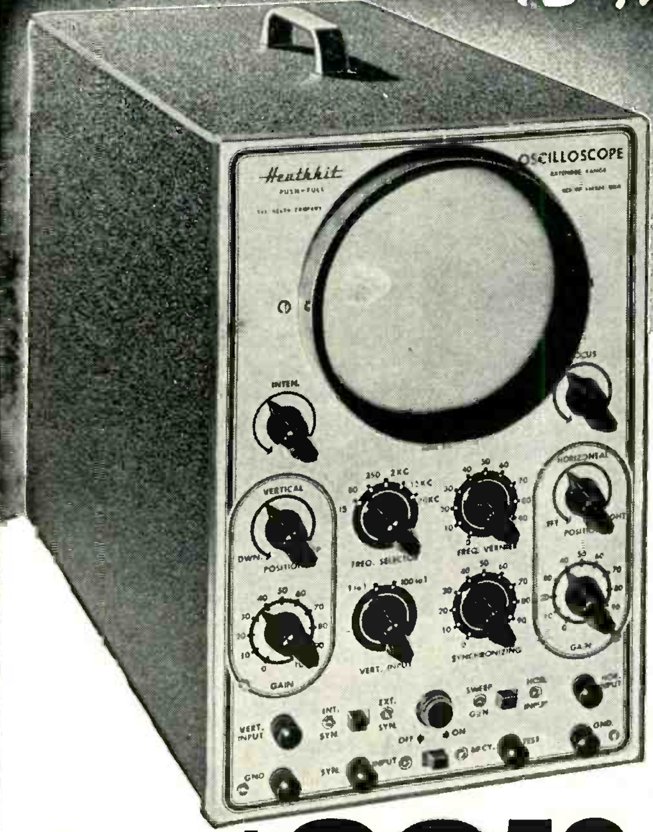
* Distributed by Graybar—formerly manufactured by Western Electric Co. Inc.

ALTEC
LANSING CORPORATION

12 Improvements IN NEW 1951

MODEL O-6 PUSH-PULL

Heathkit OSCILLOSCOPE KIT



- ★ New AC and DC push-pull amplifier.
- ★ New step attenuator frequency compensated input.
- ★ New non frequency discriminating input control.
- ★ New heavy duty power transformer has 68% less magnetic field.
- ★ New filter condenser has separate vertical and horizontal sections.
- ★ New intensity circuit gives greater brilliance.
- ★ Improved amplifiers for better response useful to 2 megacycles.
- ★ High gain amplifiers .04 Volts RMS per inch deflection.
- ★ Improved Allegheny Ludlum magnetic metal CR tube shield.
- ★ New synchronization circuit works with either positive or negative peaks of signal.
- ★ New extended range sweep circuit 15 cycles to over 100,000 cycles.
- ★ Both vertical and horizontal amplifier use push-pull pentodes for maximum gain.

Only $39.50

The new 1951 Heathkit Push-Pull Oscilloscope Kit is again the best buy. No other kit offers half the features — check them.

Measure either AC or DC on this new scope — the first oscilloscope under $100.00 with a DC amplifier

The vertical amplifier has frequency compensated step attenuator input into a cathode follower stage The gain control is of the non frequency discriminating type — accurate response at any setting. A push-pull pentode stage feeds the C.R. tube. New type positioning control has wide range for observing any portion of the trace.

The horizontal amplifiers are direct coupled to the C.R. tube and may be used as either AC or DC amplifiers. Separate binding posts are provided for AC or DC.

The multivibrator type sweep generator has new frequency compensation for the high range it covers; 15 cycles to cover 100,000 cycles.

The new model 0-6 Scope uses 10 tubes in all — several more than any other. Only Heathkit Scopes have all the features.

New husky heavy duty power transformer has 50% more laminations. It runs cool and has the lowest possible magnetic field. A complete electrostatic shield covers primary and other necessary windings and has lead brought out for proper grounding.

The new filter condenser has separate filters for the vertical and horizontal screen grids and prevents interaction between them.

An improved intensity circuit provides almost double previous brilliance and better intensity modulation.

A new synchronization circuit allows the trace to be synchronized with either the positive or negative pulse, an important feature in observing the complex pulses encountered in television servicing.

The magnetic alloy shield supplied for the C.R. tube is of new design and uses a special metal developed by Allegheny Ludlum for such applications.

The Heathkit scope cabinet is of aluminum alloy for lightness of portability.

The kit is complete, all tubes, cabinet, transformer, controls, grid screen, tube shield, etc. The instruction manual has complete step-by-step assembly and pictorials of every section. Compare it with all others and you will buy a Heathkit. Model 0-6. Shipping Wt., 30 lbs.

New INEXPENSIVE MODEL S-2 ELECTRONIC SWITCH KIT

Twice as much fun with your oscilloscope — observe two traces at once — see both the input and output traces of an amplifier, and amazingly you can control the size and position of each trace separately — superimpose them for comparison or separate for observation — no connections inside scope. All operation electronic, nothing mechanical — ideal for classroom demonstrations — checking for intermittents, etc. Distortion, phase shift and other defects show up instantly. Can be used with any type or make of oscilloscope. So inexpensive you can't afford to be without one.

Has individual gain controls, positioning control and coarse and fine switching rate controls — can also be used as square wave generator over limited range. 110 Volt transformer operated comes complete with tubes, cabinet and all parts. Occupies very little space beside the scope. Better get one. You'll enjoy it immensely. Model S-2. Shipping Wt., 11 lbs.

Only $19.50

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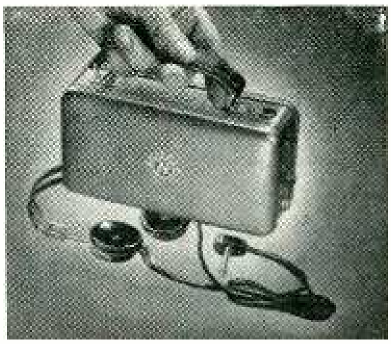

Low-cost Geiger counter weighs only two pounds

cated both visibly and audibly with a high degree of accuracy.

The Geiger-Muller tube shown in the schematic, Fig. 1, is filled with a mixture of argon and butane. It has a stainless-steel cathode and a two-mil tungsten anode. The tube has a wall thickness of five mils and is mounted behind a thin brass window in the bottom of the instrument. Gamma rays and beta particles of medium energy may enter the tube and be counted.

High a-c voltage is supplied to the 5785 rectifier by the vibrator-transformer unit. A nonlinear tapped-Thyrite resistor serves as a voltage regulator. Creation of the order of 10^{10} ion pairs in the G-M tube causes a voltage pulse in the circuit.

The neon-tube elements are held just below striking potential. The pulse from the G-M tube causes the neon to discharge, giving a visible flash and causing additional current to flow from a charged capacitor. This results in an audible count in the phones. The flashlight cells furnish approximately 200 mils.

SHOP SHORTCUTS

WATER-SOLUBLE crystals such as the EDT type are cut with a "string saw" in which a wet string is drawn continuously across the crystal. A tightly stretched endless string passes over four pulleys, one of which is driven by a motor, at a speed of about 100 fpm. The lower part of the string passes through water, most of which is removed by the sponge. Pressed against the string by a motor-driven feed, the crystal is accurately dissolved along

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Armco Thin-Gage Electrical Steel is given a full-annealed treatment and insulated at the mill. No additional annealing is necessary except for relieving coiling strains after cores have been wound.

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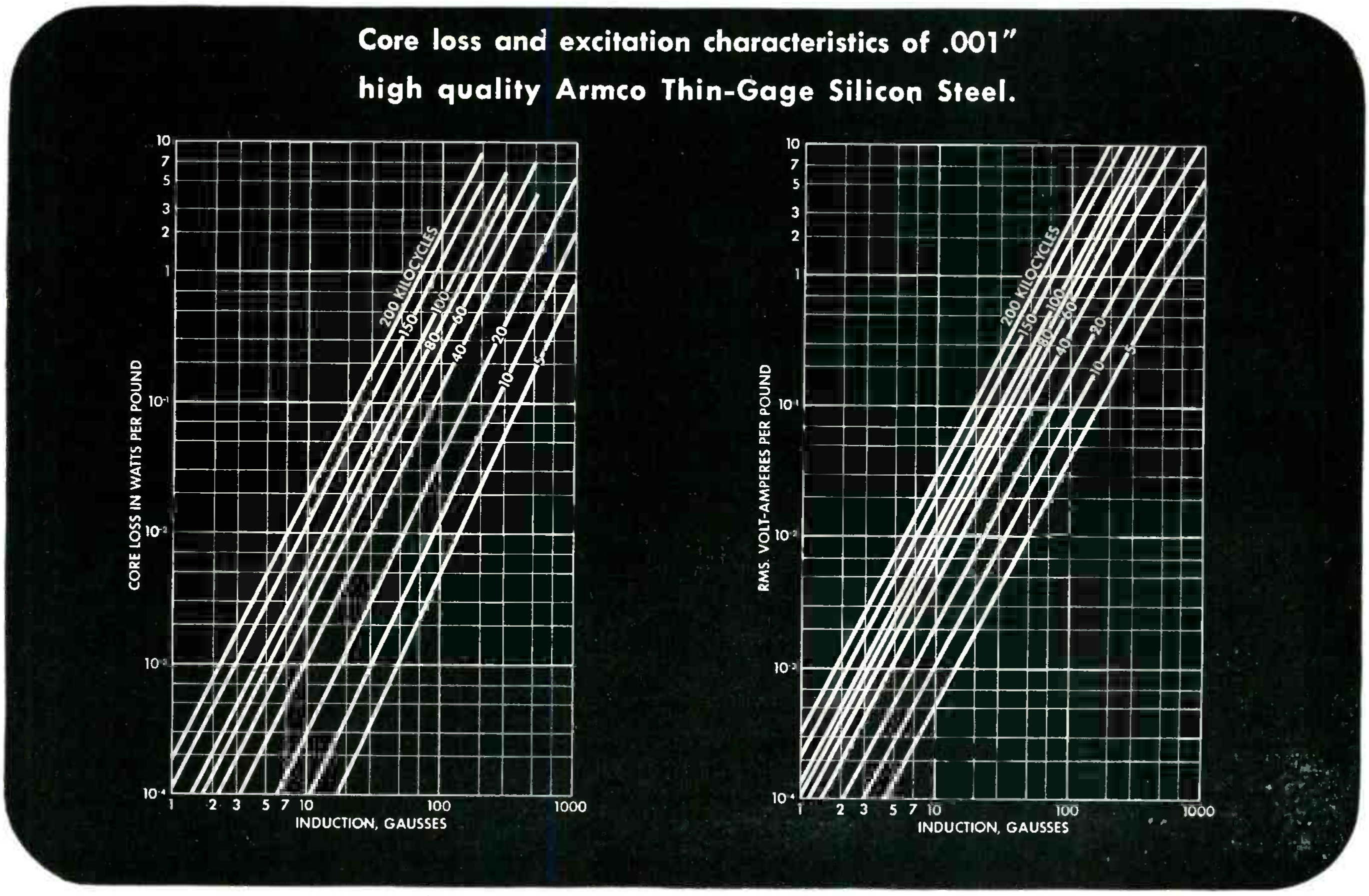
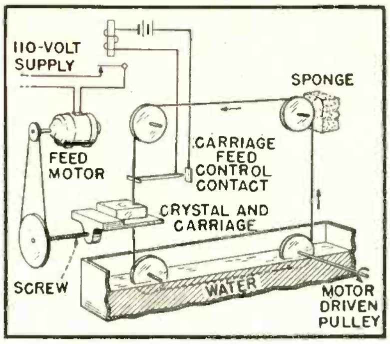


Core loss and excitation characteristics of .001″ high quality Armco Thin-Gage Silicon Steel.



its line of contact with the string. To obtain maximum cutting speed and eliminate human error, the saw is made self-adjusting. The string moves past a lever which operates an electrical contact. If the string is bent by excessive crystal feed the string moves a lever, thus closing the contact. Battery current then flows through a relay causing it to open the feed-drive motor circuit. When the two pulleys nearest the crystal are a foot apart, the contact lever is usually set to operate for a maximum string deflection of $\frac{1}{32}$ in.

Bell Telephone Laboratories, Inc.
New York, N. Y.

DIRT in a velocity microphone can be detected readily by listening to the output of the microphone while it is swung at arm's length. If the microphone is clean, nothing but the rushing sound of air will be heard. If the microphone is dirty, the output will be characterized by a scratchy roughness.

Broadcast Equipment Section
Radio Corp. of America
Camden, N. J.

VELOCITY microphone failures caused by the presence of dirt can be practically eliminated by the use of a fine-mesh screen of magnetic material. The screen is slightly curved and is placed on each side of the ribbon assembly of the microphone. The wires become magnetized from the leakage field and catch any magnetic particles which penetrate the outer screen.

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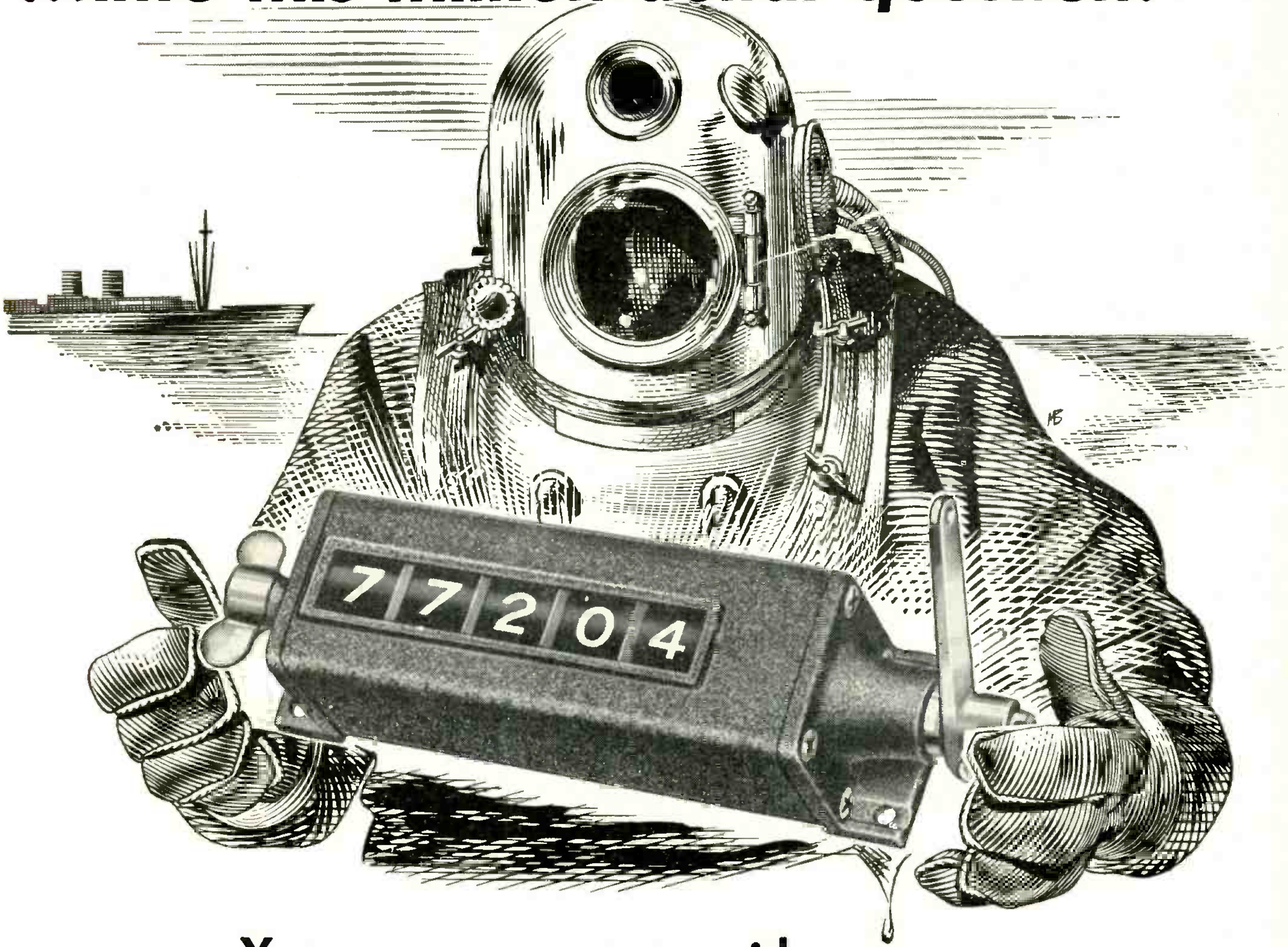

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THE ELECTRON ART

(continued from p 126)

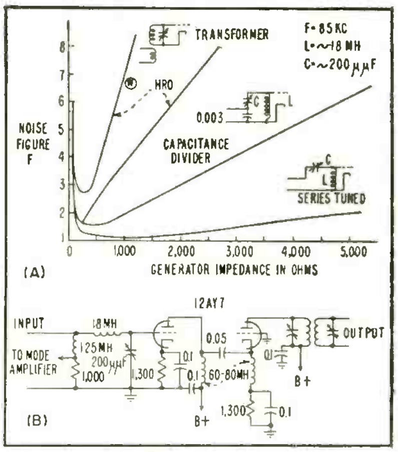


FIG. 2—Curves in *A* show comparison of noise factor for various input circuits including HRO and special circuit used in Westinghouse microwave spectroscope. Circuit in *B* shows low-noise 85-kc preamplifier

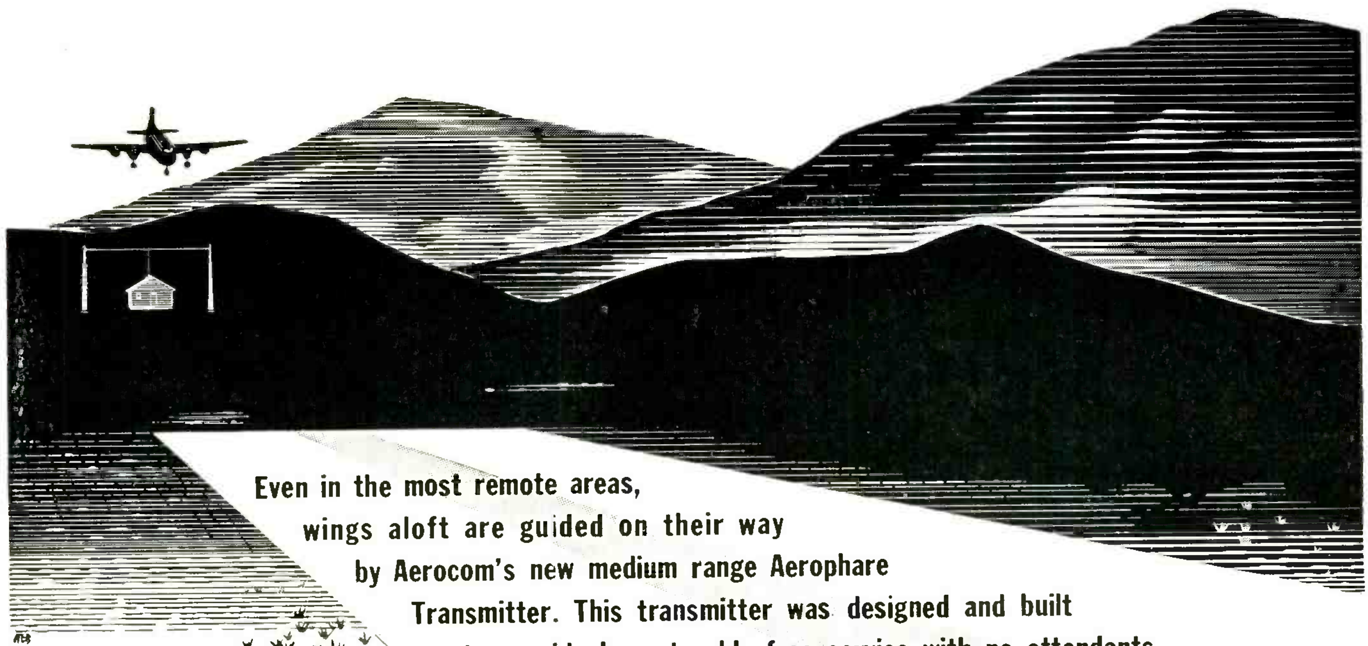
quency detects a signal at that frequency when the microwave frequency is near or on an absorption line. Moving of the absorption line, first onto and then off of the microwave frequency, causes an absorption at the Stark modulation frequency.

Figure 1 shows a block diagram of a Stark-modulation microwave spectroscope developed by Westinghouse and described by William E. Good at the 1950 National Electronics Conference in Chicago. The system operates at 85 kc with a nominal bandpass of about 1,500 cps. The bandpass may be reduced to as low as 50 cps by R-C filters, and the bandpass of the 85-kc amplifier may be narrowed to 10 kc by a crystal filter, thereby improving the signal-to-noise ratio.

The most important factor in obtaining a low signal-to-noise ratio is, however, the proper use of the crystal detector. Over the range of power involved, one milliwatt to less than one microwatt, the impedance of a typical crystal may vary from 300 to 5,000 ohms—tending to flatten off at the higher resistance at low power levels, and to flatten off at the low resistance value at the higher power levels and to change rapidly in between.

The problem of designing an amplifier input circuit to match this wide range of crystal impedances requires special attention in the design of a low-noise amplifier for

POPULATION-0



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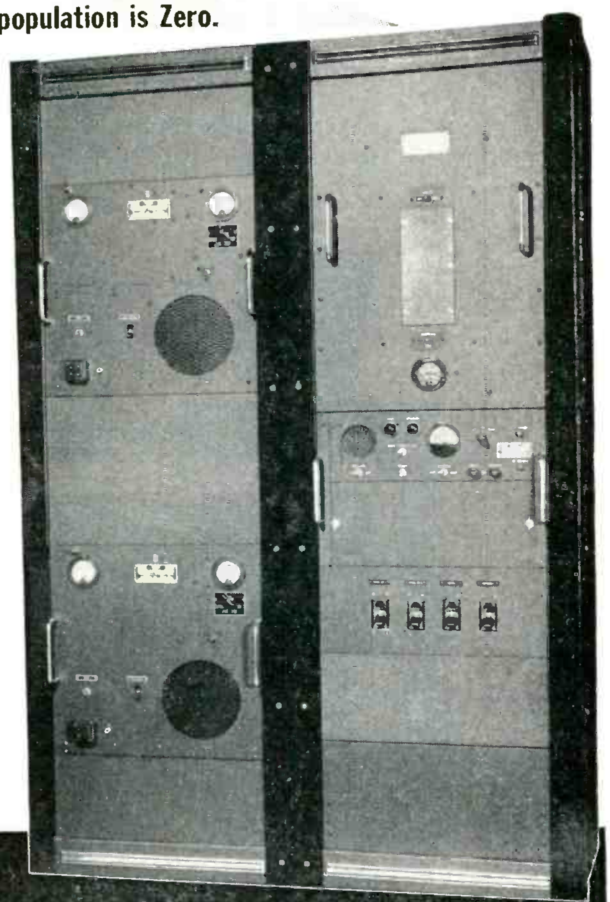

for completely unattended service. This aerophare (illustrated) consists of two 100 watt (or 50 watt) transmitters, one AK-3B keyer, one ACA automatic transfer, and an antenna tuner. (Power needed 110 volt or 220 volt – 50/60 cycles)

Frequency range 200 – 415 Kcs.: self-contained P. A. coil covers entire range, 1 "plug-in" crystal oscillator coil covers 200 – 290 Kcs., other 290 – 415 Kcs, (Self-excited oscillator coils covering same ranges are available). High level plate modulation of final amplifier is used, giving 35% tone modulation in 100 watt transmitter and 35 – 50% in 50 watt model. Microphone P-T Switch when depressed interrupts tone, permitting voice operation.

Using 866A rectifiers, unit can be operated in air temperature range 0°c to + 45°c; using 3B25 rectifiers, – 35°c to + 45°c; humidity up to 95%.

Aerocom's Automatic Transfer unit will place the "stand-by" transmitter in operation when main transmitter suffers loss (or low level) of carrier power or modulation. The characteristics of the keyed call letters are so modified on "stand-by" that a distant monitoring station can determine whether the main or "stand-by" transmitter is operating.

Unit is ruggedly constructed and conservatively rated, providing low operating and maintenance costs. Engineering data on this unit and other Aerocom communications products are available on request.

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the Stark-modulation frequency. Figure 2A shows curves for several input circuits including a National HRO and a special amplifier used in the Westinghouse spectroscope for amplifying the 85-kc signals. The noise measurements were made with a Sylvania type 5722 noise diode with different values of output resistors. The series-tunnel resonant circuit appeared to give the best performance over the range of impedances encountered.

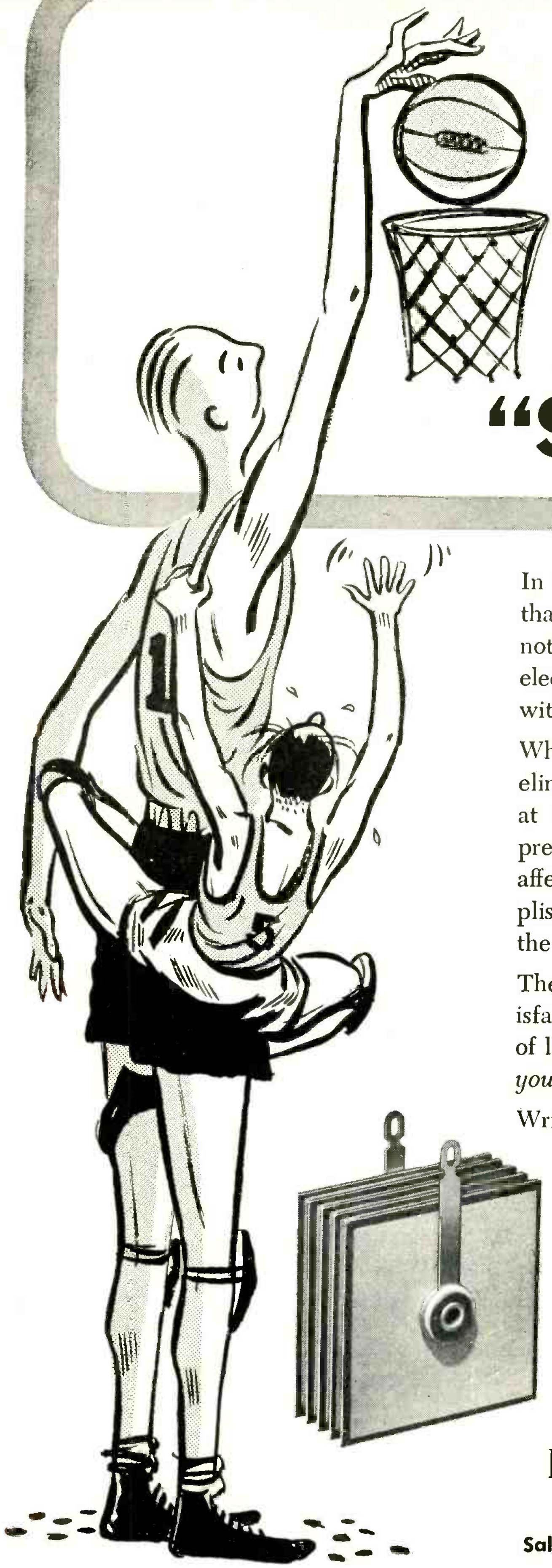
The actual circuit used in the Westinghouse microwave spectroscope amplifier is shown in Fig. 2B. It employs a 12AY7 in cascode circuit. Using the Stark-modulation system, the 23,534.71-mc line of $O^{17}C^{12}S^{32}$ gas which has an absorption coefficient of 2.0×10^{-8} cm^{-1}, in its natural isotopic abundance, was seen to be about 2½ times noise. The sweep rate was 2 cps and the bandpass was set at 50 cps.

Frequency measurements are made by comparing absorption lines with harmonics of a 500-mc crystal-controlled source which is modulated by a 50-mc signal. Interpolation between marker frequencies is accomplished by a Collins 51-J communications receiver whose dial is accurate to ± 2 kc.

Field-Sequential Color Television Tube

FIELD SEQUENTIAL color-television pictures can be reproduced by a special cathode-ray tube in a way that resembles the Thomas color system of color cinematography. In the Thomas color movie system, a scene is recorded on different parts of a film through primary color filters and projected through a similar set of filters by a parallax-free optical system that superimposes the monocolor images to form a natural-color image.

In color television, a corresponding series of black and white images, containing the light and shade values for the three primary colors, appear on different parts of the screen of a cathode-ray tube, having only one gun and one deflection system. Primary color filters are placed in front of the image sections of the tube, and the color images derived therefrom are



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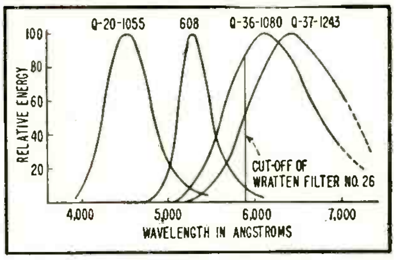


FIG. 1—Response curves for three phosphors used in banded color television tube

superimposed on a viewing screen by a suitable projection-optical system.

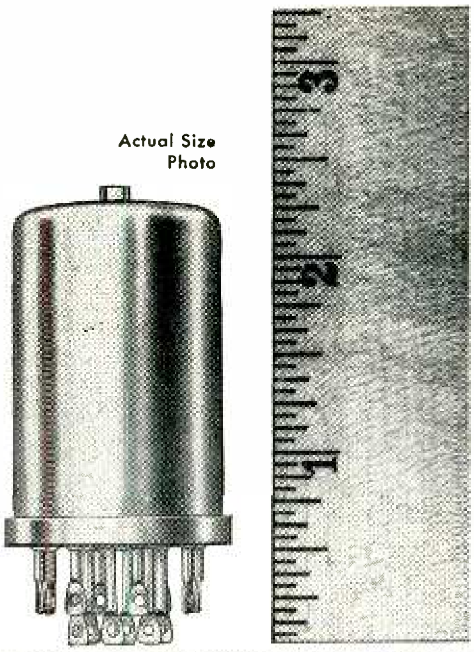
Individual areas are completely scanned in sequence and it is convenient to arrange the image areas one below the other. Since primary color images must be superposed optically, it is strictly a projection system and is not applicable to direct-view television.

Fluorescent Screen

The filters used (Wratten 26, 47, and 58) have an average light transmission of only about 15 percent, so that approximately 85 percent of the light is wasted. A cathode-ray tube was constructed having three image areas capable of fluorescing in the three primary colors in response to electron bombardment. The screen consists of three phosphor bands; a blue band of zinc sulphide activated with silver, a green band of zinc orthosilicate activated with manganese, and a red fluorescing band of zinc cadmium sulphide activated with silver. The spectral distribution curves of these phosphors are shown in Fig. 1. Characteristic curves have been given for two red powders which were used in different tubes. The cutoff of Wratten filter No. 26 is also shown. A substantial portion of the energy of these phosphors falls in the unwanted orange region. It is possible that cadmium phosphates or borates would have more suitable spectral distribution.

Two systems of applying the phosphor bands have been tried. In the first, the three bands are applied separately. Each band is allowed to dry before the next is applied, and so on. The second system employs a water-tight compartment screen that fits snugly against the inside of the tube face and forms

Actual Size Photo



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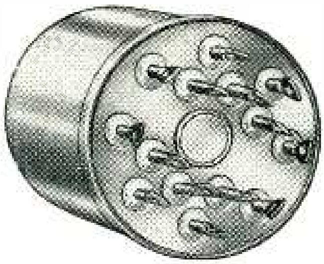

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1. **CONTACT RATING:** 2 A, 28 V, D.C.; 2A, 115 V, A.C., 400 cycle.
2. **CONTACT OVERLOAD RATING:** 12 A, 28 V, 20 sec.
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5. **COIL VOLTAGE:** 28 V, D.C.; amperage .1.
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8. **VARIATIONS:** Virtually innumerable, in voltage, amperage, number of poles (4 maximum) and temperatures.

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City ______________ *State* ______________ three sections which are simultaneously filled with the three different phosphor materials. In either case, the screen end of the tube must be separated from the gun end for application of phosphors and then reassembled after aluminizing by customary aluminum evaporating techniques.

The area of one color image is approximately one-ninth of the entire raster area of the tube. This means that only one-ninth of the light flux which could be made available, is utilized. The situation is even less favorable when saturation phenomena of the phosphors are taken into account. It is found that the zinc sulphide and zinc cadmium sulphide types of phosphors saturate considerably at the high current densities prescribed by the spot size necessitated by the small area of one color image. Their luminous efficiency drops at high beam current densities.

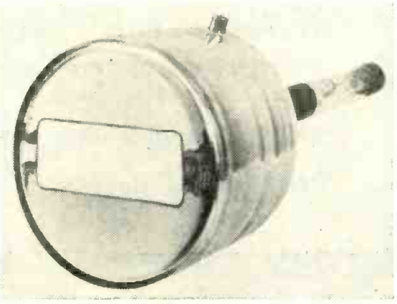

FIG. 2—Seven-inch picture tube with three phosphor bands. Tube is useful only in projection applications, and light output is limited

In view of the small size of each color image the raster-current density of the tube is unusually large and, since the heat cannot be adequately dissipated, the screen heats up. This is most undesirable because certain zinc sulphides lose luminous efficiency at elevated temperatures. The lower field-scan rate of the sequential system helps to reduce temperature rise.

While saturation limitations may one day be overcome by new and better phosphors, improvement of light loss due to insufficient utilization of the screen area may be visualized by scanning primary areas that are larger and give more light even though their aspect ratio is incorrect, so long as appropriate

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ELECTRICAL BRIDGES in resistor inspection, moisture detection, conductivity measurements, vacuum gauging, transient stresses.

ELECTRONICS in tube development, vacuum gauging and wave guide studies.

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Input elements include thermocouples, photo cells, pirani gauges, strain gauges and others. The instrument is used generally with a recorder. The output can also be applied to a suitable milliammeter indicator or to actuate automatic control relays or signal devices. Design advantages include accuracy, sensitivity, stability and high speed response.

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cylindrical lens elements are also used to gather light from the whole of the scanned area and project an image having the correct aspect ratio.

Resolution

The small size of each color image imposes exacting resolution requirements, which are inherently impossible to meet with the present three-band tube. Approximately 475 lines must be resolved in each picture, a resolution of 12 lines per millimeter. Moreover, while one color-image area is approximately in the center of the screen, the other two are towards the edges, and excessive deflection defocusing cannot be tolerated. Unfortunately, a small spot size in the center and minimum defocusing towards the edges of a screen are contradicting requirements from the point of view of tube design.

A paper describing this three-band tube and its capabilities in somewhat more detail was presented by C. S. Szecho at an SMPTE Semi-annual Convention on April 25, 1950.

Thyratron Control Circuits For Over 180-Degree Phase Shift

BY CHARLES F. SPITZER
Yale University
New Haven, Connecticut

OCCASIONALLY, there arises need for a phase-shift network in which a small change in one of the variables brings about a larger change in the thyratron plate current than can be obtained from the conventional phase-shift circuits. The following article shows two circuits which meet this specification and outlines design procedures for their use.

Figure 1A shows the circuit most commonly encountered. Figures 1B and 1C show the vector diagram, and the phase shift as a function of the ratio X/R, respectively. It should be noted here, that for a ratio of X/R of 0.1 the phase shift is about 168 degrees. This is a satisfactory design value for nearly all applications, allowing a variation from 168 degrees to zero degrees

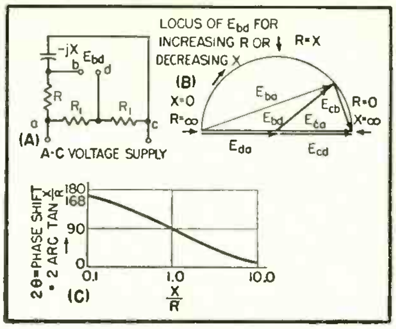

FIG. 1—Conventional thyratron phase-shift circuit provides theoretical phase shift through 180 degrees as either X or R varies from zero to infinity

as R is varied from $R = 10X$ to $R = 0$.

Phase Shift to 270 Degrees

The circuit shown in Fig. 2A shows a network capable of a theoretical variation over 270 degrees. The vector diagram illustrates how this circuit functions. The diameter of the outer semicircle is, as before, equal to the applied voltage $(\overline{OR} = E_{ca})$; the inner semicircle has a diameter determined by $\overline{OS} = E_{ca}R_1/(R_1 + R_2)$.

The extreme range of phase variation occurs when $R_2 = 0$ and is, of course, 270 degrees. For this condition the diameter of the inner semicircle becomes equal to the applied voltage E_{ca}, also. As a result, there will be one value of phase shift for which the output voltage E_{bd} is zero. If a lesser range of phase shift is tolerable, E_{bd} will remain more and more constant in

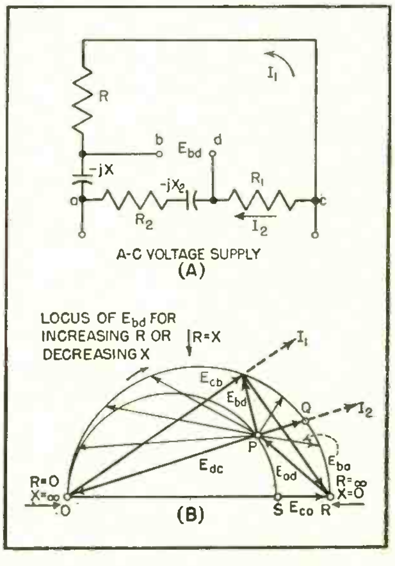

FIG. 2—Improved circuit provides phase shifts up to 270 degrees. Vector diagram shows behavior of circuit. Note output voltage changes

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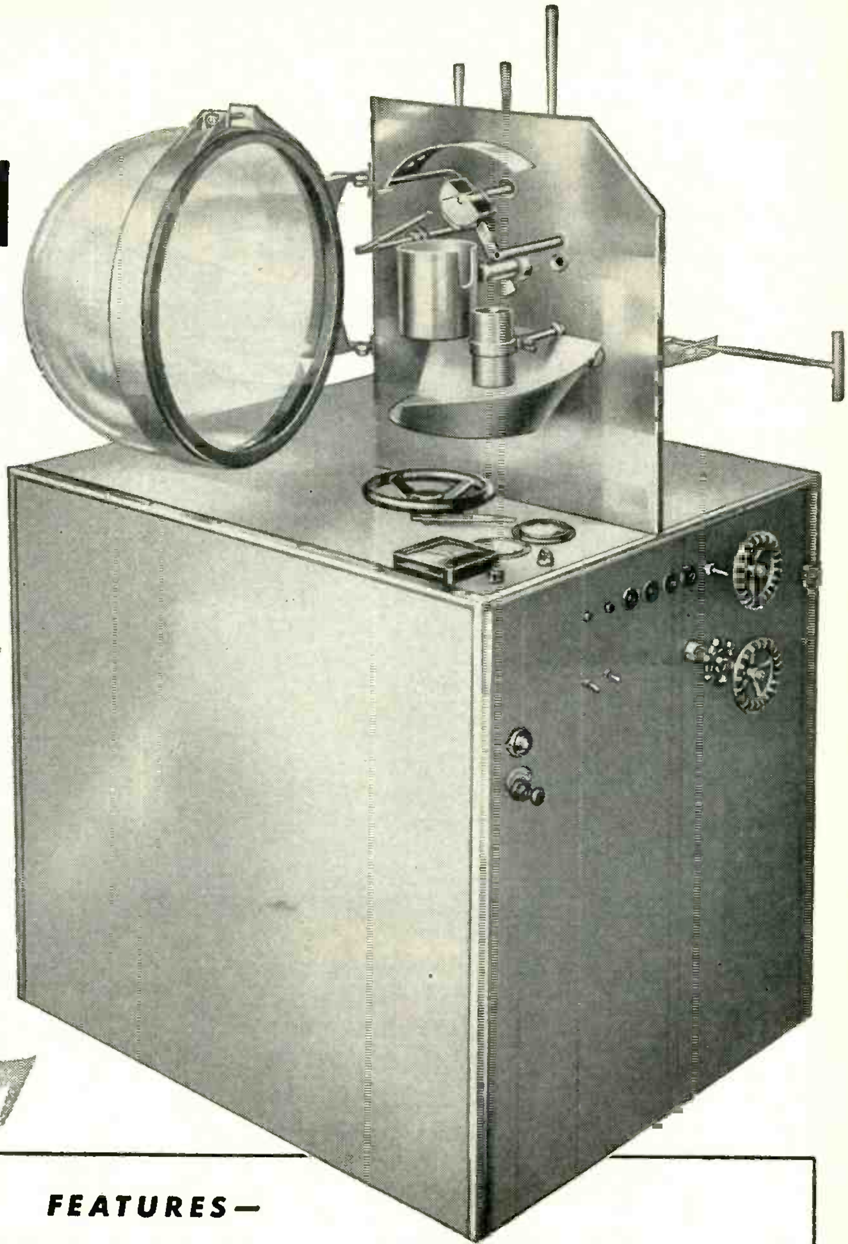

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In the United Kingdom: BRITISH-AMERICAN RESEARCH, LTD., London S.W. 7 — Wishaw, Lanarkshire magnitude, until the system of Fig. 1 is obtained by letting $R_2 = R_1$ and $X_2 = 0$.

For design purposes a graphical construction is most expedient. Figure 3A illustrates the procedure. First, a semicircle 1 is made, with $\overline{OR} = E_{ca}$ as the diameter. The desired full range of phase shift determines the next step. Thus, if the maximum shift is to be θ degrees, a point T is located at a distance

$$\overline{TM} = E_{ca}/2\cot(360 - \theta).$$

Also

$$\overline{OT} = \overline{RT} = \frac{E_{ca}}{2\sin(360 - \theta)}.$$

either expression may be used. Next, circle 2 of radius $\overline{TO}$ is drawn with T as the center.

The next step is the construction of circle 3 of radius $\overline{MU}$, with M as the center, such that the distance $\overline{OU}$ corresponds to the smallest output voltage that can be tolerated at any one phase angle. It should be noted here that, in the limit, the minimum output voltage cannot exceed the value

$$\overline{OU} = \frac{E_{ca}}{2}[1 - \cot(180 - \theta/2)].$$

If this is less than can be tolerated, then a less generous choice of range of phase shift angle θ will have to be made.

Circles 2 and 3 intersect at two points P_1 and P_2. Either of these points can be chosen to represent point P in Fig. 2B. This fact is illustrated in Figs. 3B and 3C.

The construction described above needs interpretation for ranges of phase shifts of less than 180 degrees. However, since from a practical point of view such cases are of

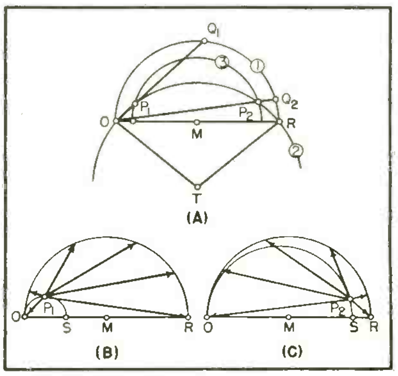
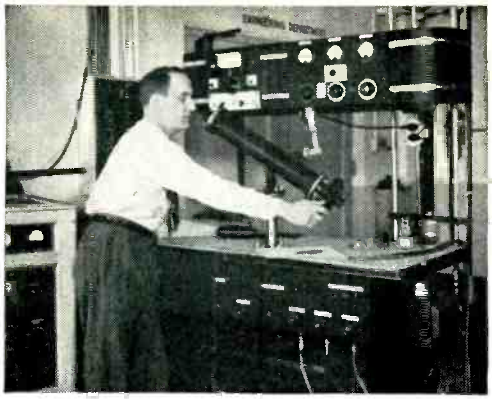
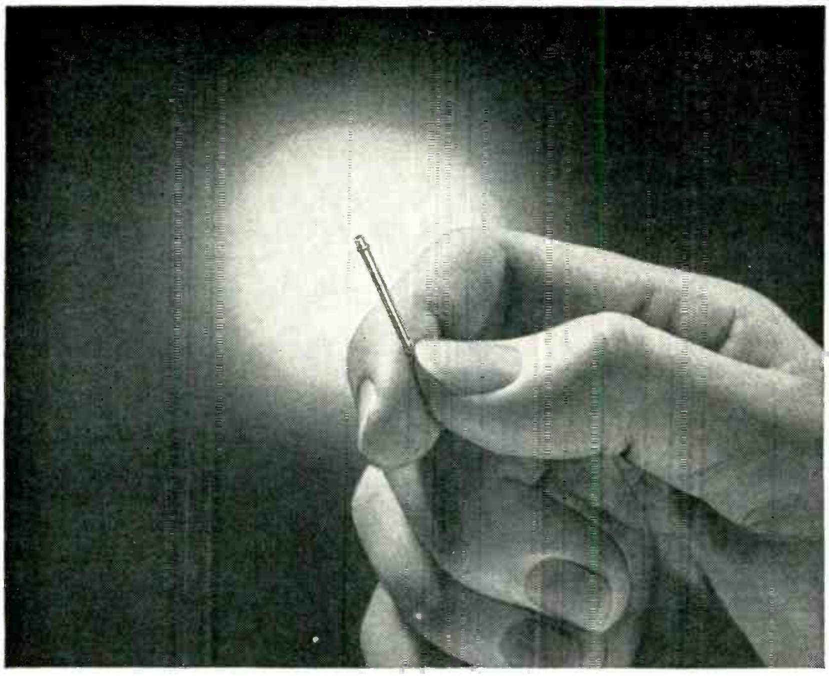


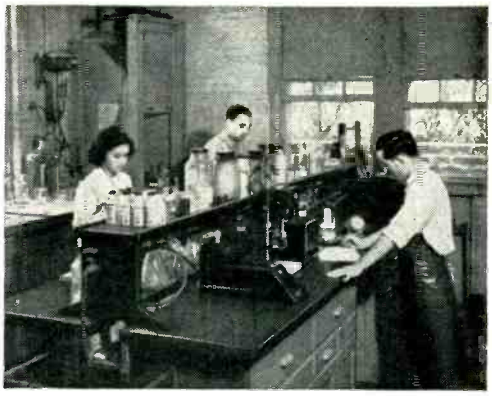
FIG. 3—Graphical method for designing circuit of Fig. 2 are shown at A. In B and C are two solutions resulting from graphical method

Trifles...
that taboo Troubles–



Electronic Engineering Laboratory equipment for testing emission characteristics of nickel cathode materials.





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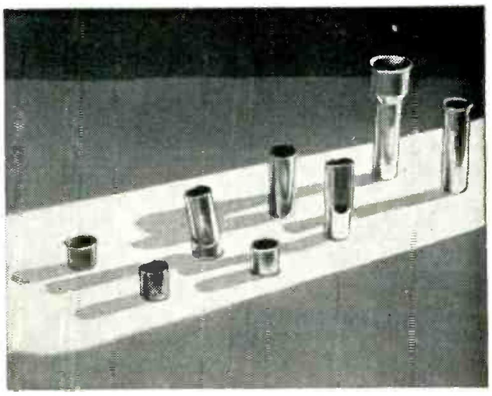

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Phase Shift Multiplication

Figure 4 illustrates a second method of extending the range of available phase shifts beyond 180 degrees. Its action is readily understood if, for the sake of simplicity, the value of $N'k$ is assumed to be sufficiently high (10 for example) to render the loading effect of the inner circuit negligible, as regards the outer circuit. In this case

$$E_{bd} = \frac{E_{ca}}{2} \underline{/2\,\theta}$$

where θ = arc tan X/R there follows, for the inner circuit $E_{c'a'} = N\,E_{bd}$ (where N is the ratio of transformation) and

$$E_{b'd'} = \frac{1}{4\,N} E_{ca} \underline{/4\,\theta}$$

Quite clearly, so long as loading can be ignored, this scheme can be extended to n circuits within each other, with the final result

$$E_{out} = \frac{1}{2n\,N^{n-1}} E_{ca} \underline{/2n\theta}$$

The significance of this result lies in the fact that the original phase shift 2θ has been multiplied by a factor n, without the use of any vacuum tubes. Where transducer output is in terms of phase shift, the sensitivity of the device is readily increased by a factor of three, for example.

So long as transformers are not objectionable, a circuit similar to that of Fig. 4 should be suitable for a considerable factor as phase-shift

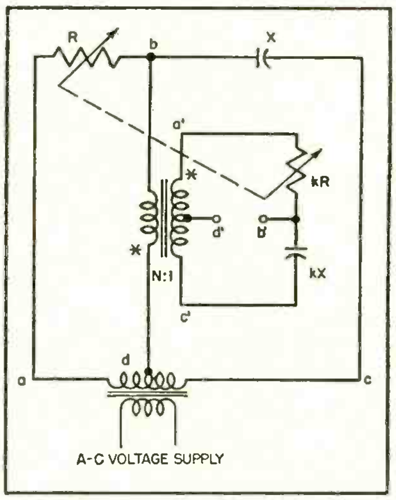


FIG. 4—Phase-shift multiplying circuit provides theoretical shift through 360 degrees. Greater shifts (integral multiples of 180 degrees) are possible by extending this scheme

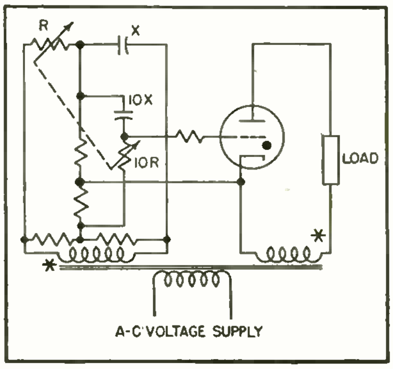


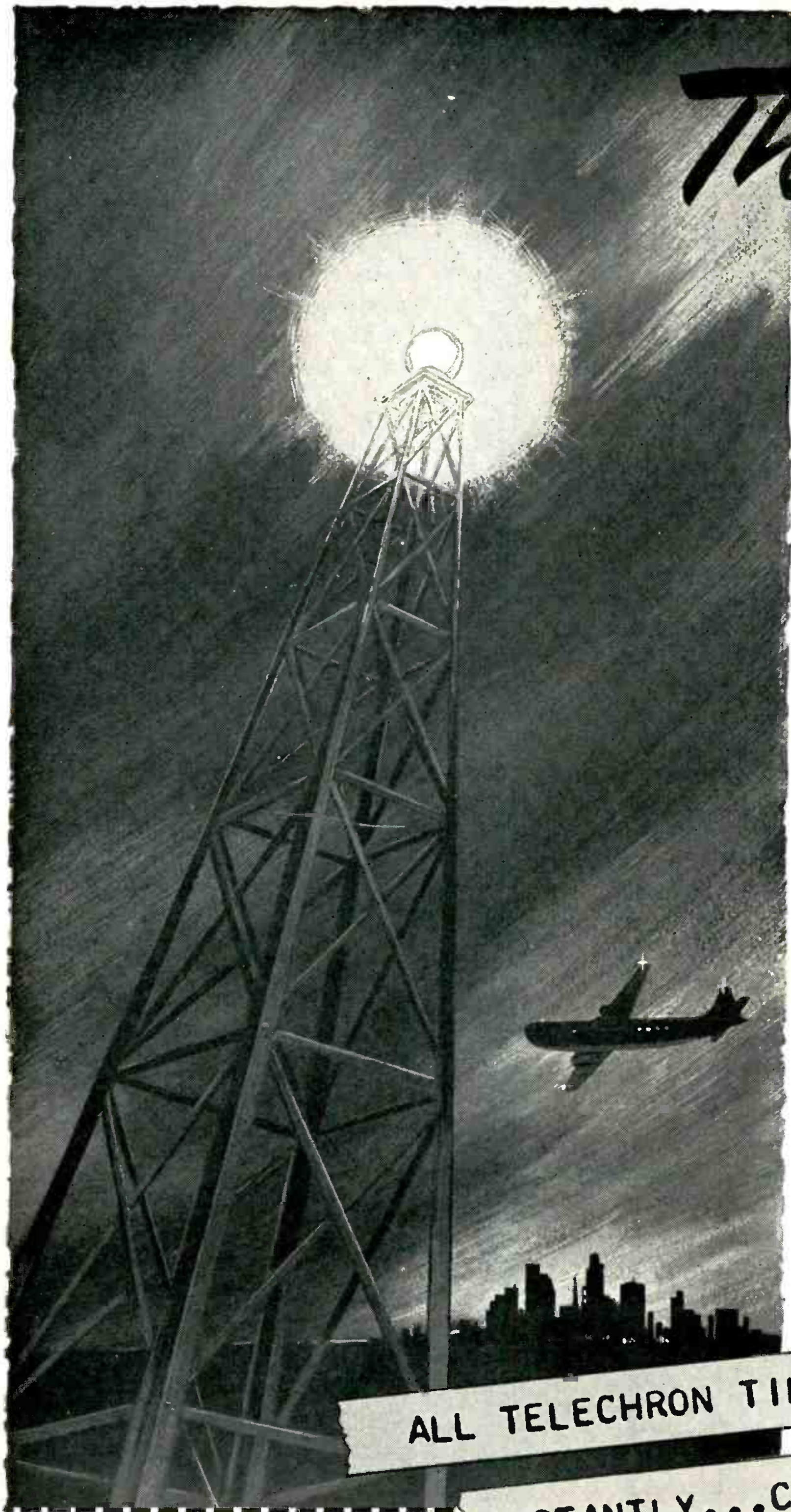
FIG. 5—Practical application of the circuit shown in Fig. 4. Asterisks indicate polarity

multiplication. The output voltage is, of course, reduced by each transformer, but if a large enough voltage is available at points *a-c*, or if a step-up transformer is used at the output, no difficulty should be experienced from this cause. The only real objection arises from the necessity of the ganged potentiometers, which may not be readily available beyond three ganged units. If inductance or capacitance is made the variable element ganging of many units should present no problem.

Transformers can be avoided by the use of two identical resistors; in this case the system suffers from a serious difficulty, however. To avoid loading of successive stages the impedance level must be raised by a factor of at least 5 or 10 in each stage.

Since potentiometers above 10 megohms are not desirable, more than four stages may not be practical, for the following reason: If four stages are used, then the potentiometer of the outermost stage must have a range of zero to 10,000 ohms if a factor $k = 10$ is allowed between stages. To attain a 168-degree range in each stage, the ratio X/R must be 0.1, as pointed out earlier. Thus, the reactance of the outermost stage may be only 1,000 ohms. At 60 cycles this corresponds to 2.65 μf, which is probably as large a capacitance as one would care to use.

If an additional stage were used, the capacitor would have to be 26.5 μf, which is clearly prohibitive in cost and space requirements. At higher frequencies, of course, many more stages can be used. It is seen



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that if the loading effects are ignored, the total available range of phase shift is four times greater for this circuit than for the single circuit described initially. A variation over about 670 degrees is possible. The loading effect of the resistors replacing the transformers will reduce the overall gain somewhat.

Figure 5 shows how a two-stage circuit may be used with a thyratron. Other circuits are equally easily designed, but an isolating transformer will, in general, be necessary. It should be noted that the relative polarities of the transformer windings are of the greatest importance. In Figs. 4 and 5 small stars are used to indicate the relative polarities of primary and secondary windings. Failure to observe proper polarities will render the circuit unable to perform its intended function.

BIBLIOGRAPHY

J. C. May, H. G. Reich and J. G. Skalnik, Thyratron Phase-Control Circuits, p 107, ELECTRONICS, Jul. 1948.

O. G. Villard, Jr., Tunable A-F Amplifier, p 77, ELECTRONICS, Jul. 1949.

Measure Coupling Coefficient In Tuned R-F Transformers

BY S. G. FELDMAN

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Robert Dean Research
Division of
Malan Plumbing Co., Inc.
Long Island City, New York

and

M. GOLDSTEIN

Development Engineer
Emerson Radio and Phonograph Corp.
New York, N. Y.

IN THE DESIGN of proximity-coupled double-tuned transformers, the measurement of the coupling coefficient in terms of critical coupling has been a tedious process producing less than accurate results. The measurement can be simplified to a great extent by application of the equations resulting from the analysis of double-tuned transformers.

Proximity coupling in double-tuned transformers usually consists of the resultant of inductive coupling and distributed capacitive coupling as shown in Fig. 1A. The more common methods of measuring the amount of coupling present

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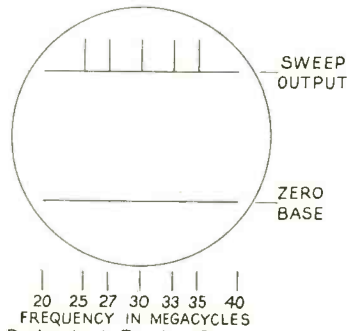

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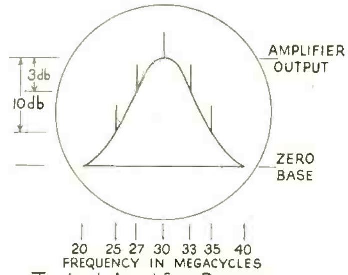

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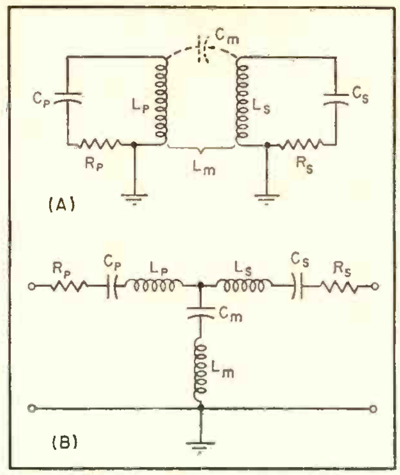

FIG. 1—Basic diagram showing contribution of inductive and distributed-capacitance coupling

usually determine the inductive component and neglect the other on the assumption that the capacitive coupling component is very small through proper design. This assumption is erroneous as it introduces a variable parameter that often results in unaccountable nonuniformity among mass-produced transformers. The following method will measure the composite effect of both types of coupling, and evaluate the result in percent of critical coupling.

Application and Measurement

Referring to the equivalent circuit of a proximity-coupled double-tuned transformer in Fig. 1B, analysis of the circuit results in the following equation:

$$\frac{Q_p'}{Q_p} = \frac{1}{1 + (K_E/K_R)^2} \tag{1}$$

where the following terminology has been used

K_L = coefficient of inductive coupling
K_C = coefficient of capacitive coupling
$K_E = K_L - K_C$ = effective coefficient of coupling
$K_R = 1/(Q_PQ_S)^{\frac{1}{2}}$ = coefficient of critical coupling
R_p = series primary resistance at resonance
R_s = series secondary resistance at resonance
R_P' = effective series primary resistance at resonance
C_P = series primary capacitance at resonance
C_S = series secondary capacitance at resonance
L_P = series primary inductance at resonance
L_S = series secondary inductance at resonance
$Q_P = \omega L_P/R_P$ = primary Q without secondary coupled

Continued on page 236

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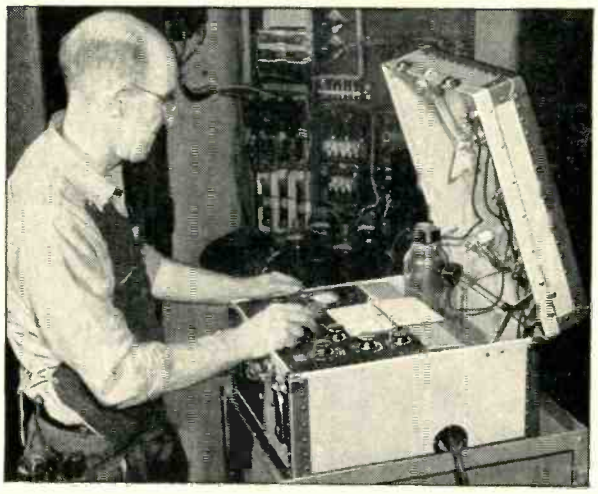

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GENERAL ELECTRIC

$Q_S = \omega L_S/R_S$ = secondary Q without primary coupled
$Q_P' = \omega L_P/R_P'$ = effective primary Q with secondary coupled
$L_M = K_L/(L_PL_S)^{\frac{1}{2}}$ = inductive coupling component
$C_M = (C_PC_S)^{\frac{1}{2}}/kc$ = capacitive coupling component
f = resonant frequency
$\omega = 2\pi f$

Equation 1 has been plotted for values of K_E/K_R up to 2, thus developing Fig 2.

Interpretation of Eq. 1 indicates that Q_P'/Q_P is a function of composite coupling in percent of critical. Therefore, to evaluate Eq. 1 all that is necessary experimentally is to measure Q_P'/Q_P. With the aid of Fig. 2, the amount of effective coupling present in percent of critical can be readily determined.

One of the more simple methods to evaluate Q_P'/Q_P is as follows: Using a Q-meter or equivalent circuit, resonate the primary winding at the proper frequency with the secondary winding open, or shorted, or detuned, so as not to affect the primary Q (Fig. 3A). Note the Q reading as being equal to Q_P. Then tune secondary winding to resonance by an indication of minimum response in primary Q reading (Fig. 3*B*). Interaction between primary and secondary will require a number of resettings of primary resonance for a maximum Q reading. The adjustments should be continued until no further interaction is noted. The new reading obtained is Q_P'.

Examples

Example 1. On the Q-meter Q_P reads 80; Q_P' reads 40. Thus, Q_P'/Q_P equals 0.5. From Fig. 2, K_E/K_R is equal to 1.0, or the transformer is critically coupled.

Example 2. On the Q-meter Q_P reads 70; Q_P' reads 20. Thus, Q_P'/Q_P equals 0.35. From Fig. 2, K_E/K_R is equal to 1.35, or the transformer is over-coupled. To obtain

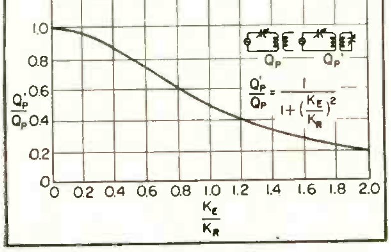

FIG. 2—Curve for determining coupling coefficient in percent of critical coupling

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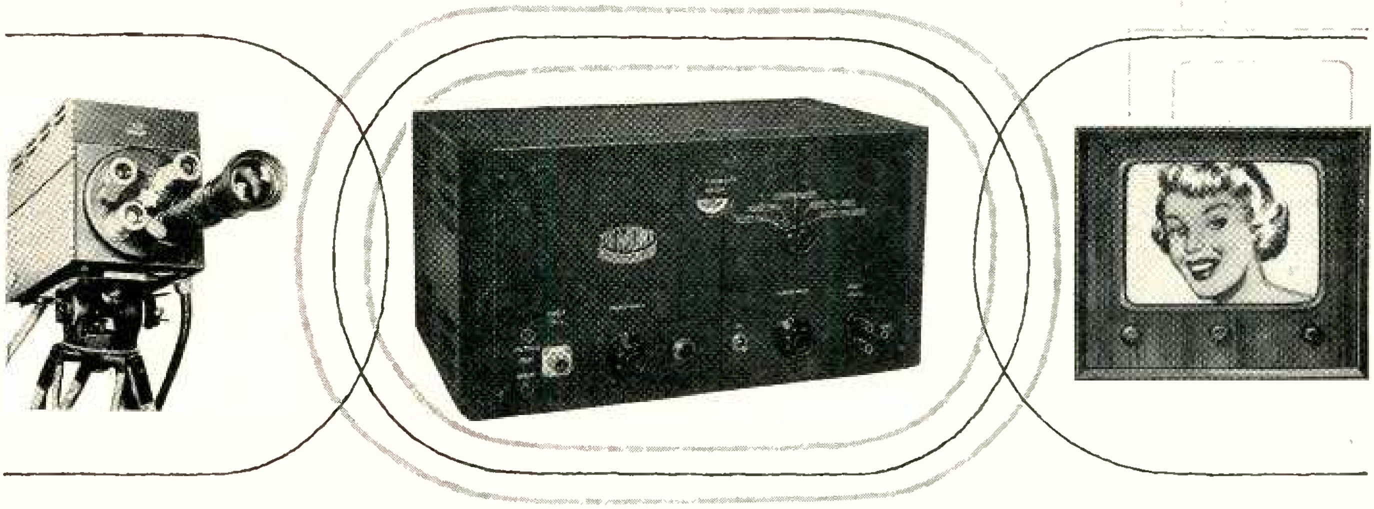

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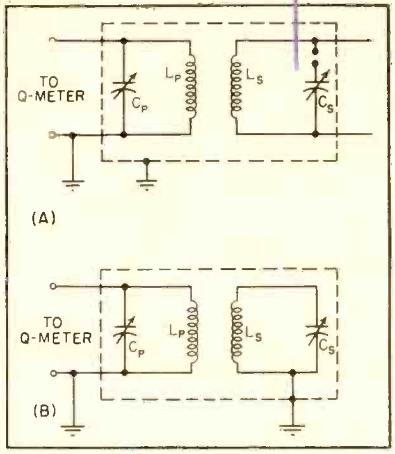

FIG. 3—Techniques used in determining coefficient of coupling with Q-meter

The most accurate results, certain safeguards and precautions should be included in the measurement technique. The shunting effect of plate resistances and input grid resistances of tubes must be simulated by an equivalent resistor across each tuned circuit. The transformer shield can should be used and also grounded. The secondary winding should be properly oriented as to phase relationship. In making measurements on a transformer that is thought to be over-coupled, the reading for Q_P' must be considered in the light of a double-humped response curve. Variation of the signal frequency source will indicate the resonant point as being a minimum lying between two maximum indications at frequencies slightly removed from the resonant frequency.

Conclusion

Although this paper is intentionally restricted to the measuring of the percent of critical coupling present in a double-tuned transformer, it may also be applied to other types as well. For instance, taking the case of an untuned primary coupled to a tuned secondary transformer, Q_P'/Q_P may be evaluated with the Q-meter method by assuming the tuned winding as being the primary. Then Q_P will be the reading obtained with untuned winding open-circuited, and Q_P' will be obtained by loading the untuned winding properly with a resistor simulating the desired input matching impedance. The ratio Q_P'/Q_P thus obtained will indicate the amount of coupling present from Fig. 2 in percent of optimum coupling, where optimum coupling is equivalent to the condition of maximum transfer of power.

Likewise, though all the above equations are derived in percent of a reference term, their absolute magnitudes can be obtained readily, in most cases, by evaluating the reference term.

The procedures outlined in this paper should augment the present techniques available on the subject by minimizing the error, introduced upon neglecting stray capacitance coupling when measuring the coupling coefficient of tuned radio-frequency transformers.

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In addition, the crt is rotated continuously to present fresh screen at the rate of about one inch per second, while the deflection of the beam (at right angles to the screen travel) is locked to the frequency of the local oscillator. The persistence of the crt screen thus enables a two-dimensional pattern, corresponding to groups of syllables, to appear.

NEW PRODUCTS

(continued from page 130)

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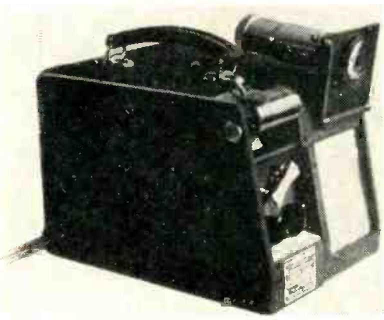

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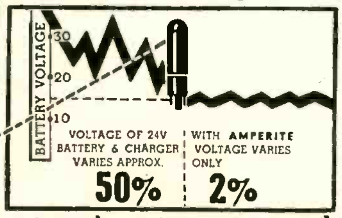

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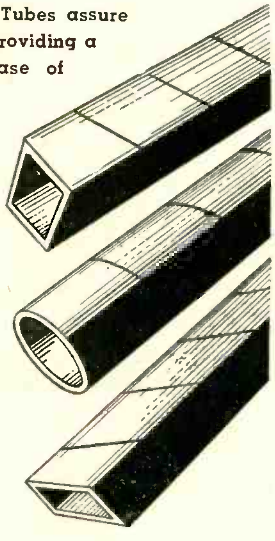

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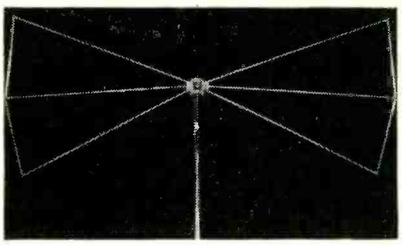
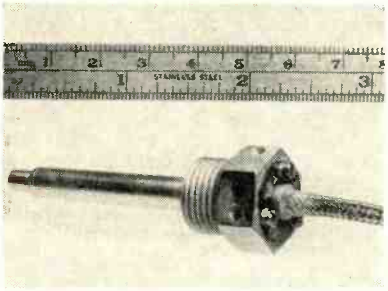


TV Antenna

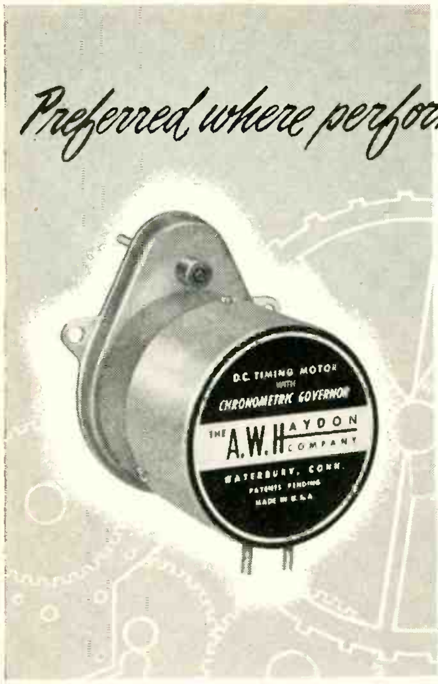
The Brach Mfg. Corp., 200 Central Ave., Newark, N. J., has developed the Bow-Tie V antenna illustrated, which requires no directors or reflectors. It is a closed circuit V antenna in which three antenna rods of the same electrical length emanate from each side of a nonhygroscopic insulator and are joined at the ends by means of shorting bars. The shorting bars provide more surface area and raise the gain of the antenna proportionately higher than would the adaption of directors or reflectors particularly on the upper channels. It will withstand high winds and ice loading as there are no free vibrating elements and it uses seamless tubing and a high impact insulator.



Bulb Temperature Pickups

Trans-Sonics, Inc., Bedford Airport, Bedford, Mass. Type 19 high-speed bulb temperature pickups are based on the resistance-thermometer principle and are suitable for the measurement of liquid, gas and metal temperature. Resistance of the sensing element changes 6.2 ohms over the specified temperature range of the instrument. As a result the pickups may be placed in a 300-ohm bridge to simulate strain gage pickups having an output voltage of 5 mv per volt. Up to 155 mv may be obtained from the pickup

Preferred where performance is paramount



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with Chronometric Governor

A primary power source of extreme accuracy, this revolutionary development of the A. W. Haydon Company is the first successful production combining the accuracy of a clock with the power of a motor. Made with jeweled movements, this extraordinary timer permits the solution of problems heretofore considered insurmountable.

Special Features:

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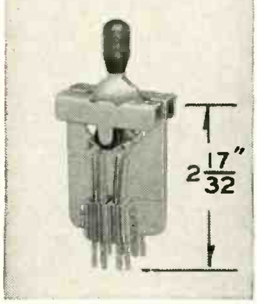
FOR ONE-HOLE MOUNTING



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The new Type MCT-1
telephone-type switch — the smallest made — mounts in a single round hole — eliminates need for slotting panel and drilling and tapping four small holes — provides versatile switching action in addition to its standard features.

"Universal" Type MCT-4
Mounting plate has two sets of four, tapped, mounting holes to fit all standard mounting centers.

BOTH MODELS FEATURE

Electrostatic shielding
between two sets of contact sections reduces coupling between circuits; grounding tab, integral with frame, is included in terminal assembly.

Versatile lever action
provides either locking on both sides, non-lock on both sides, non-lock on one side, lock on one side.

Contact buildups
permit all popular as well as special circuit arrangements.

Cam-spring mechanism
is especially designed for quiet operation and to reduce contact bounce to a new minimum.

MCT Ratings
Palladium contacts rated at 1 amp. at 115 volts, 60 cycles, non-inductive load.

Request Catalog Sheet and B/P #D35-100 giving details of contact arrangements, dimensions, and prices.

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Examine the tubular metal parts shown here twice size. If you use anything similar . . . in large quantities . . . important savings can be yours. Send us the part and specs. Our quotation will show why the Bead Chain Company's MULTI-SWAGE Process has long been known as the most economical method of making electronic tube contact pins, terminals, jacks and sleeves. And, why more and more users of mechanical parts (up to ¼" dia. and to 2" length) employ our facilities. WRITE for Data Bulletin.

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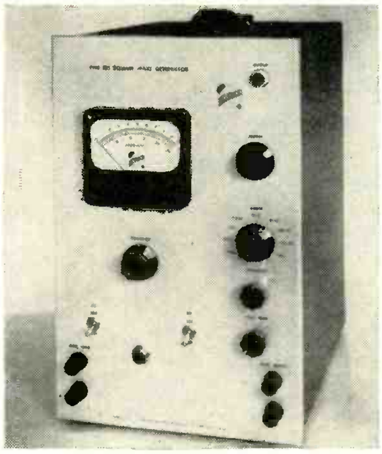
Tr. Mark 88 MOUNTAIN GROVE ST., BRIDGEPORT 5, CONN.

proper. The pickups can be supplied in ranges up to 1,100 C.

Null Detector Amplifier

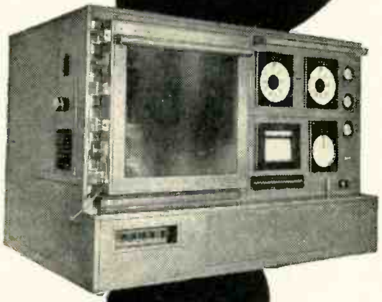
FREED TRANSFORMER CO., INC., 1718-38 Weirfield St., Brooklyn 27, N. Y. Model 1140 is a high-gain selective, a-c operated null indicator used for bridge measurements. It may also be used as a high-gain amplifier for general laboratory work. Input impedance is 1 megohm in parallel with 25 μμf. Gain is 98 db with 1-megohm load (6 μμf shunt capacitance) down 1.5 db at 25,000 cycles, down 5 db at 50,000 and down 2 db at 20 cycles. At 1 kc, 100 μv will give a 15-percent meter deflection.



Square-Wave Generator

TEKTRONIX, INC., 712 S.E. Hawthorne Blvd., Portland, Ore. Type 105 square-wave generator is continuously variable in frequency from 25 cps to 1 mc. Rise time of about 0.02 μsec is maintained at all frequencies without overshoot. It is essentially a square-wave current generator with maximum current capability of 160 ma to output load. When used with the 93-ohm output

What are YOUR Testing Problems



Whatever test specifications your product has to meet, you can depend on Bowser, because ***standard*** Bowser Environmental Simulation Chambers meet all Governmental test specs. In most cases ***one*** Bowser Unit will perform all the tests required. To meet unusual testing requirements special accessories and instrumentation can be furnished.

All Bowser Units are self-contained, and will automatically maintain preset conditions within close tolerances. Their design and rugged construction assures continuous operation for indefinite periods, yet they require no special skills to operate. To meet specific requirements, Units can be provided with automatic cycling of temperature, altitude and humidity.

WALK-IN CHAMBERS . . . Bowser also builds walk-in chambers of all sizes, field constructed or completely assembled in our plant.

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High Temp. Tests	☐	Mildew Resistance Tests	☐
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Fungus & Humidity Tests	☐	Explosion Proof Tests	☐
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Refrigeration Division
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The All-Weather Resistors

Photo Courtesy Photovolt Corp., New York, N. Y.

ARE USED IN THIS ULTRA SENSITIVE ELECTRONIC PHOTOMETER

In this instrument—designed for measurement of very low light values—S.S.White Resistors serve as the grid resistance in the all-important high-gain D.C. amplier circuit. The manufacturer, Photovolt Corp., New York, N. Y., reports that the resistors "work very satisfactorily"—which checks with the experience of the many other electronic equipment manufacturers who use S.S.White resistors.

S.S.WHITE RESISTORS
are of particular interest to all who need resistors with inherent *low noise level* and *good stability* in all climates.
HIGH VALUE RANGE
10 to 10,000,000 MEGOHMS
STANDARD RANGE
1000 OHMS to 9 MEGOHMS

WRITE FOR BULLETIN 4906

It gives essential data about S.S.White Resistors, including construction, characteristics, dimensions, etc. Copy with price list on request.

THE S.S.White INDUSTRIAL DIVISION
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Dept. R 10 East 40th St.
NEW YORK 16, N. Y.

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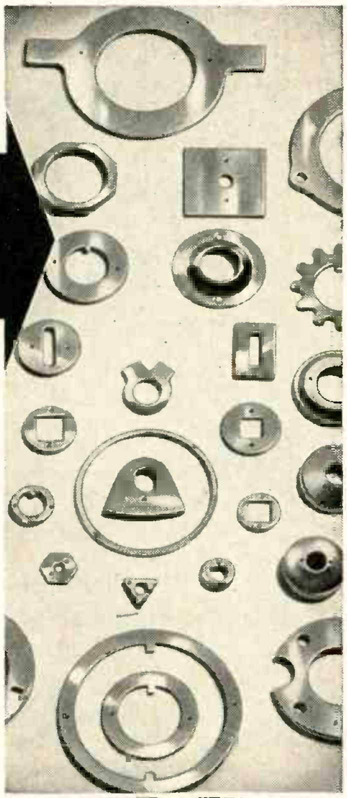
MILWAUKEE WROT WASHERS



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Large volume production, the most advanced methods and facilities, plus more than 60 years of continuous experience in the manufacture of Washers, are factors that enable us to offer you top quality washers and stampings at competitive costs. Over 22,000 sets of dies for making Washers of every type (Standard and Special), from every type of material, for every purpose, in any finish. STAMPINGS of all descriptions; Blanking, Forming, Drawing. *Submit your blueprints and quantity requirements for estimates.*

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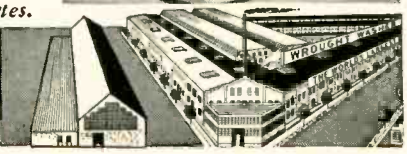
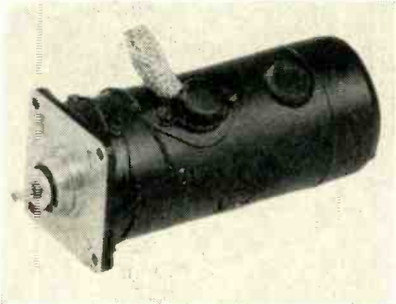
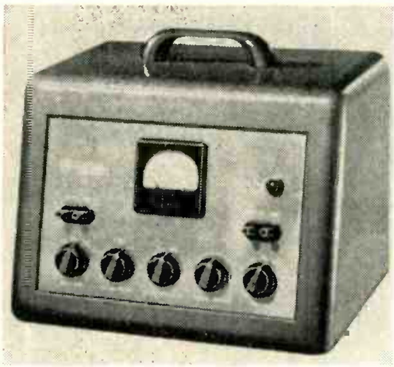


cable furnished, approximately 15 volts is available.



Precision-Built D-C Motor

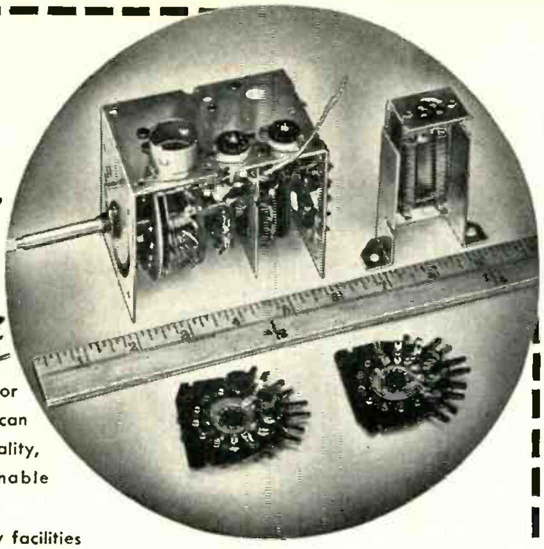
LEAR, INC., 110 Ionia Ave., NW, Grand Rapids, Mich. Model BC-05C-1, a new 15,000-rpm 26-v d-c motor with 1/50 hp-output, is designed to operate over an ambient temperature range from −65 F to +165 F. The motor has a duty cycle of 3 min on and 17 min off. It weighs 0.82 lb, is corrosion resistant, and is available with any of the following features: Fastop clutch, electromagnetic brake, thermal protector, mounting option (flange or base-type), and radio noise filter.



Pulse Generator

NUCLEAR INSTRUMENT AND CHEMICAL CORP., 229 W. Erie St., Chicago 10, Ill. Model 1022 pulse generator, designed for checking and general test work, provides pulses, either positive or negative, with a choice of 1, 10, or 100-μsec width. Maximum pulse amplitude is 20 v, in three ranges of 0 to 0.5, 0 to 5 and 0 to 20 v full scale reading. On 60-cycle supply pulse frequency is 60 per second. If an external oscillator is connected, pulse frequency may vary between 10 and 200,000 pulses per second. Accuracy of the

These **"SUBS"** *are first-string* **PERFORMERS!**



If you're looking for radio, TV or electronic sub-assemblies you can depend on for uniformly high quality, prompt delivery and reasonable price, search no further!

Clippard Instrument Laboratory facilities are at your service to produce sub-assemblies which will release your assembly departments for greater production. This service, relied upon by many of the biggest (and smallest) names in the electronic field, also eliminates endless engineering and production detail.

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Equipped to produce custom built metal goods for domestic or government requirements—any quantity, style or material.

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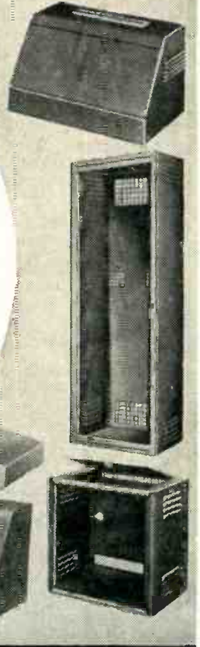

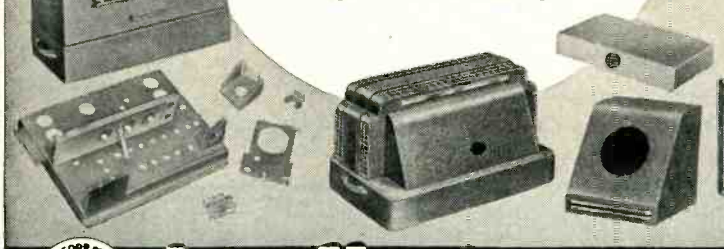

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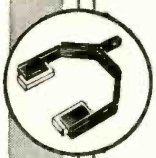
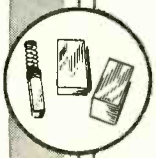
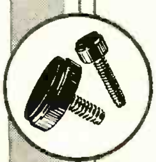


- for high current density
- minimum wear

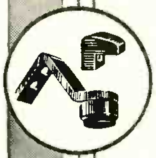


- low contact drop
- low electrical noise
- self-lubrication

IN CONTACTS



- for low resistance
- non-welding character



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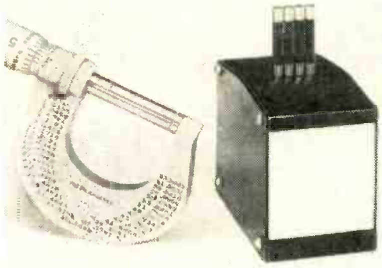
instrument is within the meter reading accuracy of 5 percent over the entire range.



Small Galvanometer

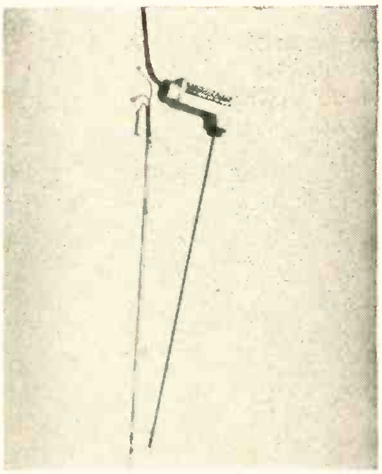
MIDWESTERN GEOPHYSICAL LABORATORY, Tulsa, Oklahoma, has developed the model 102 small light galvanometer which requires only 16.1 ma for 1-in. deflection at 15 inches in the 2,000-cps model, and 0.008 ma for 1-in. deflection in the 100 cps model. It is available in appropriate undamped natural frequency steps from 50 cps to 5,000 cps. It is readily adapted to any type of oscillograph and is available in magnet structures up to 50 traces. Elements are 1/8 in. in diameter and 2 1/32 in. long. An 18-trace model weighs only 3 1/4 pounds.

Potentiometer

ELECTRO-MEC LABORATORY, 225 Broadway, New York, N. Y. The ultra-low-torque potentiometer illustrated, was primarily designed as an industrial or aircraft instrument component, but may be used in any installation where an exceedingly small mechanical moving force needs to be converted into a corresponding electrical voltage. It can be had with a shaft torque as low as 0.003 inch-ounces. Resistance values between 50 and 200,000 ohms are provided for. Accuracies as high as 0.05 percent are available and satisfactory operation under vibration at frequencies up to 200 cps has been demonstrated.

Proportional Temperature Controller

W. S. MacDonald Co., Inc., 33 University Road, Cambridge 38, Mass. Type 218 proportional temperature controller maintains the temperature of electrically heated ovens within less than 0.1 deg C at temperatures up to 1,000 C by electronic adjustment of the input power to the oven. Power flows continuously rather than in on-off cycles. The controller operates on 110 volts a-c and will control 100 watts. It measures 8 in. × 9 in. × 12 in. and can be adapted readily to particular installations.



Resistance Thermometer

W. S. MacDonald Co., Inc., 33 University Road, Cambridge 38, Mass. Type 1000 resistance thermometer with sensing element sealed in a quartz chamber is designed for extending the useful range of resistance thermometers to 1,000 C in measurement and control. The element is tungsten and the chamber is evacuated prior to sealing. Thermometer resistance is 25 ohms at 25 C and sensitivity is 0.1 ohm per deg C. Sensing length is 2 in. and

overall length is 18 in.. Diameter of the sealed quartz chamber is ¼ in. and of the jacketed assembly, 5/16 in.

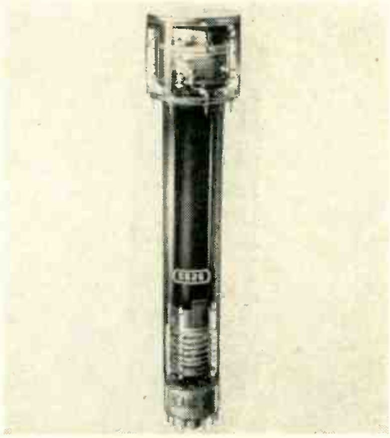


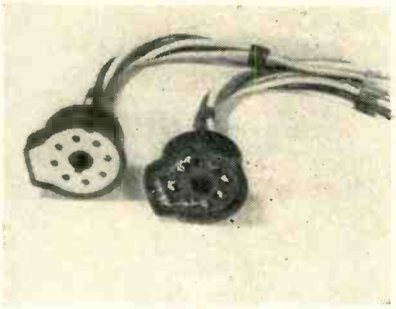
Image Orthicon

RADIO CORP. OF AMERICA, Harrison, N. J. Type 5826 tv camera tube is intended for studio use and other tv applications where the lighting can be controlled. It combines exceptionally high sensitivity, a resolution capability of better than 500 lines, high signal-to-noise ratio—about twice that of outdoor camera types—and improved gray-scale rendition in the vicinity of the blacks. It has a 3-in. diameter bulb and is 15¼ in. long. A 12-page technical data bulletin is available.

Audio Oscillator

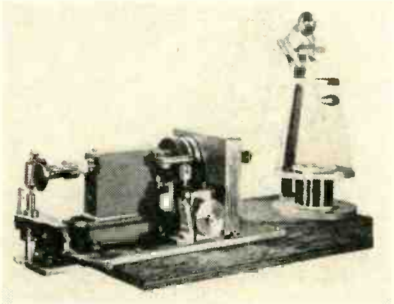
THE ELECTRONIC WORKSHOP, INC., 351 Bleecker St., New York 14, N. Y. Model 510-A audio oscillator has a frequency range of 18 cycles to 210,000 cycles in four decades. It will deliver 10 volts into 10,000 ohms with output constant within 0.5 db over the entire frequency range. Distortion at this amplitude

is less than 0.3 percent from 100 cycles to 15,000 cycles and rises to no more than 0.5 percent at 30 cycles. Source impedance of the cathode-follower output is 560 ohms. Total frequency error due to drift and dial calibration is less than ±2 percent.



Built-In-Resistor Connector

ALDEN PRODUCTS CO., 117 North Main St., Brockton 64, Mass. Type 208 FERC octal-base connector has a fully-insulated 3,300-ohm resistor complete with leads built in the molding. Ready for immediate connection it enables television manufacturers to incorporate a 6AL7-GT tuning indicator in their set design, and thus obtain precision tuning for optimum audio quality at a minimum effort and cost.

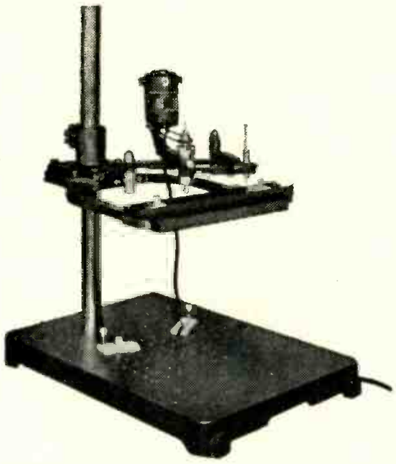


Small-Armature Winder

GEO. STEVENS MFG. CO., INC., Chicago 30, Ill., has announced a new Model 36 armature winder. Wire is fed through a hollow spindle to a revolving arm that winds wire in the armature slots, permitting the armature to remain stationary so that it cannot fly out and injure the operator. The machine winds 1,000 turns per minute on either straight or skewed armatures. Very tight armatures may be wound because of the uniform tension with which the wire is automatically guided

—MICO— ENGRAVER

Model 253 For LARGE PANELS



A further adaptation of the already proven model 252 Mico Engraver. Permits accurate engraving on metal or plastic panels up to 19 inches wide and of unlimited length. Maximum height of work above table, 19 inches. Micrometer spindle and four reduction ratios are standard equipment.

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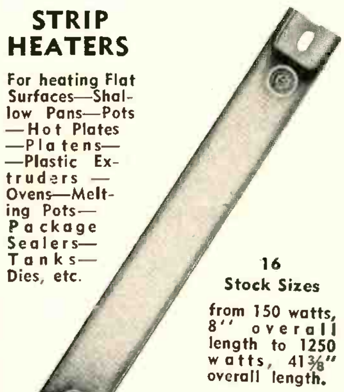
ELECTRIC HEATING UNITS

STRIP HEATERS

For heating Flat Surfaces—Shallow Pans—Pots—Hot Plates—Platens—Plastic Extruders—Ovens—Melting Pots—Package Sealers—Tanks—Dies, etc.



16 Stock Sizes

from 150 watts, 8'' overall length to 1250 watts, 41⅜'' overall length.

115 and 250 volts.

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ECONOMY ACCURACY STABILITY COMPACTNESS

IN PRECISION RESISTORS

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Have your Cake . . . and Eat it, too, with

JELLIFF ALLOY 1000 RESISTANCE WIRE

The new high in Resistivity—100 ohms/cmf—plus an impressive array of important electrical and physical characteristics, make our new ALLOY 1000 the most desirable material for windings in compact, precision resistors of all types. And the best thing about it is that you don't gain one characteristic at the cost of serious losses elsewhere. Write today for Bulletin 17, with the full story and technical data on

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LEKTROMESH • RESISTANCE WIRE • STRAINERS • WIRE CLOTH • WIRE MESH PARTS • DIPPING BASKETS

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Completely Accessible

from operating surface

dependable instruments

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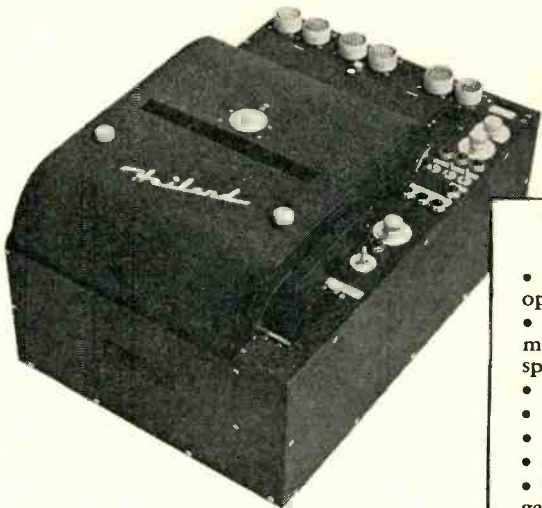
Type A-708...24-channel



FEATURES

- Completely accessible from operating surface
- Compact...can be mounted in a minimum of space...lightweight
- Can be panel mounted
- 6 to 24 channels
- Paper widths 5", 8", 12", 18"
- Simplicity of loading
- Direct monitoring of galvonometer light spots
- Flexibility of operation
- Simultaneous viewing, recording and scanning
- Trace identification...zero mirror...synchronizing reference trace
- Adjustable automatic record length

AUTOMATIC OSCILLOGRAPH RECORDER

Affording complete accessibility from operating surface and requiring only a minimum of space for mounting, the HEILAND A-708 meets the exacting specifications of research and development personnel in aircraft flight testing, laboratory and industrial testing.

Write for complete details

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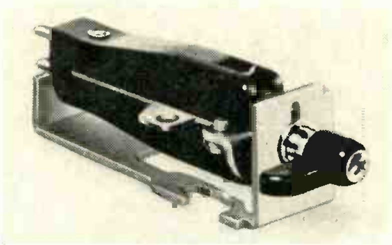
and laid in the slots. Amount of tension is limited solely by the strength of the wire.



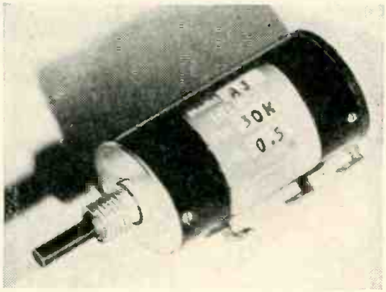
Crystal Cartridge

ELECTRO-VOICE, INC., Buchanan, Mich., has developed the Model 96-T turnover cartridge for high-quality reproduction on records of all speeds. Each needle is completely isolated and there is no added distortion caused by new resonance and its subharmonics created by the unused needle. Compliance is 1.2 on 3-mil tip and 1.0 on 1-mil tip. Response is beyond 10,000 cps.

Dynamic Analyzer

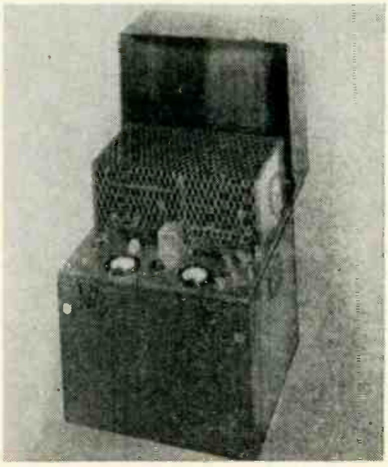
INDUSTRIAL CONTROL CO., 1462 Undercliff Ave., New York 52, N. Y. Model 100-A dynamic analyzer facilitates the measurement of frequency and transient response of low-frequency systems by electrical methods. It is particularly applicable to the servomechanism, either as a closed loop, or in its individual components. The unit functions by providing periodic perturbation signals to be injected into the error or input channels of the device under test, together with sweep and comparison voltages with which to view the output member excursion on the cro. These waveshapes are generated by electromechanical elements geared together and driven by a precision speed control. Range of modulating

frequencies is from 0.1 to 50 cps for transfer function tests. Phase measurements can be made with accuracies of ± 2 deg.



Miniature Potentiometer

THE HELIPOT CORP., 916 Meridian Ave., South Pasadena, Calif., Model AJ Helipot, a new potentiometer, occupies no more panel space than a copper penny. Designed especially for aircraft and guided-missile control and telemetering equipment, the new potentiometer has a wire-wound resistance element 18 in. long contained in a case whose diameter is ¾ in. The AJ model is available from stock and also in special resistance values from 100 to 50,000 ohms with accuracies of ±0.5 percent and also ±0.1 percent. Power rating is 2 w.



Regulated Power Supply

THE RICHARDSON-ALLEN CORP., 15 West 20th St., New York, N. Y., has developed a compact, portable, closely regulated power supply for use in testing laboratories, on production lines, and for testing radio communication and electrical equipment in airplanes. The unit has a selenium rectifier, full-wave, six

phase. Its a-c input is 220 v, three phase, 60 cycles; and it delivers d-c 24 to 32 v, 30 amperes. The supply is continuously variable by rheostat control saturable reactor. Regulation is ± 4 percent from 0 to full load.

Ion Exchange Demineralizer

THE PENFIELD MFG. CO., Meriden, Conn., has announced a new ion-exchange demineralizer for laboratories and other users of up to 10 gallons of demineralized water per hour. Designed to attach to any wall near a tap, the demineralizer has a permanent cartridge and a flow meter. An electric conductivity meter built into the unit provides a visual indication of the quality of the treated water being produced, warning when the resin charge should be renewed.

Twin Triode

GENERAL ELECTRIC CO., Syracuse, N. Y. Type 6SN7-GTA twin triode is designed for use as a combined vertical oscillator and vertical-deflection amplifier in tv receivers. Plate dissipation rating is 5.0 watts per plate or 7.5 watts for both plates; plate voltage rating, 500 volts, and heater-cathode rating, 200 volts. It carries a peak positive-pulse plate voltage rating of 1,250 volts and a peak negative-pulse grid voltage rating of 200 volts for tv applications. Other uses include such general purpose applications as resistance-coupled amplifiers, phase inverters and multivibrators.

Literature

Counter Bulletin. Durant Mfg. Co., 1929 N. Buffum St., Milwaukee 1, Wisconsin. A recent instrument counter bulletin illustrates several of the company's line of special counters that have been designed and manufactured for specific instrument applications in the electronic industry.

Thermocouple Manual. Wheelco Instruments Co., 847 W. Harrison

NEW WIDE BAND D.C. AMPLIFIER

MODEL 120

A precision instrument designed for use as a preamplifier in conjunction with an oscilloscope, vacuum tube voltmeter or other instruments.

SPECIFICATIONS

FREQUENCY RESPONSE: Within ± 1 db between D.C. and 100,000 cycles per second.

GAIN: Approximately 100.

INPUT CONNECTION: Double channel, can be used for single ended and push-pull signals or as a differential amplifier.

INPUT IMPEDANCE: One Megohm shunted by approximately 15mmf in each channel.

DUAL INPUT ATTENUATOR: One to one, 10 to one, 100 to one and "off" positions in each channel independently adjustable.

OUTPUT CONNECTION: Push-pull or single ended.

OUTPUT IMPEDANCE: Less than 50 Ohms single ended or 100 Ohms push-pull.

HUM AND NOISE LEVEL: Below 40 microvolts referred to input.

LOW DRIFT due to regulated heater voltage in input stage.

MOUNTING: Metal cabinet approximately 7" wide by 7" high by 11" deep.

Write for descriptive literature on the Model 120 D.C. Amplifier and other Furst laboratory instruments including Regulated Power Supplies.

FURST ELECTRONICS
10 S. Jefferson St., Chicago 6, Ill.

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Gives You Top Coil Performance

Deal with Dano, makers of every type of coil. From simple electrical coil windings to specially treated coils, Dano is fully set up to serve you. AND REMEMBER THIS: Dano makes every coil to your exact specifications.

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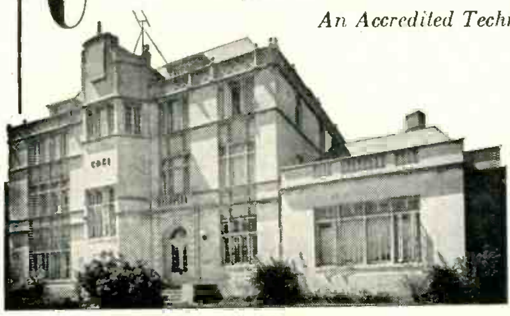

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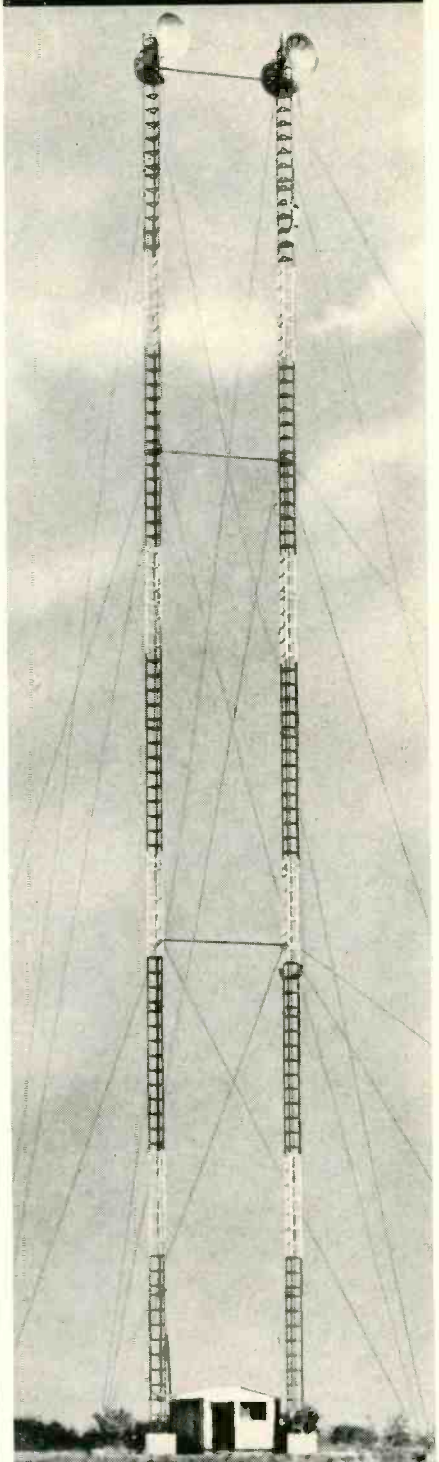

MICRO WAVE RELAY TOWER supports General Electric Relay Equipment between Chicago and Grand Rapids, Michigan, designed and erected by

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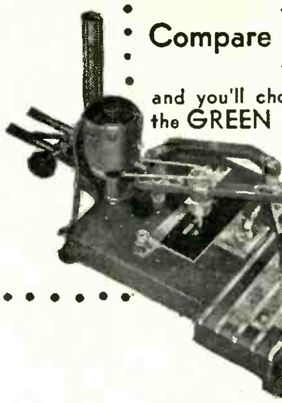
St., Chicago 7, Ill., has released a 42-page 1950 edition of its data book and catalog containing up-to-date prices, application recommendations and pertinent information concerning instrument sensing units and associated accessories. The large standard line of thermocouples, protecting tubes, lead wire and insulators is profusely illustrated with complete descriptions and specifications clearly indicated.

Polystyrene Capacitors. United Condenser Corp., 337 E. 139th St., New York 54, N. Y., has available a 4-page folder covering a line of polystyrene capacitors characterized by extremely low losses. The power factor and dielectric absorption of the units described is on the order of 0.02 percent from d-c to the megacycle range, while the insulation resistance is approximately 20 times greater than that of high grade paper or mica capacitors at room temperature. The elements discussed are ideal for use in electronic analyzers and computers, in tuned circuits and wave filters, as standards of capacitance, and in radiation detection equipment.

Micromerograph. The Sharples Corp., 342 West 4th St., Bridgeport, Pa., has issued a booklet describing the new Micromerograph, an instrument for determining the particle-size distribution of fine-sieve and sub-sieve powdered materials. General description, comparison with other methods, and a drawing of the equipment are included. Also included is a reprint of a paper presented at the Third National Conference of the American Instrument Society by R. E. Payne entitled "The Measurement of the Particle Size of Sub-Sieve Powders," and a technical report on operating ranges for the instrument.

New Equipment Catalog. Allied Radio Corp., 833 W Jackson Blvd., Chicago 7, Ill., has announced publication of its 1951, 212-page catalog covering radio, television and industrial electronic equipment. Special emphasis has been placed on equipment for industrial main-



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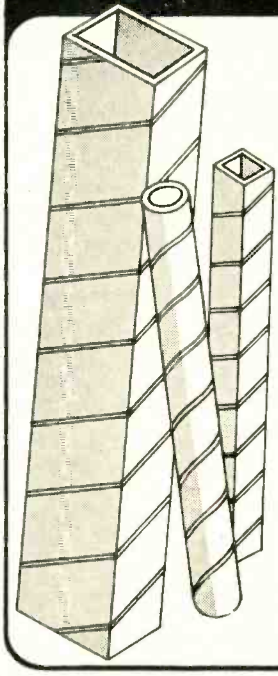

Stock Arbors or Special Tubes to Meet Every Need
SQUARE, ROUND, RECTANGULAR
.450" to 25" I.P. ½" to 30" long. Tolerances ± .002"

You find PARAMOUNT Spiral Wound Paper Tubes at the core of coil dependability in nationally known products and equipment. That's proof they're *made right* to *wind right* and *stay right* on the job. Hi-Dielectric. Hi-Strength. Kraft, Fish Paper, Red Rope, or any combination, wound on automatic machines.

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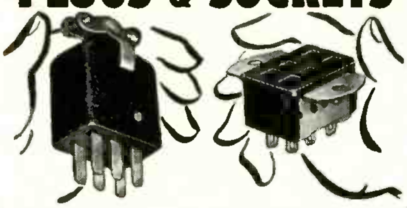

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Made in 2 to 33 contacts for 45 volts, 5 amps, for cap or panel mounting. Higher ratings where circuits permit. All plugs and sockets polarized. Knife switch socket contacts phosphor bronze, cadmium plated. Engage both sides of flat plug—double contact area. Bar type plug contacts hard brass cadmium plated. Body molded bakelite.

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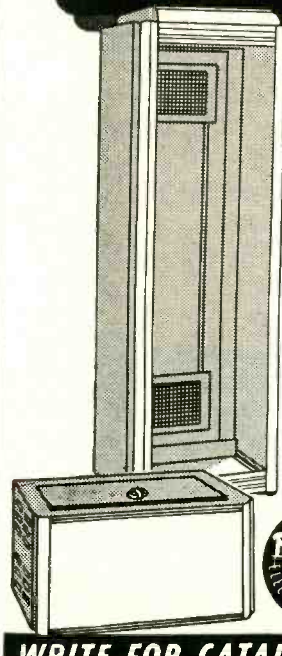

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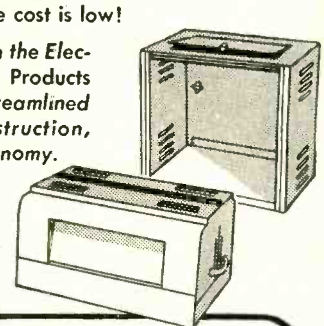
Because we *specialize in the Electronics field*, Par-Metal Products excel in *functional streamlined design, rugged construction, beautiful finish*, and economy.



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tenance, research and production requirements. There are detailed listings of standard and special-application electronic tubes, test instruments, voltage stabilizers, transformers, resistors, capacitors, rheostats, relays, switches, rectifiers, tools, wire and cable, batteries, sockets, generators, power supplies and other types of equipment in the industrial field.

Thermal Time Delay Tube. Eclipse-Pioneer Division of Bendix Aviation Corp., Teterboro, N. J. Bulletin 73-3A gives a full treatment of the Chronotron tube, a temperature-resistance device mounted in a miniature-size vacuum-tube envelope. The tube described, developed primarily for use in electronic-control circuits, provides a time delay and also functions in a manner similar to an integrating device. Circuits, illustration and a technical data table are included.

Beryllium Copper. The Beryllium Corp., Reading, Pa. Technical bulletin No. 2, the second in a new series of data sheets, provides engineers with factual information on beryllium copper. The publication makes available case history and technical information on Berylco 25, Berylco 20C and investment castings. Future issues will cover other products in wrought and cast forms.

Hermetic Terminals. T. C. Wheaton Co., Millville, N. J., has published a 12-page catalog filled with engineering data to assist those confronted with the design and specification of hermetic terminals for electrical and electronic products. It contains complete details of the many terminals available. In addition, there is a special section devoted to metallized glass seals and electronic insulators and another to engineering information relating to terminal selection and use.

Soldering Gun Catalog. Weller Electric Corp., Easton, Pa. New soldering information, helpful to tv and radio technicians, electricians and industrial laboratory workers, is contained in the soldering gun

catalog recently issued. The publication covers the company's complete line and features the new light-duty model with dual spotlights. It gives detailed descriptions and lists prices.

Small Converter. Minneapolis-Honeywell Regulator Co., Brown Instruments Division, Wayne and Roberts Aves., Philadelphia 44, Pa. Instrumentation data sheet No. 10.20-1; deals with the new $8\frac{1}{2}$-oz, 400-cycle converter designed for high-altitude operation in various electronic and electrical equipment and in servomechanisms for aircraft and guided missiles. Complete description, illustration and wiring diagram are given.

Quick-Coupling Connectors. Thermo Electric Co., Inc., Fair Lawn, N. J., has just published a new section for its catalog, section 23, covering quick-coupling type thermocouple connectors and panels. The 4-page section is well illustrated and contains complete descriptive details.

Bimetal Thermostats. Stevens Mfg. Co., Inc., Mansfield, Ohio. A new bulletin describes the type S bimetal strip thermostats for use in appliances and industrial apparatus. It is illustrated with photographs of 13 standard models, schematic diagrams showing operating principles and dimensions and typical thermostat response curves.

TV Antennas. American Phenolic Corp., 1830 South 54th Ave., Chicago 50, Ill., has published a 16-page booklet comprising a discussion of tv antennas based on actual field tests, dealing with the characteristics of the various types of antennas and the conditions which affect their performance. The booklet is well illustrated and contains two pages dealing with tv accessories.

Temperature Indicators. Manning, Maxwell & Moore, Inc., Bridgeport 2, Conn. Bulletin 404 introduces a line of thermocouple-actuated Microsen temperature indicators and recorders. The units

described have a −100-F to +3,000-F range and can be employed in a wide variety of electrical measuring requirements particularly where low-level electrical signals necessitate microammeter sensitivity.

Receiving Tubes. Radio Corp. of America, Harrison, N. J. The RC-16 receiving tube manual is a new edition containing over 300 pages and covering more than 460 receiving tubes and kinescopes. The section on electron tube applications has been expanded and includes formulas and examples for calculation of power output, load resistance, and distortion for several classes of amplifier service, as well as cathode-follower information. The section on installation now includes high-voltage and safety considerations for kinescopes. The section on circuits has been expanded and contains many new audio-amplifier and receiver-circuit designs. Price is 50 cents.

Electron Microscopy. National Bureau of Standards, U. S. Dept. of Commerce, Washington 25, D.C., recently issued circular 502, a new compilation of technical literature on electron microscopy. Titles of the publications in the bibliography have been grouped in the following categories: Books, survey articles, instrumentation, electron optics, related instruments and applications. The 87-page circular is available from the Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C., at 25 cents a copy.

Portable Sound Equipment. Newcomb Audio Products Co., 6824 Lexington Ave., Hollywood 38, Calif. A new catalog now available covers portable audio equipment designed especially for schools, churches, clubs and recreational activities. It includes a wide selection of combination transcription players and p-a systems with both 2-speed and 3-speed turntables. Two recently developed portable phonographs described have the exclusive Floating Sound feature that eliminates needle skipping. All models are illustrated and thoroughly de-

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World-wide recognition for this outstanding line of electric soldering irons —

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– specified by the big names for the *TOUGH JOBS!*

WESTERN ELECTRIC, BENDIX, MINNEAPOLIS HONEYWELL RADIO CORP. OF AMERICA, STROMBERG CARLSON, SPERRY, WESTINGHOUSE, EMERSON, KAISER, etc.

PLUG OR SCREW TIPS 40 to 700 Watts
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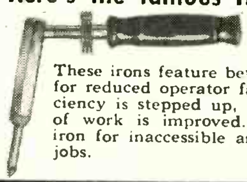

These irons feature better balance for reduced operator fatigue. Efficiency is stepped up, and quality of work is improved. The ideal iron for inaccessible and intricate jobs.

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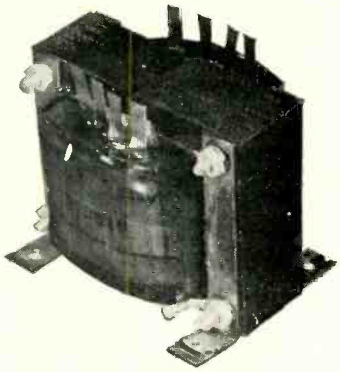

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Units treated with Acme Star Compound can be operated intermittently at temperatures as high as 300°F. At sub-zero temperatures such as —67°F., due to the natural resiliency of the compound, there will be no evidence of cracking or brittleness.

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A TIME-TESTED **DEPENDABLE** SOURCE FOR

HIGH-PRECISION FRACTIONAL H.P. INSTRUMENT-TYPE
MOTORS & GENERATORS
PRODUCED TO ORDER

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Experienced for years in meeting customers' exacting requirements for high-precision instruments designed by engineers of ability and ingenuity, and manufactured with extreme care and skill. Over 500 different basic types may be varied to meet your own unique requirements of use, either electrically or physically.

ELECTRIC INDICATOR CO.
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TWIN BEAM OSCILLOSCOPES

independent amplifiers for each beam —no electronic switching.

You can use COSSOR TWIN BEAM SCOPES in *your* work! Here are a few reports of the innumerable applications now possible . . .

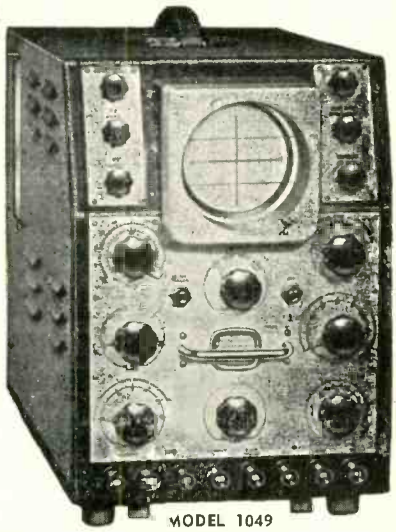
Cement Research Lab measures sound velocity in concrete with Model 1035 by measuring delay between transmitted and reflected sonic pulses.

Transformer Manufacturer uses 1035 to measure winding unbalance by simultaneous comparison of voltages on two phases.

Manufacturer of radar video stages uses 1035 to compare input and output waves for gain, phase shift and distortion.

Boxcar manufacturer sets up phase shift controls in spot welder with 1049.

Audio amplifier manufacturer uses 1049 to balance push-pull circuits.



MODEL 1049

Use Model 1035 for fast sweeps, HF amplifier applications.
Use Model 1049 for slow sweeps, twin DC amplifier work.
Use Model 1428 Camera for still or moving film recording.

Write today for details and demonstration!

COSSOR (CANADA) LIMITED
301-303 Windsor Street, Halifax, N. S.
BEAM INSTRUMENTS CORPORATION
Room 907, 511 5th Avenue, New York 17, N.Y.

scribed with detailed specifications.

Photoelectric Amplifiers, De-Tec-Tronic Laboratories, Inc., 1227 N. Clark St., Chicago 10, Ill. Catalog 550 is an 8-page folder treating of a line of specially designed photoelectric amplifiers for smoke control, fire detection, counting, production-line control, inspection, burglar alarms, warning devices and many other industrial applications. Specifications are included.

C-R Equipment. Allen B. Du Mont Laboratories, Inc., 1,000 Main Ave., Clifton, N. J. A 16-page folder describes and illustrates a line of cathode-ray oscillographs, complete with specifications for each, for general laboratory and servicing applications, for precision measurement useful down to d-c and for specialized applications in h-v oscillography. Also included are auxiliary instruments, accessories and c-r tubes.

TV Components. The Plessey Co. Ltd., Ilford, Essex, England. A 24-page booklet describes and illustrates a range of tv components available to manufacturers. It contains much information of particular interest to designers. Several of the scanning and output transformers are based on the company's special tv grade of Caslam molded core material which is claimed to be suitable for tv applications by virtue of its low losses at higher audio and ultrasonic frequencies and freedom from objectionable noise producing magnetostriction effects.

Hermetically-Sealed Relays. Guardian Electric Mfg. Co., Inc., 1621 W. Walnut Ct., Chicago 12, Ill. Catalog 5-H covers a line of hermetically-sealed relays available in four standard mounting arrangements—the lug header type, Army-Navy connector type, octal plug type and the screw terminal type. A wide variety of contact combinations and operating voltage ranges available are treated. Included in the current catalog is technical information concerning the performance of

units conforming to requirements of the ANR-20b and the 10-G vibration tests.

Geiger Counters. New York University College of Engineering, New York 53, N. Y. A recent four-page folder illustrated with a dozen drawings explains the elements of a Geiger counter as well as the behavior of electrons, positive ions, ion clouds and impulses. A section of the folder deals with penetrating, nonpenetrating and decaying cosmic-ray particles. Data is also given on special counting circuit arrangements. The publication is available at 10 cents per copy.

Test Equipment Catalog. Electronic Instrument Co., Inc., 276 Newport St., Brooklyn 12, N. Y., recently released the 1950-51 edition of their catalog for radio-television technicians, engineers and students. It describes a complete line of vacuum-tube voltmeters, oscilloscopes, sweep generators, signal generators, tube testers, signal tracers, volt-ohm-milliammeters, battery eliminators, high-voltage probes, r-f probes and crystals.

Waterproof Outlet Box. Equipment and Service Co., 6815 Oriole Drive, Dallas 9, Texas. Type 6005 Greenbilt waterproof outlet box designed for a-m, f-m and tv remotes, is illustrated and described in a recent bulletin. The unit featured has five interruption-proof all-weather outlets from one inlet. Each outlet of the product described will conservatively carry 1,500 watts and the inlet receptacle is rated at 6,000 watts, all at 115 volts. Ordering information is given.

TV Control & Resistor Replacement. Clarostat Mfg. Co., Inc., Dover, N. H., has released further data sheets covering tv control and resistor replacements. The sheets (8½ × 11 with standard binder punchings) constitute handy reference charts indicating model and chassis, stock and part numbers, the company's catalog number, list price, function and description.

NEWS OF THE INDUSTRY

(continued from page 134)

released from the dispenser by packboard from a soldier's back without use of hands, from any land or amphibious vehicle, or any plane. A soldier who has a rifle, grenade, or bazooka can lay the wire by shooting it over rivers or cliffs. Two or more dispensers may be connected in tandem and the wire strung without splicing.

THE SIGNAL CORPS has developed a 7-contact miniature connector which is watertight in coupled and uncoupled positions. It uses butt contacts which can be easily cleaned in the field. The coupling and uncoupling action is obtained by a rotation of 30 degrees. The contacts are rated at a minimum of 2 amp at 125 v a-c. The plug is 11/16 in. in diameter and 1 in. long.

Electronic Engineers Needed

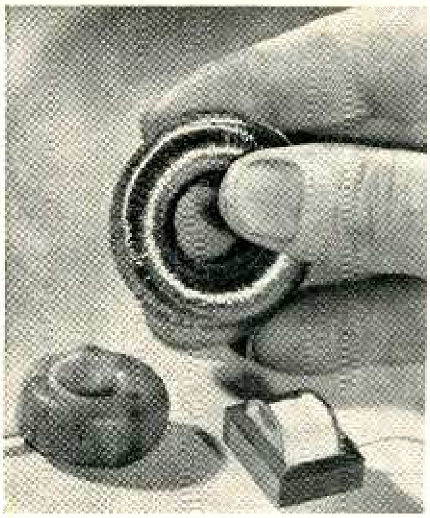
CIVILIAN electronics and communications engineers interested in assignments in the Pacific area with Airways and Air Communications Service (AACS) are requested to write the Commanding General, Headquarters AACS, Washington 25, D. C., Attn: Director of Personnel.

The AACS (part of the Military Air Transport Service) urgently needs these engineers to fill positions in grades 7 thru 12. It is the major air communications system of the USAF and as such furnishes air communications and navigational flying aids to U. S. military aircraft throughout the world.

1BCG Memorial

DEDICATION ceremonies by the Radio Club of America for a monument commemorating the first short-wave radio message across the Atlantic were held in Greenwich, Conn. a few yards from the site of the shack that housed the original transmitter.

The historic message was transmitted from amateur station 1BCG on the night of Dec. 11, 1921 using power of less than a kilowatt on a wavelength of approximately 230 meters. It was received by Paul F. Godley, who had been sent to



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Your filter or inductor problem may be best solved by using toroids. Or the problem may require the use of laminations. Acme is completely equipped to design and produce, to your specifications, using whichever construction method best suits the purpose.

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ANNOUNCES A NEW LINE

- COLOR AND MONOCHROME PICTURE GENERATORS
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PRECISION MINIATURE 6" DRILL PRESS *WITH*—

SENSITIVE FEEL!

Spindle lowers to work—makes small drilling easier . . . greater accuracy.

MODEL 204-B meets the increasing post-war demand for small drilling to ever higher accuracy standards. Spindle turns smoothly on Selected Bearings; run out less than .0004"; table square to spindle within .0006" at 2½" radius. Permanent accuracy; castings annealed and ground. Write Bulletin E-1.

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Model 86 — 1 to 20 KV and Model 101 — 1 to 50 KV

Complete Information Available

POWER SUPPLIES of any voltage or current built to specifications

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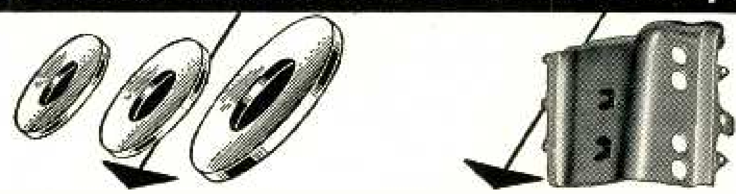

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A preferred source of precision-made WASHERS and STAMPINGS. 46 years of experience and up-to-the-minute facilities, assure highest quality and service.

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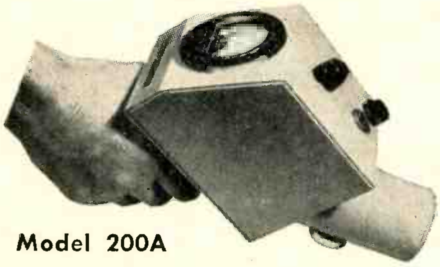
UNIVERSAL SCINTILLATION COUNTER
for *ALPHA-BETA-GAMMA*
Reliable—Accurate—Portable



Model 200A

A really "portable" precision instrument. Absence of "zero drift" especially notable, compared to usual ion chamber type instrument. Develops absolute discrimination against Beta and Gamma (when measuring Alpha radiation levels) by use of a very thin phosphor having a low counting efficiency for Beta or Gamma (approx. .0002%) but extremely high for Alpha particles. Switches easily from phosphor to crystal for counting Beta and Gamma radiations. Design and size facilitate Bench Contamination surveys.

Specifications:

1. **Power:** Batteries (self contained). Penlite or PM cells.
2. **Power input:** 6 volts 50 ma.
3. **Detection element:** 1P21 photomultiplier and phosphor, or crystal.
4. **Window:** Aluminum foil 1.75 mg/cm2
5. **Indication:** Meter plus aural.
6. **Calibration:** Disintegrations per min. for Alpha radiation. Milliroentgen or roentgen units per hour for Beta and Gamma radiation.
7. **Sensitivity:** 150 D/M — 500,000 D/M in ranges desired.
8. **Weight:** Approx. 2½ lbs! (one hand operation)
9. **Price:** $215.00.

We can supply laboratory instruments and field survey units.

Model 240A—Alphatron Geiger Detector
Model 241 —Geiger-Meuller Detector
Model 242 —Alphatron Geiger Meuller Detector

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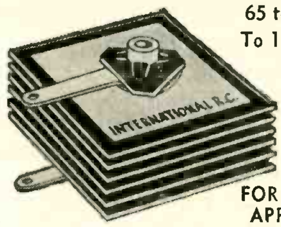

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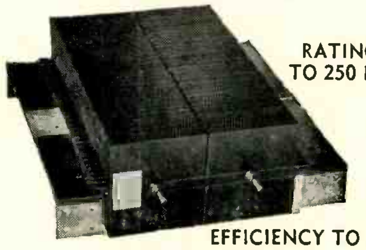

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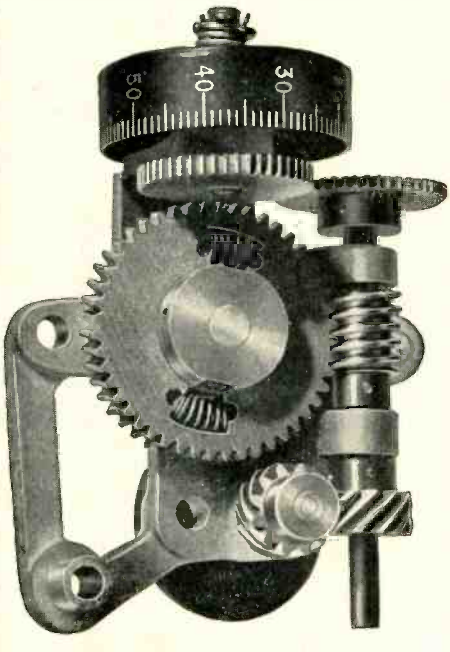

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Monument commemorating first short-wave transatlantic radio message was recently dedicated at Greenwich, Conn., by Radio Club of America

Scotland by the American Radio Relay League for the express purpose of listening for U. S. amateur signals. The success of this test was also a turning point in commercial utilization of short waves, heretofore neglected.

Replicas of the Radio Club of America Armstrong Medals were presented to the original participants at the ceremony. Present to accept the awards were E. H. Armstrong, E. V. Amy, G. E. Burghard and P. F. Godley. Receiving awards in absentia were Minton Cronkhite, J. F. Grinan and Walker Inman.

BUSINESS NEWS

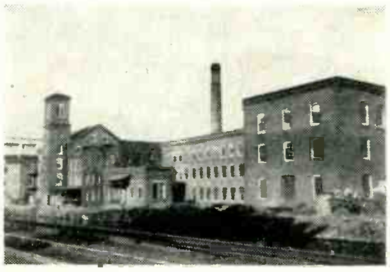
Federal Telephone and Radio Corp., Clifton, N. J., will install a ptm microwave communication system for the Trunkline Gas Co., Houston, Texas, to serve the latter's 1,300-mile pipeline from natural gas fields in Texas and Louisiana to Tuscola, Ill., where the mainline route will tie in with the Panhandle Eastern Pipeline Co. It will be the second longest microwave system used for industrial communications.

General Electric Co. will soon reopen its Clyde, N. Y., plant and transfer production of germanium products now made at its Thompson Road plant in Syracuse to the newly occupied factory. Full production of these items for use in radio and tv receivers and in industrial and military electronic equipment is expected about February 1.

Radio Corp. of America recently acquired a new plant with 180,000 sq ft of floor space in Cincinnati, Ohio, for the manufacture of miniature electron receiving tubes. The plant is scheduled to be in full production by the autumn of 1951.

Facsimile and Electronics Corp. is the new name of Finch Telecommunications, Inc., Passaic, N. J., manufacturer of facsimile equipment for communications and reproduction purposes.

The LaPointe-Plascomold Corp., manufacturer of Vee-D-X television antennas and accessories, has purchased an entire new plant at Windsor Locks, Conn., to more than double its present production.



New La Pointe-Plascomold plant has a production area of 105,000 sq ft

The Audio-Master Co., manufacturers of transcription players, have moved to larger quarters at 341 Madison Ave., New York 17, N. Y.

Radio Corp. of America recently re-established radio contact and telegraph service between the U. S. and Seoul, capital of South Korea. Reopening of the circuit was made possible by repairing radio transmitting and receiving facilities in Seoul which had been damaged during the North Korean occupation.

PERSONNEL

Lynn C. Holmes, associate director of research at Stromberg-Carlson Co. since April 1950, has been named director of research for the company.

Raymond C. Miles, formerly with Haller, Raymond & Brown, Inc., as

chief engineer, has been named deputy head of the design and test section of the engineering and production division of Airborne Instruments Laboratory, Mineola, N. Y.

P. N. HAMBLETON, formerly of the Philco tube development laboratory, has been appointed electronics engineer in charge of the electronic laboratory at Superior Tube Co., Norristown, Pa.

JOHN N. DYER, supervisor of radar and air navigation research and development for Airborne Instruments Laboratory, Mineola, N. Y., has been named director of research and engineering for the company.

J. N. Dyer

M. A. Tuve

MERLE A. TUVE of the Carnegie Institution, Washington, D. C., has been awarded a Howard N. Potts Medal by The Franklin Institute of Philadelphia, Pa., for his supervision of the development and engineering design of the proximity fuse.

ROY W. AUGUSTINE, founder of the Joy-Kelsey Co., radio set manufacturers, and the Oxford Co., speaker manufacturers, was recently appointed to the engineering staff of the Muter Co., Chicago, Ill., television components manufacturers.

ROBERT DOWD, head of the quality control department, Tel-O-Tube Corp. of America, East Paterson, N. J., has been appointed chief field engineer for the firm.

R. G. E. HUTTER, head of the electronics research section of the physics laboratory, Sylvania Electric Products Inc., Bayside, N. Y., has been appointed adjunct professor at the Brooklyn Polytechnic Institute, where he will conduct classes in electron tube theory and electron optics.

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detriment of the interests of the listening public.

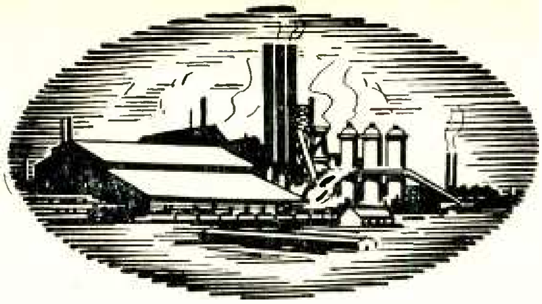
As a specific example for the f-m field, I enclose copy of a report made to me a year ago concerning the radiation of an RCA 8X71 and a Zenith 7H822 (S-15840) table model, respectively. The report is hard to believe, but unfortunately too true. It shows the RCA set developing a radiating voltage of 1 volt across a 300-ohm transmission line, the principal cause being, of course, the failure to use an r-f amplifying stage. The corresponding value for the Zenith set was 1/50th of a volt.

The report further shows that at a distance of 50 miles from New York City the RCA set, when connected to an antenna 15 feet high, destroyed reception of WCBS-FM over a radius of ½ mile when the oscillator was tuned to radiate on CBS' frequency. Under similar conditions, the Zenith radius of interference was under 500 feet.

At the time this type of RCA set was introduced, I learned on authority which is unimpeachable that the radiating characteristics were known to its designers but that, nevertheless, the RCA organization intended to proceed with its marketing plans. Contrast this with the fact that in the nineteen-twenties RCA, when confronted with the superheterodyne radiation problem, took the lead in finding a solution.

For a correspondingly bad example in the engineering of television sets it is necessary only to examine what happened in the Providence area, where a similarly "engineered" type of tv set, likewise made by a nationally known manufacturer, Motorola, was turned loose in quantities in that area.

In governmental circles the grade of engineering is little better. In fact, the present situation is due as much to FCC engineering incompetence as to unsound commercialism in the manufacturing industry. The discredited Norton and Allen theories (see *Proceedings, IRE*, Feb., 1, 1947), which moved f-m to its present wave band, brought about the interference which, without the move, could not have existed. That is not, however, the major error in judgment. The major error is the allocation of the frequencies



of an air navigation service to a place within the interference range of f-m and television sets where, with a large number of sets scattered about the country, the chance of something going wrong, even with properly designed sets, must be considered. Why some of the non-vital types of air communication services were not assigned there to serve as a buffer region so that all services adjacent to safety-of-life channels could be under CAA supervision, is something in need of much explanation.

There is likewise a second question which requires answering: Why is the guidance of a ship and its passengers entrusted to a transmitter having the peanut-like power of 200 watts—just about a quarter horsepower, when thousands of horsepower are employed in the other part of the transportation problem—that of keeping the ship in the air? Sound engineering judgment would dictate the use of sufficient power from ground transmitters to override even chance radiations from damaged f-m or tv sets or diathermy machines out of control. Equal lack of foresight came to light a few years ago when planes were provided with superheterodynes for instrument landing operation with insufficient image rejection against f-m transmitters in the center of the band.

The list of mistakes that should not have been made could be continued, but sufficient instances have been given to make the point. Chairman Coy of the Federal Communications Commission is to be commended for bringing into the open a problem which both the Commission and the industry have been aware of for at least two years. This Commission, however, would inspire more confidence were it to admit the mistakes of the former Commission, in whose actions the basic responsibility lies. The present Commission is now face to face with the laws of Nature; it will find that they are as immutable as the laws of the Medes and Persians. A refusal to recognize that a bridge is improperly designed will not prevent the future collapse of that bridge.

I suggest to the Radio and Television Manufacturers Association if it expects to continue to do its own engineering that it take the steps necessary to see either that that engineering is done properly, or that the facts about sound engineering be so plainly presented that responsibility for their violation can be squarely placed. If it does not do this it will find its engineering being conducted for it by some government bureau, perhaps on a lower plane of competence, but none-the-less being conducted for it.

Very sincerely yours,
Edwin H. Armstrong

Memorandum concerning the Observation and Measurement of Radiation Interference from Certain F-M Receivers (included with letter to Dr. Baker):

(1) Laboratory measurements were made with a vacuum-tube voltmeter to determine the magnitude of the receiver oscillator voltage appearing at the antenna posts when terminated with a 300-ohm resistor. The following results were noted:

Receiver Model	*Voltage Across Antenna Terminals*
RCA 8X71	1.0 volt
RCA 8R71	0.4 "
ZENITH S-15840	0.02 "

(2) On the 23rd of June 1949, W. G. Russel, P. Sadenwater and F. Hargesheimer made a field trip to Eastern Long Island for the purpose of observing the interference created by the above f-m receivers. These tests were performed at a distance of aproximately fifty airline miles from New York City.

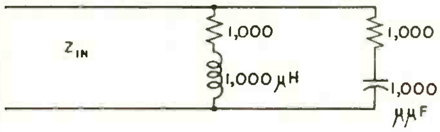
The RCA 8X71 receiver was connected to a folded dipole extending approximately 15 feet above ground. This receiver was tuned so as to generate an oscillator frequency of 101.1 mc to coincide with the transmitting frequency of WCBS-FM. The Zenith S-15840 receiver, connected to a dipole antenna mounted on the roof of the car, was then tuned to WCBS-FM. However, the presence of the undesired signal being radiated from the RCA receiver made reception of the New York station impossible. The automobile containing the Zenith set was then driven away from the location of the RCA set until a position was reached where reception of WCBS-FM was normal and clear. The field strength of the desired signal being received from WCBS-FM was measured with a field strength meter and found to be 35 microvolts at the height of the car antenna (8 feet). Under the above conditions radiation interference was considered to be intolerable whenever the RCA set was located within one-half mile of the receiving position.

A similar test run was performed using the RCA 8X71 to receive the desired signal and the Zenith set oscillator tuned to give an interfering signal. Radiation interference from the Zenith set could not be detected in the RCA 8X71 beyond a distance of 500 feet.

Electronics Quiz

THIS MONTH'S PUZZLER IS submitted by B. Lindeman of Brooklyn, New York. For his contribution, Lindeman will receive our check for $5.00, as will other contributors whose problems appear in this department. Solution to last month's problem appears below.

What is the input impedance and the frequency for which the following circuit has



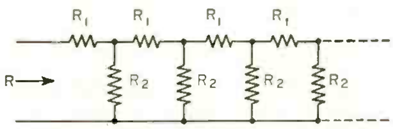
unity power factor (antiresonance)?

Answer will appear next month.

Last Month's Solution

THE PROBLEM for last month, as submitted by Bob Wakeman of Bloomfield, New Jersey, was:

What is the impedance across the input terminals of the



infinite ladder shown? Assuming R_1 to be 2 ohms, and R_2

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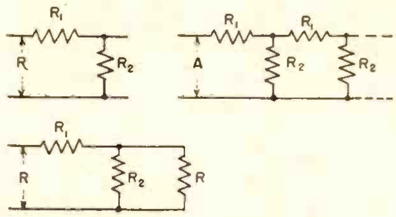
to be 4 ohms, find R.

Solution. If we remove the first section, the resistance across the input to the second section A will



also be R, since we assumed an infinite network. Therefore the problem reduces to

$$R = R_1 + \frac{R\,R_2}{R + R_2}$$

$$R^2 = R\,R_1 + R_1\,R_2$$

$$R = \frac{R_1 \pm \sqrt{R_1^2 + 4\,R_1\,R_2}}{2}$$

The minus sign before the radical would result in a negative R, so it is discarded. Thus if R_1 is 2 ohms, and R_2 is 4 ohms,

$$R = \frac{2 + \sqrt{4 + 32}}{2} = 4 \text{ ohms}$$

Red Face Department

SEVERAL READERS have kindly informed us that the solution to October's puzzle problem, as printed in the November issue, is even more of a puzzle than the original quiz problem itself. According to these hawkeyes, the solution of the integral

$$P = \frac{1}{2\,\pi\,R}\int_0^{2\pi} (e_1 \sin\theta + e_2)^2\,d\theta$$

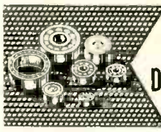
is $\dfrac{e_1^2}{2R} + \dfrac{e_2^2}{R}$

and not $\dfrac{e_1^2}{2R} + \dfrac{e_2^2}{R} + \dfrac{2e_1e_2}{\pi R}$

John C. Schruder, of Purdue University, goes on to point out that the correct solution is in agreement with the well-known principle that a voltage consisting of a d-c component and a sinusoidal component will have an effective value equal to the square root of the sum of the squares of the d-c component and the effective value of the sinusoidal component. We stand corrected. The Editors.

CONTACTS

FOR THE FIELD OF ELECTRONICS



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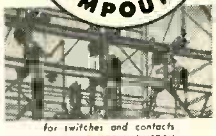

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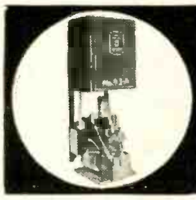

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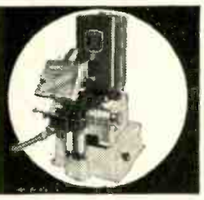

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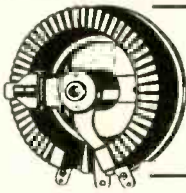

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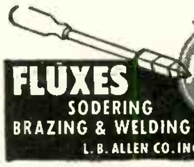

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Mechanical, electromechanical, small instrument. Small parts designed, manufactured, sub-assembled by long-established manufacturer.

Precision Products Division

OSTBY & BARTON CO.
118 Richmond St., Providence, R. I.

WANTED

(Additional Wanted Ads on page 319)

We are empowered to buy for manufacturers and pay highest prices for

RESISTORS TUBES CONDENSERS

Volume controls and other electronic components.

We need everything. Send us your complete lists.

ELECTRONIC SURPLUS BROKERS
3232 Broadway New York, N. Y.
Riverside 9-4955

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INSULATORS; POLE LINE HARDWARE; GUY STRAND WIRE; COPPERWELD WIRE; WESTERN ELECTRIC TOOLS; SPLICING SLEEVES.

VICTOR-BERNARD INDUSTRIES
NE Cor. 22nd & Lehigh Aves., Phila. 32, Pa.

WANTED

WESTERN ELECTRIC VACUUM TUBES

Types 101F, 102F, 272A, 274A or B, 310A or B, 311A, 313C, 323A, 328A, 329A, 348A, 349A, 352A, 373A, 374A, 393A, 394A, 121A Ballast Lamps.

W-6863, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED

Tubes, Test equipment, Condensers, & general inventories. Highest prices paid.

W-7965, Electronics
330 W. 42nd St., New York 18, N. Y.

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Teletypewriters complete, components or parts. Any quantity and condition.

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WANTED TO BUY

PRIVATE LABORATORY Wishes To Purchase For Its Own Use High Grade Test Equipment and Basic Radio Components. Replies Held in Confidence.

W-7171, Electronics
330 W. 42nd St., New York 18, N. Y.

RCA VICTOR
Camden, N. J.

Requires Experienced Electronics Engineers

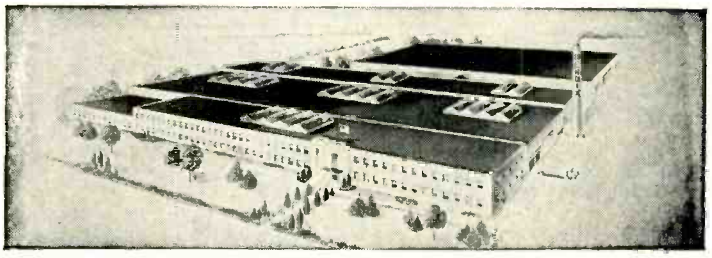
RCA's steady growth in the field of electronics results in attractive opportunities for electrical and mechanical engineers and physicists. Experienced engineers are finding the "right position" in the wide scope of RCA's activities. Equipment is being developed for the following applications: communications and navigational equipment for the aviation industry, mobile transmitters, microwave relay links, radar systems and components, and ultra high frequency test equipment.

These requirements represent permanent expansion in RCA Victor's Engineering Division at Camden, which will provide excellent opportunities for men of high caliber with appropriate training and experience.

If you meet these specifications, and if you are looking for a career which will open wide the door to the complete expression of your talents in the fields of electronics, write, giving full details to:

National Recruiting Division
Box 930, RCA Victor Division
Radio Corporation of America
Camden, New Jersey

ELECTRONIC ENGINEERS
BENDIX RADIO DIVISION
Bendix Aviation Corporation



PRODUCTION DESIGN RESEARCH

Bendix Radio Division, a leader in the field of high quality radar and communications equipment, has positions for engineers experienced in the design and development, for production, of radio and radar equipment or electronic research.

Positions are available at all salary levels.

Good advancement opportunities, air-conditioned plant in suburban location, excellently equipped laboratories, technical library, large experimental engineering model shop.

Housing and rentals in Baltimore are plentiful.

Interviews will be held in Baltimore, Chicago and New York. Please send resume of experience promptly to:

MR. W. L. WEBB, *Director* Engineering and Research
BENDIX RADIO DIVISION
Bendix Aviation Corporation • Baltimore 4, Maryland

RESEARCH ENGINEERS ELECTRICAL ENGINEERS AND PHYSICISTS

THE FRANKLIN INSTITUTE

Laboratories for Research and Development

have openings for personnel with 2-10 years experience. Advanced degrees are desirable in certain of the positions. Fields of interest covered are: Mathematical Analysis of Physical Problems, Statistical Theory of Communications, Electromagnetic Theory, Circuit Analysis, Servomechanism Theory, Electrical Computing, Advanced and Fundamental Circuit Development, Radar and Pulse Circuits, Supervision of Operation of G.C.A. or Tracking Radar, Air Traffic Control Air Navigation, Automatic Controls, Industrial or Marine Power Drives, and Electrical Machinery.

Send resume of education and experience, salary requirements and photograph to:

Personnel Department

THE FRANKLIN INSTITUTE
Philadelphia 3, Pennsylvania

Bachelors, Masters, Ph.D's in PHYSICS or E.E.
Experienced electronic engineers;
supervisory personnel for vital war work

OPPORTUNITY ON LONG ISLAND

for research minded engineers

Offers attractive working conditions, salary commensurate with experience, access to graduate schools, first-rate research and development facilities; other advantages.

Projects underway in fields of microwave receivers, transmitters, antennas; radar, air traffic control; servos, motor control systems; general electronics.

Write PERSONNEL MANAGER

Airborne Instruments Laboratory
INCORPORATED
160 OLD COUNTRY ROAD • MINEOLA, N. Y.

ELECTRICAL ENGINEER

Medium size midwest Company is seeking Electrical Engineer to do research and development work on automatic control problems involving hydraulic and electronic equipment in Aircraft and Industrial field. Knowledge of analytical techniques preferred. Present research group small, but expanding. Good opportunity for the right man. Give resume of education, experience and salary requirements.

Write:

SUNDSTRAND
Hydraulic Division
2531 11th St. Rockford, Illinois

Opportunity with Manufacturer of Electronic, Electro-Mechanical and Radiation Instruments.

1. **Senior Electronics Engineer**
   Requirements:
   5 years experience in design and development of pulse circuits, computers, nuclear instrumentation or video circuits required. Manufacturing or production experience desirable.
2. **Production Engineer**
   Requirements:
   5-10 years experience as electronic and mechanical instrument production engineer in small lot production. Thorough electronic theory grounding.

Send complete resumes and salary requirements.

BERKELEY SCIENTIFIC COMPANY
P. O. Box 1826 Richmond, California

RADAR, COMMUNICATIONS *and* SONAR TECHNICIANS WANTED

For Overseas Assignments

Technical Qualifications:

1. At least 3 years' practical experience in installation and maintenance.
2. Navy veterans ETM 1/c or higher.
3. Army veterans TECH/SGT or higher.

Personal Qualifications:

1. Age, over 22—must pass physical examination.
2. Ability to assume responsibility.
3. Must stand thorough character investigation.
4. Willing to go overseas for 1 year.

Base pay, bonus, living allowance, vacation add up to $7,000.00 per year. Permanent connection with company possible.

Apply by Writing to
A-1, P. O. Box 3414
Philadelphia 22, Pa.

Men qualified in RADAR, COMMUNICATIONS or SONAR give complete history. Interview will be arranged for successful applicants.

ELECTRONICS TECHNICIANS WANTED

The RCA Service Company, Inc., a Radio Corporation of America subsidiary, needs qualified electronics technicians for U.S. and overseas assignments. Candidates must be of good character and qualified in the installation or maintenance of RADAR or COMMUNICATIONS equipment or TELEVISION receivers. No age limits, but must have at least three years of practical experience.

RCA Service Company offers comprehensive Company-paid hospitalization, accident and life insurance programs; paid vacations and holidays; periodic review for salary increases; and opportunity to obtain permanent position in our national and international service organization, engaged in the installation and maintenance of AM, FM and TV transmitters, electronic inspection devices, electron microscopes, theatre and home television, R-F heating equipment, mobile and microwave communications systems, and similar electronic equipment.

Base pay, overseas bonus, payments for actual living and other expenses, and benefits mentioned above add up to $7,000 per year to start for overseas assignments, with periodic review of base salary thereafter. Openings also available at proportionately higher salaries for specially qualified technicians with supervisory ability.

Qualified technicians seeking an advantageous connection with a well-established company, having a broad-based, permanent peacetime and wartime service program, write to:

MR. G. H. METZ
Personnel Manager
RCA SERVICE COMPANY, INC.
Camden 2, New Jersey

RESEARCH AND DEVELOPMENT ENGINEERS

MECHANICAL, ELECTRICAL, and ELECTRONIC ENGINEERS and ENGINEERING PHYSICISTS

Excellent positions on experimental research and development projects related to intricate electro-mechanical and electronic devices.

Men with advanced degrees or equivalent experience may qualify for permanent positions in our laboratories in New York State.

Give full details of education and experience indicating age and marital status.

P-7894, Electronics
330 W. 42 St., New York 18, N. Y.

SENIOR ELECTRONICS ENGINEER

For Design and Development of circuitry for ultrasonic equipment, timing circuits, audio oscillators, amplifiers and audio measuring equipment to meet Navy specifications.

EXPERIENCE REQUIRED:

3-5 years in development of audio or supersonic equipment for government or industrial usage.

EDUCATION:

BS in Physics or EE

DEVELOPMENT TECHNICIANS

At least three years of experience in layout. (Including rough drafting) of electronics chassis. Should also be experienced in electronic testing and trouble shooting.

WRITE:
Personnel Director
Box 30 State College, Pennsylvania

ENGINEERING OPPORTUNITIES *In* Westinghouse

Wanted:

DESIGN ENGINEERS
FIELD ENGINEERS
TECHNICAL WRITERS

Must have at least one year's experience.

For work on airborne radar, shipborne radar, radio communications eqpt., micro-wave relay, or micro-wave communications.

Good pay, excellent working conditions; advancement on individual merit; location Baltimore.

Send resume of experience and education to: Manager of Industrial Relations,

WESTINGHOUSE ELECTRIC CORP.
2519 Wilkens Ave. Baltimore 3, Maryland

PHYSICISTS SR. ELECTRONIC ENGINEERS

Familiar with ultra high frequency and micro wave technique.
Experience with electronic digital and/or analog, computer research and development program.
Salaries commensurate with experience and ability. Excellent opportunities for qualified personnel.

Contact:
C. G. Jones, Personnel Department
GOODYEAR AIRCRAFT CORPORATION
Akron 15, Ohio

ELECTRONIC ENGINEERS

SENIOR ENGINEERS or PHYSICISTS
Degree and experience in Radar, Pulse Circuits, Digital or Analogue Computers, or Servomechanisms
JUNIOR ENGINEERS and recent graduate in EE or Physics.

ELECTRONIC ENGINEERING COMPANY
180 S. Alvarado St. Los Angeles, Calif.

REQUIRE KEY MEN FOR RESEARCH LABORATORIES

Outstanding opportunities now available in undertaking highly responsible research and development work in important electro-mechanical instrumentation laboratories. Require section chiefs with MS or PHD degree in E.E., M.E., or Physics with scholastic achievement in upper 10% of class.

Important to have more than 5 years practical experience in developmental work, supervision of projects or group activities to qualify applicant to supervise and direct several diversified projects and administer related activities.

Men with proven ingenuity, imagination, creative ability and with a record of tangible accomplishments can command attractive salaries.

COOK RESEARCH LABORATORIES
Division of Cook Electric Company
1457 W. Diversey Parkway, Chicago 14, Ill.

LABORATORY PERSONNEL

Excellent opportunities exist for men with Senior Matriculation or equivalent education as Laboratory Assistants. Skill in Electronics, or Physics Laboratory Techniques is required. A knowledge of Machine Shop practice, Photographic Processes and/or Vacuum Techniques is also desirable. Salary range from $1650.00 to $3000.00 per annum depending on qualifications. Living accommodation available. State age, marital status, education and experience. Please quote file 10B.

NATIONAL RESEARCH COUNCIL
ATOMIC ENERGY PROJECT
Chalk River, Ontario, Canada

SENIOR ELECTRONIC CIRCUIT PHYSICISTS

for

Advanced Research and Development

MINIMUM REQUIREMENTS:

1. M.S. or Ph.D. in Physics or E.E.

2. Not less than five years experience in advanced electronic circuit development with a record of accomplishment giving evidence of an unusual degree of ingenuity and ability in the field.

3. Minimum age 28 years.

Hughes Aircraft Company

Attention: Mr. Jack Harwood

CULVER CITY, CALIFORNIA

MECHANICAL DESIGN ENGINEERS

COLLINS RADIO COMPANY, one of the leading manufacturers of radio and electronics equipment, has openings for mechanical design engineers. The work calls for the ability to lay out and design intricate mechanisms consisting of fine pitch gears, cams, and linkages as well as sheet metal structures. A thorough knowledge of working tolerances applicable to the above design functions is essential. Good advancement opportunities, excellent working conditions. Send resume of education and experience to:

Glenn G. Johnson
COLLINS RADIO COMPANY
Cedar Rapids, Iowa

PROJECT ENGINEERS

Five years or more of experience in charge of design and development of radio and communication equipment. Must be a graduate of a credited Engineering School. Well equipped laboratory in modern radio and television plant, with excellent opportunities for advancement.

Send resume of qualifications to Mr. S. F. Cascio, Personnel Director of the Hallicrafters Company
4401 West Fifth Ave., Chicago 24, Illinois

ELECTRICAL ENGINEER

Nationally known electronics firm has need in its Long Island laboratories for engineer with BS or MS to work with group on circuit and miniaturization problems, relating to electronics equipment and techniques. Must be capable of job planning and project control. Minimum 5 years experience in both audio and TV circuits and in tube component design or equipment production. Prefer engineering physicist or electrical engineer with some mechanical design experience and major interest in circuits. *Send complete resume to*

Box EE-381, 221 W. 41 St., N. Y.

SEMI CONDUCTOR RESEARCH

Physicists, chemists or EE's with PhD or equivalent and experience in the field of solid state physics for research work on semi-conductor devices employing germanium and silicon. An excellent opportunity in a research laboratory of a leading manufacturer with laboratories in New York State. Send complete resume. Our employees have been notified.

P-8023, Electronics
330 W. 42 St., New York 18, N. Y.

ELECTRONIC ENGINEERS

DESIGN ENGINEER

Minimum five years experience in electronic development and circuit design for production.

PRODUCTION ENGINEER

Several years experience in electronic equipment production. Experience desirable both in large quantity commercial equipment and high quality equipment to government specifications.

Interesting work and excellent opportunity, with established Los Angeles firm. Possible interview with representatives in East.

P-8156, Electronics
1111 Wilshire Blvd., Los Angeles 17, Calif.

ELECTRICAL ENGINEER

Graduate electrical engineer with a minimum of 2 years experience. For design and development of audio transformers and filters. Permanent position with progressive firm located in Chicago. Give details stating age, education, experience, references, availability for work and salary expected.

P-7849, Electronics
330 W. 42nd St., New York 18, N. Y.

ATOMIC POWER

Westinghouse Electric Corporation

Immediate Openings

For Experienced
Senior and Junior Engineers

- Circuit designers, sequence control and regulating systems.
- Designer of amplifiers for indication, detection and control functions.
- Designer for servosystems in the instrument range.

For application write—

Manager, Technical Employment,

306 FOURTH AVE.
PITTSBURGH 30, PA.

ELECTRONICS ENGINEERS

with a background in patent specification writing desired for an expanding Patent Department in a growing research and development organization located in the Midwest. Unlimited opportunity for advancement for properly qualified men. Law degree unnecessary. Must be U. S. citizen and free to make occasional trips to Washington, D. C. Please give full details in first letter.

P-7752, Electronics
520 No. Michigan Ave. Chicago 11, Ill.

ELECTRONICS Sales Engineers

Positions open for sales engineers having practical experience in application of radio frequency heating. A good knowledge of electronics and of mechanisms, such as are used in quantity production lines, is a requirement. The work involves application engineering and sales of induction and dielectric heating generators and associated work handling apparatus. Locations in Detroit, Boston, Buffalo and Richmond, Virginia. For application write:

Manager, Technical Employment
Westinghouse Electric Corporation
306 Fourth Avenue
Pittsburgh 30, Pennsylvania

ELECTRICAL ENGINEERS

Independent industrial research and development laboratory has openings for electrical engineers with training and experience in the following fields: UHF; Instrumentation; Telemetering; Computers; Servo and Control Systems; and Electromagnetic Devices.

Candidates should have an excellent scholastic record. Advanced degree helpful, but not essential. Requires 2—5 years experience, with record of accomplishment in one or more of the above fields.

Good salaries for outstanding men plus other benefits—such as a retirement plan (immediate vesting), group insurance, and nearby opportunities for graduate work. Excellent opportunities for advancement.

Write, giving survey of qualifications, to

Electrical Engineering Research

ARMOUR RESEARCH FOUNDATION of
Illinois Institute of Technology
Technology Center
CHICAGO 16, ILLINOIS

The W. L. MAXSON CORPORATION

IS SEEKING

Outstanding

ENGINEERS AND PHYSICISTS

with AMBITION to

FURTHER PRESENT STANDING

Immediately

Minimum Requirements are:

1. Five to ten years experience in advanced electronic research and development.
2. Outstanding record of ingenuity.
3. Ph.D., M.S. or equivalent.

Please send resume and salary requirements to:

The W. L. MAXSON CORPORATION
460 W. 34th St.
New York 1, N. Y.

NATIONAL UNION RESEARCH DIVISION

Electrical Engineers and Physicists are needed for research on Cathode Ray, Subminiature, Secondary Emission and other types of Vacuum Tubes.

Permanent interesting positions are available in the following fields:

Tube design & development
Tube processing
High vacuum systems
Solid state physics
Electron optics
Phosphorescence

Men qualified in any of the above are invited to send their resumes to:

Divisional Personnel Manager
National Union Research Division
350 Scotland Rd., Orange, N. J.

CIRCUITS and MICROWAVE ENGINEERS

Rapidly expanding company in instrumentation field has openings for Senior Engineers with several years of experience. Men with Masters or PhD Degrees preferred. Excellent opportunities in field of VHF, UHF and microwave test equipment. Location Brooklyn. Send complete resume to ...

P-8206, Electronics
330 W. 42nd St., New York 18, N. Y.

ELECTRONIC ENGINEERS AND PHYSICISTS

Senior staff positions are available for electronic engineers and physicists with experience in the following fields:

- Radiation Instrumentation
- Computers
- Radar Systems
- Microwave Components
- Servomechanisms
- Telemetering
- Nuclear Physics
- Automatic Controls

If interested in working in a research laboratory separated from immediate production operations, send resume.

Bendix Aviation Corporation Research Laboratories
4855 Fourth Avenue, Detroit 1, Michigan

TECHNICAL EDITORS and WRITERS

These are senior positions, the men selected must be able to outline, compile, edit, proofread, plan and check art, dummy, and direct the final publication of technical and scientific publications.

A good working knowledge of radio and radar theory and application is essential, in addition to extensive editorial and journalistic experience. Some knowledge of structural and mechanical engineering is desirable.

Send complete resume with first letter to:

James E. Thompson
Department 29
HUGHES AIRCRAFT COMPANY
CULVER CITY, CALIFORNIA

All replies will be handled in the strictest confidence.

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COAX CONNECTORS
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DELAY LINES
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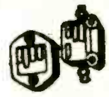

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.00005	.29
.000075	.29
.0001	.29
.00015	.29
.00025	.29
.0003	.29
.0004	.29
.0005	.35
.00075	.35
.00085	.35
.001	.35
.0015	.35
.0016	.35
.0017	.35
.002	.50
.0023	.50
.003	.50
.004	1.79
.005	1.79
.006	1.79
.0063	1.79
.0069	1.79
.007	1.79
.0075	1.79
.0076	1.79
.008	1.79
.01	1.10
.015	1.10
.02	1.10
.025	1.10
.027	1.10
.03	1.10
5000 V Test	
.0015	1.75
.002	2.00
SOLAR XO Solder Lugs 2500 V Test	
.01	.85
.015	.85
.02	.85
.04	.85
.001	.60
.0015	.60
.002	.60
.0022	.60
.0023	.60
.0024	.60
.0025	.60
.0027	.60
.003	.60
.004	.60
.005	.60
.0056	.60
.006	.60
.0063	.80
.0075	.80
.0076	.80
.008	.80
.0085	.80
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Write For Many Others

Trimmer Cond. Variable

15 MMF
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PROJECTION LAMPS
RECORDERS
RESISTORS
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CHOKE SWINGING
9/60Hv .400/.05 Amp 10000V ins. Mfg Super Elect $7.95

FT234A274N Single Xmtr Rack. New $1.69

AMPLIFIER
AM-32/PRS1 less batt w/carry case for Mine Detector AN/PRSI. Price ea. $7.95

Horsie Talkie BC745 Xmtr Revr 3-6Mc w/ITU Less Pwr Supply. . $11.95

PE157 Vibropack for above 2V in. from storage batt in case which is charged from 6V AC or DC contains 5" Speaker & Jacks for Mike & Hdst. Used. exc. cond. $9.95

LP21 LM Radio Compass Loop. Excellent condition. **$10.95**

LM Freq. Meter. No calibration. Book used. Fair As Is. Less Xtal. Special $22.50

TVI Line Filter 110VAC 1 Amp Reject Range .15-150 MC Chassis Mt. Herm sealed 1⅛"x1¼"x2". Price 69c

GP7 Aircraft XMTTR Fair Condition. As Is. Less T. U. $19.95

Avail. in Stock. Dual XMTTR & Dual Rec. Triple Rack Mounts MT63—MT 65-MT71 Bent & Banged Up. Sold As Is. No Refund. Repairable $1.00 ea.

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Line FILTER, GE 100 Amp Filter w/2x5Mfd 50V oil cond. Operates on 110V AC DC $1.98

Aircraft Radio Transmitter CRV 52233. 28VDC ATB Equip. RCA less T. U. As Is $39.95

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ID6 APN4 Scope 5" Loran. Full of Resis. Micas Basic Assay for Scope. N. G. As Is. Less Tubes. $12.95

BC433 Mod or unmod CW Reception 200-1750KC in 3 bands 14 or 24V & 115V AC ADF Radio Compass As Is. Less Tubes.
Poor Condition ... $11.95

BC929A 3BP1 Scope Indicator containing Ant. Switch & Motor w/Tubes 2—6H6GT, 2—6SN7, 1—6H6, 1—6X5, 1—3BP1, 1—2X2. P/o SCR 729 & APN2. New..... $25.95 w/Conver. Dia. to 110V 60 cy.

Motor Driven Yagi Switch 24V 1800 RPM. Price English Type...... $3.95

BC434 CONTROL BOX
Remote Control for 433 Radio Compass contains 0-5MA Meter, Dial Control **$3.95**

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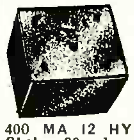
There Are No Shortages of Equipment at C.E.C.

Our warehouses are full of surplus radio, radar, electronic equipment, for your needs, as a manufacturer, jobber, amateur, experimenter, engineer, everything of surplus prices. We own what we sell, phone or write us your needs and let us quote.

Mr. Chas. Rosen
Digby 9-4124



400 MA 12 HY Choke 90 ohms Herm. sealed. Special $3.75

Universal Output Transformer
Amertran Silcor. PRI: 20,000/16,-000/5000/4000 ohms, Sect. 500/15/7.5/5/3.75/1.25 ohms. 30 db. contin. Flat to 17,000 CY. w/ Diag. & Inst. for 6 watt amplifier $4.75

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1.01	128	2230	30000
3	150	4300	33000
5	200	5000	35000
5.05	250	7000	40000
10.1	300	7500	50000
18	430	8500	55000
43.5	468	10000	57000
50	800	12000	75000
75	920	17000	Ship
82	1000	17300	type in
120	1100	20000	stock
125	1450	25000	

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¢

Voltage Stabilizer VR3
95-130V 2.4A 60CY 1ϕ Out. 115V 120 Watt 100% Mfg. Raytheon w/ert Bx Box. Sockets & cable used but good $19.95

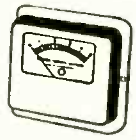
Voltage Regulator VH623
95-130V 1.76A 60Cy 1ϕ CU 115V 150 Watt 100%. Slightly used, excellent $19.95

Heineman Ckt Bkrs for AC-DC operation.

AM1510M	7	AMP
1614	80	AMP
1614	50	AMP
U90	100	AMP

Price ea..... $1.10
P-0322 Dual 10 Amp.
Price ea..... $2.25

METERS



0-5MA SQ 2" Metal Case or 0-10 volt movement readrite meter .... .98¢

0-30V DC Meter Westing. Type AX Aircraft type. Price. $2.49
Multimeter Mvmt. 0-100 Meg. 0-600/50/14VDC (0-5 Ma Basic) 3" Rd Metal Sim to Sipson #23............... $3.95
100-0-100 Microamp 4#" Bake. Same as Model 801 (Weston). Mfg by Sun Elect & Beede Elect. Model 4AW271.
Price ea. $8.75
0-1MA 3⅓" Rd DeJure Mod S-310.
Price ea. $4.75
0-1MA 3⅛" Rd. Same as above. Mfg Sun Mfg. Mod 3AP259, Price ea....... $3.95
0-10MA 3½" Rd. DeJure Mod. S-310.
Price ea. $4.65
0-10MA 3½" Rd. Same as above. Mfg. Sun Mfg. Mod 3AP236. Price ea.... $3.95

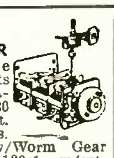
RELAYS

GE CR 2791	
B100—F3	.69
B100—J3	.69
B100—J4	.69
B100—C3	.69
B100—D4	.59
D101—F3	1.10
B109—F36	1.10
G110—F2	.35
C104—B28	1.49
F100—G3	1.49
B106—J3	1.39
J105—AS3	2.95

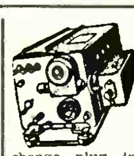
MANY OTHERS

ALLIED BJ		
DPDT	24V	.98
DPDT	28V	.98
SPST	12V	.98
BOX		
DPST	90MA	1.10
3PDT	26V	.98
SPDT	24V	1.10

Write for List of Many other Types



VFO CAPACITOR
High Grade Unit. Consists of 3 Gang Capacitor. 20 mmf per sect. Ceramic ins. Low drift w/Worm Gear (reduction) 120:1 w/ext. Shaft and Veeder 4 digit Counter $3.95



Aircraft Rec. #429 for Mobile or Aircraft Covers from 201 Kc up by interchange plug in tuning units Includes one Tuning Unit: Less Tubes, Rec. Only a few left. $3.95 ea.

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Mfd.	Volt	Price
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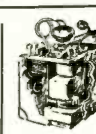
30	350	.48
40	450	.50
40	525	.70
16	350	.35
16	525	.45
16	450	.40
16	100	.24
20	25	.20
20	80	.25
20	450	.40
24	350	.30
8	400	.30
8	150	.15
10	150	.20
10	50	.15
4	50	.10
4	150	.14

RL26 Reel unit Gasoline driven wire laying & pick up unit. Reversible engine. Complete $250.00



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. (Featherweight) $9.49

ARC 5 MODULATOR
MD7/ARC5 w/ dynamotor complete w/Tubes 1-12J5, 2-1625, 1-UR50. Good cond.
Price $8.95

CERAMIC TRIMMER
Stack of 6 Ceramic Trimmers 110-460 Mmf. Can be used singly or ganged....... **69¢**

T.V. Transformer, 110V 60 cy 7" or 9" scope, 3000v/5 MA. 720 vct 200 MA, 6.4 / 8.7 A, 6.4/ .6A 5/3A, 1.25/.3A. New **$3.95**

6V Input Dynamator
Output 150V/ 75MA or 12V Input. 500V/ 50 MA Out. **$3.49**

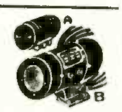
FEED THRU
2¼" L x 1¾" W Type XS1 10c ea. 10 For 50c

866 Filament Xfmr 2x2.5v 6 Amp 8000 V Test Size. Approx 3½" SQ. Easy to Mount.
Price .. $2.95

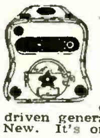
BC-733D SUPERHET RECEIVER
w/10 Tubes, 6 Selector-Relays operate on Xtal Controlled Freq. 108.3-110.3 MC. Can easily be converted to 2 Mtr. ham bands.

R5/ARN 7 Compass Rec.
ADF Rec. 100 to 1750 KC, in 4 Bands 5-Gang Tuning Capacitor w/ 15 Tubes, 4-6K7, 1-6L7, 1-615, 2-6B8, 2-6F6, 1-6N7, 1-6SC7, 2-2051, 1-524. Excellent Cond.

DYNAMOTORS AT SURPLUS PRICES



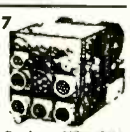
Type	Input Volts	Input Amps.	Output Volts	Output Amps.	Radio Set
PE88	28	1.25	250	.060	RC 36
DM416	14	6.2	330	.170	RU 19
DY-2/ARR-2	28	1.1	250	.060	ARC-5
DM36	28	1.4	220	.080	SCR 508
DM25	12	2.3	250	.050	BC 367
	28	1.25	275	.070	BC 348
DM31A	28	7	540	.250	BC 456
DM42	14	46	515	.110	SCR 506
			1030	.050	
			2/8		
PE10C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	375	.150	
23350	27	1.75	285	.075	APN-1
35C0458	28	1.2	250	.060	
ZA.085	12/24	4/2	500	.050	
ZA.056	12/24	8/4	12/275	3/110	
B-19pack	12	9.4	275	.110	Mark II
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
#5053	28	1.4	250	.060	APN-1
PE 73CM	28	19	1000	.350	BC 375
DM21	14	3.3	235	.090	BC 312
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
			9	1.12	
BD 77KM	14	40	1000	.350	MC 191
PE 94	28	10	300	.200	SCR
			150	.010	522
			14.5	.5	



GIBSON GIRL
The Emergency Radio Transmitter. Send S O S signals automatically on 500KC. 150-mile range. No batteries required. Has hand-driven generator, tubes, wire. New. It's only....... $3.95

PE 157 VIBROPACK FOR BC 745
Runs on 2V DC. Obtained from small Willard Rechargeable battery contained in case which is charged from 6 Vac or DC. Also contains 5" PM Speaker & Jacks for Mike Hdsets. Used, excellent $9.95

RL 9 or RL 7



Interphone Amplifier Convert to High Fidelity Phone Amp. or Spch. Amp. Compl. w/12 A6, 12SL7, 2 Chokes, IXFRMR, DYN for 24v operation, etc. $2.29

CONDENSER TUNING UNITS FOR BC 191
Write up in OCT QST for conv to vhf freq meter

TU	5—	1500 to	3000 KC
TU	6—	3000 to	4500 KC
TU	7—	4500 to	6200 KC
TU	8—	6200 to	7700 KC
TU	9—	7700 to	10000 KC
TU	26—	200 to	500 KC

Price $2.49 ea.

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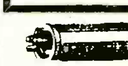


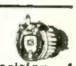
ELECTROLYTICS Prong Mount D. Y. Type

MFD	Volt	Price
8	450	.25
30	450	.29
30	300	.25
40	450	.30
8-8	450	.40
10-10	450	.40
24-24	400	.45
40-40	400	.70
80-50	450-50	.69
50-40	300-250	.60
80-10	450	.69
250 / 1000	10 / 6	.98
20-10	350-300	.40
10-10 / 20	450 / 25	.29
10-30 / 30	450-400 / 300	.59
10-15 / 20	350 / 25	.49
10-50 / 100	350-100 / 50	.69
20-20 / 20	400 / 25	.69
20-10 / 50	450 / 50	.59
20 / 250-100	150 / 15	.79
40-40 / 130	450-150 / 50	.79
40-40 / 20	450 / 25	.69
50-50 / 40	150 / 25	.49
50-50 / 40	200 / 25	.69
80-40 / 150	400 / 50	.79
90-90 / 20	200 / 50	1.10
120-60 / 20	150 / 25	1.10

Many Others Write for List

HEADSETS & MIKES
HS23 8000Ω used Good.......... 2.49
HS 33 600Ω Used Good.......... 2.49
HS 30B Elements 60¢ ea.
HS 30B Ear Plugs 10 for 25¢
Matching XFRHRS Less Cds..... 59¢ ea.
T45 Lip Mikes... 98¢
T30 Throat Mikes 39¢
T30 Ext Cds. w/sw 141 (CD508)..... 1.25
Gas Mask Mike elements.......... 49¢
Cords 3 conductor color coded 42" Long 15¢ ea.
HB4 Headband 30¢ ea.
HB1 Headband 25¢ ea.
HB30 Headband 25¢ ea.

WIRE WOUND POTS



20000Ω Precision 4 watt........... 95¢
5000Ω 1070 8 watt 95¢
20000Ω Precision 8 watt........... 1.25
100000Ω Precision 25 watt........... 1.49
Dual 50Ω 25 watt. 95¢
Dual 250Ω 50 watt 1.95
1000Ω 50 watt... 98¢
200Ω 25 watt.... 69¢
15Ω 25 watt..... 69¢
.5Ω 250 watt..... 2.95

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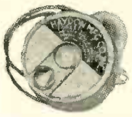
A.C. MOTORS

5071930, Delco, 115 V., 60 Cycle, 7000 r.p.m. **Price $4.50 each net.**



36938-2, Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 4/5 r.p.m. **Price $3.00 ea. net.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 3.2 w., 4 r.p.m., with brake **Price $4.00 each net.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 2.2 w., 1/240 r.p.m. **Price $3.00 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 2.3 w., 1 r.p.m. **Price $2.70 each net.**

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1 1/5 r.p.m. **Price $2.70 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 3.5 w., 1 r.p.m. With shift unit for automatic engaging and disengaging of gears. **Price $3.30 each net.**

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1/60 r.p.m. **Price $3.00 each net.**

Eastern Air Devices Type J33 Synchronous Motor 115 V., 400 cycle, 3 phase, 8,000 r.p.m. **Price $8.50 each net**

Telechron Synchronous Motor, Type B3, 115 V., 60 cycle, 2 r.p.m., 4 w. **Price $5.00 each net.**

Barber-Colman Control Motor, Type AYLC 5091, reversible 24 volts D.C. .7 amps 1 R.P.M., Torque 500 in. lbs. Contains 2 adjustable limit switches with contacts for position indication. Ideal for use as a remote positioner or a beam or television antenna rotator, will operate on A.C. 60 cycle. **Price $6.50 each net**

SERVO MOTORS

CK 1, Pioneer, 2 phase, 400 cycle. **Price $10.00 each net.**

CK 2 Pioneer, 2 phase, 400 cycle. **Price $10.00 each net**

10047-2-A Pioneer 2 phase, 400 cycle, with 40:1 reduction gear. **Price $10.00 each net**

FPE-25-16 Diehl Low-Inertia 20 V., 60 cycle, 2 phase, 1600 r.p.m., 85 amps. **Price $10.00 each net.**

CK2, Pioneer, 2 phase, 400 cycle, with 40:1 reduction gear. **Price $11.50 each net.**

CK5 Pioneer, 2 phase, 400 cycle. **Price $20.00 ea. net.**

MINNEAPOLIS-HONEYWELL TYPE B Part No. G303AY, 115 V., 400 cycle, 2 phase, built-in gear reduction, 50 lbs. in torque. **Price $10.00 each net.**

Kollsman Type 776-01 400 cycle 2 phase drag-up type, fix phase voltage 29, variable phase 35V. maximum, frequency 400 cycle. **Price $10.50 each net.**

REMOTE INDICATING MAGNESYN COMPASS SET

Pioneer Type AN5730-2 Indicator and AN5730-3 Transmitter 26 V., 400 cycle. **Price $40.00 per set new sealed boxes.**

Kollsman Remote Indicating Compass Set Transmitter part No. 679-01, indicator part No. 680k-03, 26 V., 400 cycle. **Price $12.50 each net.**

GYROS

Schwein Free & Rate Gyro type 46800. Consists of two 28 V. D.C. constant speed gyros. Size 8" x 4.25" x 4.25". **Price $15.00 ea. net.**

Sperry A5 Directional Gyro, Part No. 656029, 115 volts, 400 cycle, 3 phase. **Price $17.50 each net.**

Sperry A5 Vertical Gyro, Part No. 644841, 115 V., 400 cycle, 3 phase. **Price $20.00 each net.**

Sperry A5 Amplifier Rack Part No. 644890. Contains Weston Frequency Meter. 350 to 450 cycle and 400 cycle, 0 to 130 voltmeter. **Price $15.00 each net.**

Sperry A5 Control Unit Part No. 644836. **Price $7.50 each net.**

Sperry A5 Azimuth Follow-Up Amplifier Part No. 656030. With tube. **Price $5.50 each net.**

Sperry A5 Autopilot Indicator: contains Pioneer AY20 Autosyn 26 V., 400 cycle. **Price $9.50 ea. net.**

Pioneer Type 12800-1-D Gyro Servo Unit. 115 V., 400 cycle, 3 phase. **Price $10.00 each net.**

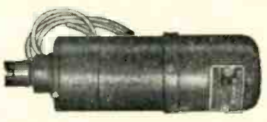
Norden Type M7 Vertical Gyro. 26 V., D.C. **Price $19.00 each net.**

Allen Calculator, Type C1 Bank and Turn Indicator, Part No. 21500, 28 V. D.C. Contains 28 V. D.C. constant speed gyro. **Price $10.00 each net.**

Type C1 auto-pilot formation stick, part No. G1080A3. **Price $15.00 each net.**

GOVERNMENT approved instrument repair station No. 3564.

D.C. MOTORS



5069625, Delco Constant Speed, 27 V., 120 r.p.m. Built-in reduction gears and governor. **Price $4.50 each net.**

C-28P-1A, John Oster Series Motor, 27 V., 0.7 amps., 7000 r.p.m., 1/100 h.p. **Price $4.50 each net.**

Jaeger Watch Co. Type 44-K-2 Contactor Motor, Operates on 3 to 4.5 volts D.C. Makes one contact per second. **Price $2.00 each net.**

General Electric Type 5BA10AJ52C, 27 V. D.C., 0.65 amps., 14 oz. n. torque, 145 r.p.m. Shunt Wound, 4 lead reversible. **Price $5.00 each net.**

General Electric Type 5BA10AJ37C, 27 V.D.C., 0.5 amps., 8 oz., in. torque, 250 r.p.m. Shunt Wound, 4 leads reversible. **Price $6.50 each net.**

General Electric Type 5BA10J18D, 27 V. 0.7 amps. 110 R.P.M. 1 oz. ft. torque. **Price $6.50 ea. net.**

D.C. ALNICO FIELD MOTORS

S. S. FD6-16, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

S. S. FD6-18, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

S. S. FD6-21, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

5069466 Delco 27.5 V. 10,000 R.P.M. **Price $10.00 ea. net**

5069600 Delco 27.5 V. 250 R.P.M. **Price $10.00 each net.**

706343 Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long. **Price $7.50 ea. net.**

5068571 Delco 27.5 V. 10,000 R.P.M. with blower assembly. **Price $10.00 ea. net.**

5071895 Delco 27.5 V. 250 R.P.M. **Price $10.00 ea. net.**

5072400 Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long with worm gear. **Price $6.75 ea. net.**

GENERAL ELECTRIC D. C. SELSYNS

8TJ9-PDN Transmitter, 24 V. **Price $3.75 each net.**

8TJ9-PAB Transmitter 24V. **Price $3.75 each net.**

8DJ11-PCY Indicator, 24 V. Dial marked —10° to +65°. **Price $4.50 each net.**

8DJ11-PCY Indicator, 24 V. Dial Marked 0 to 360°. **Price $7.50 each net.**

AMPLIFIER

Pioneer Gyro Flux Gate Amplifier, Type 12076-1-A. **Price $17.50 ea. net, with tubes.**

G. E. Servo Amplifier Type 2CV2A1, 115 V. 400 cycle. **Price $10.00 ea. net.**

Minneapolis Honeywell Amplifier Type G403, 115 V. 400 cycle. **Price $8.00**

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Leland type 10285, Input 28 V. D.C. at 60 amps. Output 115 V. 3 phase at 750 V.A., 26 V., 400 cycle, single phase at 50 V.A. **Price $100.00 each net**

149H, Holtzer Cabot. Input 28 V. at 44 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

149F, Holtzer Cabot. Input 28 V. at 36 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

12117, Pioneer. Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A. **Price $22.50 each net.**

12117-2 Pioneer. Input 24 V.D.C. Output 26 V. 400 cycle, 6 V.A. **Price $20.00 each net.**

12116-2-A Pioneer. Input 24 volts D.C., 5 amps. Output 115 volts 400 cycle single phase 45 watts. **Price $100.00 each net.**

5D21NJ3A General Electric. Input 24 V.D.C. Output 115 V., 400 cycle at 485 V.A. **Price $25.00 each net.**

PE 218, Ballentine. Input 28 V.D.C. at 90 amps. Output 115 V., 400 cycle at 1.5 K.V.A. **Price $50.00 each net.**

ACTUATORS

White Rodgers Electric Co. type 6905, number 3, 12 V., D.C., 1.3 amps., 1½ RPM, torque 75" in lbs., contains adjustable limit switches. **Price $10.50 each net**

METERS

Weston Frequency Meter, Model 637, 350 to 450 cycles, 115 volts. **Price $10.00 each net.**

Weston Voltmeter. Model 833, 0 to 130 volts, 400 cycle. **Price $4.00 each net.**

Weston Voltmeter. Model 606, Type 204 P, 0 to 30 volts D. C. **Price $4.25 each net.**

Weston Ammeter. Model 506, Type S-61209, 20-0 100 amps. D. C. **Price $7.50 each net with ext. shunt.**

Weston Ammeter. Type F1, Dwg. No. 116465, 0 to 150 amps. D. C. **Price $6.00 each net. With ext. shunt $9.00 each net.**

Westinghouse Ammeter. Type 1090-D-120, 120-0-120 amp. D. C. **Price $4.50 each net.**

Weston Model 545. Type 82PE Indicator. Calibrated 0 to 3000 RPM. 2¾" size. Has built-in rectifier, 270° meter movement. **Price $15.00 each net.**

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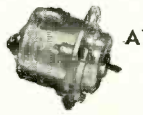
General Electric, Input 230 V. 60 cycle 3 phase. Output 130 amps. at 28 V. D.C. Continuous duty, fan cooled, has adjustable input taps. G.E. model No. 6RC146F. Size: Height 46", width 28", depth 17½". **Price $200.00 each net.** New

PIONEER AUTOSYNS

AY1, 26 V., 400 cycle. **Price $5.50 each net.**

AY14D, 26 V., 400 cycle, new with calibration curve. **Price $15.00 each net.**

AY20, 26 V., 400 cycle. **Price $7.50 each net.**



AY5, 26V., 400 cycle. Has hollow shaft. **Price $7.50 ea. net.**

AY54D, 26 V., 400 cycle, with pointer for I 81 & I 82 Indicator. **Price $10.50 each net**

PRECISION AUTOSYNS

AY131D, new with calibration curve. **Price $35.00 each net.**

AY201-2-A. **Price $35.00 each net.**

PIONEER AUTOSYN POSITION INDICATORS

Type 5907-17. Dial graduated 0 to 360°, 26 V., 400 cycle. **Price $15.50 each net.**

Type 6007-39, Dual, Dial graduated 0 to 360°, 26 V., 400 cycle. **Price $30.00 each net.**

PIONEER TORQUE UNIT

Type 12606-1-A. Price $40.00 each net.

MAGNETIC AMPLIFIER ASSEMBLY

Pioneer Magnetic Amplifier Assembly Saturable Reactor type output transformer. Designed to supply only one phase of 400 cycle servo motor. **Price $8.50 each net.**

PIONEER TORQUE UNIT AMPLIFIER

Type 12073-1-A, 5 tube amplifier, Magnesyn input, 115 V., 400 cycle. **Price $17.50 each net with tubes.**

ALL PRICES, F. O. B. GREAT NECK, N. Y.

BLOWER ASSEMBLY MX-215/APG

John Oster, 28 V.D.C., 7000 r.p.m. 1/100 h.p. **Price $5.00 each net.**

Westinghouse Type FL Blower, 115 V., 400 cycle, 6700 r.p.m., Airflow 17 C.F.M. **Price $5.00 each net.**

RATE GENERATORS

F16, Electric Indicator Co., two-phase, 22 V. per phase at 1800 r.p.m. **Price $12.00 each net.**

J36A, Eastern Air Devices, .02 V. per r.p.m. **Price $9.00 each net.**

B-68, Electric Indicator Co., Rotation Indicator, 110 V., 60 cycle, 1 phase. **Price $14.00 each net.**

PM-1-M Electric Indicator Co. Same as type B35. 2 V. per 100 R.P.M. Max. speed 5,000 R.P.M. Can be used as D.C. motor, 1/77 H.P. 115 V. D.C. **Price $9.75 ea. net.**

SINE-COSINE GENERATORS

(Resolvers)

FPE 43-1, Diehl, 115 V., 400 cycle. **Price $20.00 each net.**

SYNCHROS

1F Special Repeater, 115 V., 400 cycle. Will operate on 60 cycle at reduced voltage. **Price $15.00 each net.**

2J1F3 Selsyn Generator 115 volts, 400 cycle. **Price $5.50 each net.**

2J1G1 Control Transformer, 57.5/57.5 V., 400 cycle. **Price $1.90 each net.**

2J1H1 Selsyn Differential Generator, 57.5/57.5 V., 400 cycle. **Price $3.25 each net.**

W. E. KS-5950-L2, Size 5 Generator, 115 V., 400 cycle. **Price $10.00 each net.**

1G Generator 115 V., 60 cycle. **Price $40.00 each net**

5G Generator 115 volts, 60 cycle. **Price $50.00 each net.**

5SF Repeater, 115/90 V., 400 cycle. **Price $19.00 each net.**

2J1F1 Selsyn Generator, 115 V., 400 cycle. **Price $3.50 each net.**

5SDG Differential Generator 90/90 V., 400 cycle. **Price $15.00 each net.**

1CT Control Transformer, 90/55 volts, 60 cycle. **Price $40.00 each net.**

POSITION TRANSMITTER

Pioneer Type 4550-2-A Position Transmitter, 26 volts 400 cycle, gear ratic 2:1. **Price $15.00 each net.**

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12GP7	12.85	FG-95	20.60	GL-415/5550	22.00
1P24	.79	FG-105	10.95	8020	1.39
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- Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output—AC 115V 10.4A 800 to 1400 cy 1 ϕ; DC 30 Volts 60 Amps. Brand New — Original Packing $38.50
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- Type 12073-1A Torque Amplifier, Input 115 V 400 cy. Complete with Tubes................$14.95
- Magnetic Amplifier Assy. Saturable Reactor Type to supply one phase of 400 cycle Servo Motor $5.95

COAXIAL CABLE

REG-8/U—$65.00 per 1000 ft.—Other types in stock

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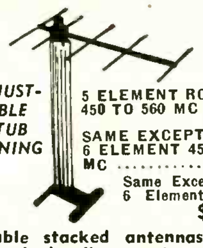
7.5 E3-1-200-67P, 7.5 KV, "E" Circuit 1 microsec. 200 PPS, 67 ohms imped. 3 sections........$4.30
7.5 E3-3-200-67P, 7.5 KV, "E" Circuit 3 microsec. 200 PPS, 67 ohms imped. 3 sections........$6.75
7.5 E4-16-67P, 7.5 KV, "E" Circuit 4 sections. 16 microsec. 60 PPS, 67 ohms imped........$8.25
15—E4-1.5-600-50P, 15 KV "E" Circuit 1.5 microsec. 600 PPS, 50 ohms imped. 4 sections..$12.00
15—E6-5-180-50P, 15 KV, "E" Circuit 5 microsec. 180 PPS, 50 ohms imped. 6 sections......$25.00

ASB YAGI ANTENNA



ADJUSTABLE STUB TUNING

5 ELEMENT ROTATABLE ARRAY—450 TO 560 MC **$7.00**

SAME EXCEPT DOUBLE STACKED 6 ELEMENT 450 TO 560 MC **$12.70**

Same Except Double Stacked 6 Element 370 to 430 MC **$29.40**

Double stacked antennas can be supplied with hydraulic remote controls at $29.50 per set additional.

SELENIUM RECTIFIER STACKS

FULL WAVE BRIDGE

MAXIMUM RATINGS AC VOLTS INPUT - 18 DC VOLTS OUT - 14.5		MAXIMUM RATINGS AC VOLTS INPUT - 40 DC VOLTS OUT - - 34	
1.2 Amps	$2.64	0.6 Amps	$3.00
2.4	3.07	1.2	3.44
6.4	4.09	3.2	5.15
13.0	7.67	6.0	9.32
17.5	8.69	9.0	10.05
26	15.33	12	18.64
39	23.00	18	20.12
52	30.67	24	35.96
65	38.33	36	41.24

All voltage and current ratings based on continuous operation in 35°C. (95°F.) ambient, self-cooled. Current ratings can be increased up to 2½ times normal ratings by intermittent operation or forced cooling.

PULSE TRANSFORMERS

UTAH 9262..............................$2.75
UTAH 9278..............................$2.75
G. E. 68G-627..............................$4.75
AN/APN-9 (901756-501)..............................$1.50
AN/APN-9 (901756-502)..............................$1.50
AN/APN-4 Block, Osc..............................$1.25

W. E. MERCURY CONTACT RELAYS

Glass sealed mercury wetted SPDT contact assemblies. Magnetically operated. Used in Western Electric D-168479 high speed plug in relays. Supply your own coil ....$2.00 each

CONSTANT VOLTAGE TRANSFORMERS

Federal Constant Voltage Transformer Input 95-135V 50/60cy Output 115V 210W..................$34.00
Sola Constant Voltage Transformer Input 95-125V 60cy-Output 15.8V 285VA..................$24.70
Sola Constant Voltage Transformer Input 105-125V 60cy-Output 115V 80VA..................$15.95

TYPE "J" POTENTIOMETERS

75¢ each

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
100	SS	10K	SS	100K	5/16"
200	SS	15K	½"	100K	⅜"
500	½"	15K	SS	100K	7/16"
650	½"	20K	SS	100K	SS
5000	⅝"	25K	1½"	150K	½"
6500	SS	25K	SS	200K	SS
10K	⅝"	30K	1⅛"	250K	SS
10K	½"	50K	SS	1 MEG	SS

Triple 100K - ⅝" Shaft - 1.47
All shaft lengths beyond bushing - SS (screw slot)

STANDARD BRANDS ONLY

TUBE SPECIALS

BRAND NEW FIRST QUALITY

COMPLETE STOCK OF RECEIVING, TRANSMITTING, CATHODE RAY, THYRATRON, IGNITRON, MAGNETRON, KLYSTRON, PHOTOCELL, T-R & ATR TUBES.
QUOTATIONS UPON REQUEST

WESTINGHOUSE HYPERSIL TRANSFORMER

PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A
WT. 30 LBS.

$11.50 EACH

KOLLSMAN INSTRUMENT

LOW INERTIA SERVO MOTORS

Type 937-0240—85/68 Volts—100 Cycles 2 Phase—5 Watts—2650 RPM
Will Operate Satisfactorily at 60 Cycles
Original Price $34.50—Our Price—$8.22 ea.

$7.50 EACH—Lots of 10

SOUND POWERED TELEPHONES

- U. S. INSTRUMENT Type A-260
- WESTERN ELECTRIC Type D-173013
- AUTOMATIC ELECTRIC Type GL-832BA0

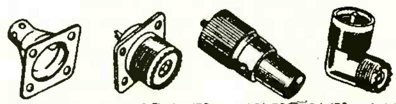
U. S. NAVY TYPE M HEAD AND CHEST SETS

These are high quality heavy-duty units not to be confused with cheaper units now available. Designed to withstand exacting shock, vibration, salt water corrosion, temperature and pressure tests. ANY TYPE ....$14.88 ea., $28.00 per pair.
TS-10 HANDSETS ....$8.92 each

MISCELLANEOUS EQUIPMENT

ID-6APN-4 Indicator $29.50
R-7/APS-2 Receiver 49.50
R-78/APS-15 Receiver 49.50
SCR-522 Transceiver 32.50
RT-7/APN-1 Transceiver 8.95
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........................ 30.00
BC-1206-CM2 Receiver 7.95
AIA Antenna—3cm conical scan........................120.00
AT-38A/APT antenna (70-400 MC)........................ 13.70
AT-49/APR-4 antenna (300-3300 MC)........................ 13.70
CY-230/MPG-1 Radar Console........................575.00
G.E. Type JP-1 portable current transformer.. 32.50
AT-8/AP Antenna 3.95
ASB-4 Radar equip. Complete........................ 69.75
DZ-2 loop antenna with pedestal........................ 14.50

COAXIAL CONNECTORS



83-1AC	.42	UG-12/U	.63	UG-86/U	1.22
83-1AP	.15	UG-21/U	.67	UG-87/U	.79
83-1F	1.12	UG-22/U	.86	UG-171/U	1.33
83-1H	.10	UG-23/U	.85	UG-175/U	.15
83-1J	.80	UG-24/U	.67	UG-176/U	.15
83-1R	.40	UG-27/U	.68	UG-180A/U	3.82
83-1SP	.40	UG-29/U	.83	UG-191/AP	.63
83-1SPN	.40	UG-30/U	1.20	MX-195/U	.41
83-1T	1.12	UG-34/U	12.80	UG-197/U	1.33
83-22AP	1.10	UG-36/U	12.80	UG-206/U	.63
83-22F	1.48	UG-37/U	12.80	UG-255/U	1.22
83-22R	.48	UG-58/U	.63	UG-264/U	1.74
83-22SP	.85	UG-85/U	.88	UG-290/U	.85

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

COMPONENT SPECIALS

FUSES	4AG	10 Amp.	$3.00/c
	4AG	20 Amp.	$3.00/c

MOLDED PAPER CONDENSERS—

.02 MFD	200 VDC	.04½ Ea.	$3.00 per 100
.05	200	.04½	3.00
.1	200	.04½	3.00
.25	200	.06	4.00
.1	400	.09	6.00
.005	600	.04½	3.00
.01	600	.07	4.75
.05	600	.08	5.50

CRYSTAL DIODES—

1N21	.79	1N22	.89	1N34	.69
1N21A	1.19	1N23	1.19	1N45	.94
1N21B	2.25	1N27	1.09	1N63	1.39

Phase shift capacitor—Type D—150734—4 stator single rotor $2.69

HIGH VOLTAGE MICA CAPACITORS—

Type G-1	.004 mfd	6 KV	$6.35
Type G-3	.00015 mfd	20 KV	12.70
Type UC-3260	.0005 mfd	20 KV	6.90
Type UC-2317K	.0035 mfd	4 KV	3.15
Type UC-2938K	.002 mfd	5 KV	3.15
Type UC-3135A	.00005 mfd	35 KV	11.90

OIL-FILLED CAPACITORS

50 MFD	220 VAC	$3.95
60 MFD	330 VAC	$5.75
32 MFD	2500 VDC	$12.80
7 MFD	660 VAC	$2.95
3.5-.5 MFD	1000 VDC	.95
.1 MFD	7000 VDC	$1.79
.045 MFD	16 KVDC	$4.70

SPECIAL
2 MFD 12,500 VDC
INERTEEN TYPE FP
$23.95

RCA HI-VOLTAGE TRANSFORMER

Pri—115/230V. 60Cy
Sec—6000V—80 MA

$11.80

Insulated for Voltage Doubler Use

TEST EQUIPMENT

- Alfred W. Barber Labs. Mod. VM-25 VTVM * $86.00
- General Radio Model P-500A Standard Signal Generator (Same as G. R. 805A except covers 9KC to 32 MC) ....* $450.00
- TS-10A/APN Delay Line Test Set.........$25.00
- TS-19/APQ-5 Calibrator $75.0
- AT-48/UP "X" Band Horn..................$3.95
- REL W-1158 Frequency Meter 160-220 MC..$32.95
- CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars $39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC..............................$11.75
- TS-146/AP X-Band Test Set. Price on request.
- TS-184/AP. ....Price on request.
- CPR-60AAJ and CPR-60AAK—IFF Test Sets, (pair) $16.95

AN/APA-23 Recorder $147.50
TN-18/APR-1 Tuning Unit..................$95.00
- C-D Quietone Filter Type IF-16 110/220 V AC/DC 20 Amps ....* $9.00

All Items New Except Where Noted * (Exc. Used Condition)

FILAMENT TRANSFORMERS

(All 115V 60cy primary except where noted)

UTC	herm. sealed	5V @ 1A	1.22
UTC	herm. sealed	6.3V @ 0.6A	1.33
UTC	herm. sealed	6.3V @ 3.2A	2.21
Raythoen	herm. sealed	6.3VAC @ 0.6A	1.35
Raytheon	herm. sealed	6.3VCT @ 3A, 6.3V @ 0.5A	2.31

G.E.—6.3V @ 13A, 6.3V @ 1.2A 3.82
Pri. 115/230V—Sec. 11V @ 15A-25KV insul. 48.00
Pri. 115/230V—Sec. 9VCT @ 35A.............7.65
Amertran—5V @ 190A—35KV insul. 19.50
6.3VCT @ 5A, 6.3VCT @ 2A, 6.3VCT @ 2A, 2½VCT @ 5A, 2½VCT @ 5A.............4.77

GENERAL ELECTRIC AMPLIDYNE Motor-Generator

Consists of G.E. 1HP 115V 1 ph 60 cy 11.5A 8450 RPM continuous duty motor coupled to G.E. model 5AM65FB31 250V DC 2A 0.5KW 3450 RPM Amplidyne generator.

Brand New $107.50

MONTHLY BULLETINS

SEND IN YOUR NAME AND ADDRESS TO GET ON OUR MAILING LIST

All material brand new and fully guaranteed. 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.

LECTRONIC RESEARCH LABORATORIES

1021-A CALLOWHILL ST. PHILA. 23, PA.
Telephones - MARKET 7-6590 and 6591

Exceptional Values From

AMERICA'S LARGEST ELECTRICAL CONVERSION HOUSE

Ideal AC to DC MG set 300 watts. Rebuilt like new. Ideal MG Set, operative at 110/220 VAC..single phase Output: 120 VDC, 2.5 amperes. Special Price $79.50

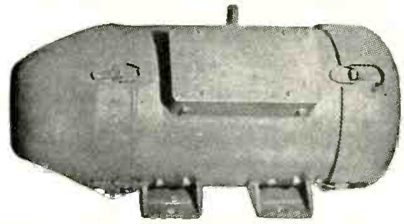
MARATHON MOTOR GENERATORS

Input at 110 VDC Output 110VAC, 1 phase, 60 cy. 500 VA. Marine Type with voltage regulator and frequency controller. Rebuilt LN $75.00
Same unit as above with 32 VDC Input and 300 VA Output.......................$64.00

CENTURY MOTOR GENERATOR SETS

7.5 KVA; 230 Volts, DC to 115 Volts, AC, single phase, 60 Cycles. Complete with automatic controller and push button station $445.00

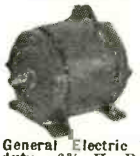
ALLIS-CHALMERS MOTOR GENERATOR



Input: 115 VDC at 14 amp. 3600 RPM. Ball Bearings. Output: 1.25 KVA; 80% PF 120 Volts, AC, 1 Ph. 60 cyc. 10.4 amp. Centrifugal automatic controller permits line start operation. Fully enclosed. **Brand New $99.95.** Also available for 230 VDC operation at the same price.

GEN. ELECTRIC TRANSFORMERS

1 KVA: 460/230-230/115. Brand New. $19.60
Used, guaranteed, do..............$12.50
5KVA, Auto transformer 110/220. Brand New $26.00



General Electric Synchronous Motor or Alternator; excitation 2 Volts; operating at or delivering 110 volts, 3 phase, 60 cycles at 1800 speed; no name plate, but lab tests determined specs as above $9.50

General Electric Type B Flange Motor for hoisting duty. 6¾ H. P. separately excited. Marine Duty. Brand New, original cases; 235 Volts, DC. 1100 RPM $85.00

ONAN 800 CYCLE MG SETS: Operative at 110/220 VAC, 1ϕ, 60 cyc. belted to alternator rated 1.5 KVA: 115 V, 1 ϕ, 800 Cy...............................$251.00
Above unit with 220/440-3-60 motor............$227.00
ONAN 500 CYCLE MG SETS; 4 KVA—Operative with 110-220 VAC, 1 ϕ, 60 Cy. Motor, rep-ind. Output single ph $490.00
With 3 Ph. 220/440 Motor.......................$440.00
GE Relays; 110 VAC—10 Amp. 60/60 cy. in steel case 5 x 5 x 6½...$3.90

Westinghouse Transformer Controller contains 300 watts 120-220 volt transformer with multi-taps. The transformer with tap switch alone is worth more than **the special price**.......................$6.25

TAPE WINDERS

These tape winders consist of a motor operative at 110 volts D. C., .6 amperes: 180 speed. A motor which is separable from the rest of the unit and which can be employed for a multitude of purposes, alone or with the gear reduction box to which it is connected. Motor is shunt wound and the speed thereof is controlled by a built-in rheostat. This makes an invaluable laboratory unit. Special Price.................................$10.99

G. E. OIL FILLED OUTDOOR TRANSFORMERS

Brand New. 3 KVA; Type HS 3000/5200Y-115/230. Also 6000/10,400Y-115/230. Brand New. Either type Special.......$40.00

HOLTZER-CABOT MG 149F

Input 28 Volts, DC at 36 amps. Output 26 Volts at 250 V. A. 400 cps. and 115 Volts at 500 V. A., 400 cycles. Rebuilt like new $24.75

GEN. ELECTRIC AMPLIDYNES

Model 5AM78AB47: 750 watts; Input: 440-3-60; Output: 250 Volts, DC; 3 amperes; 3450 RPM $185.00 Coupled directly to control motor on common base. Model 5BC76AB109; 60 volts, D-C. 12.5 amp. Special $255.00
Model 5AM78AB50A; 1500 watts input: 440-3-60; Output: 250 Volts, DC; 6 amperes; 3450 RPM....$225.00
Model 5AM78AB10; Input: 32 VDC, 60 amp. 2 H.P. 2200 RPM; Output: 250 Volts, D.C. 3 amperes; 750 watts $165.00
Model 5AM45DB20: Input: 115 Volts, single phase, 60 cyc. 5 Amps. Output: 250 Volts, D. C. .6 amp. 150 watts. 3450 RPM..............................$58.50
Model 5AM49AB30: Input: 440 Volts, 3 phase, 60 cyc. 1. amp. output: 115 Volts, D. C. 3.25 amp. 3450 RPM $78.50
Model 5AM49AB3; Input: 440 Volts, 3 ph. 60 cyc. 1 amp. Output: 250 Volts, D. C. 1.5 amp. 375 watts. $88.00
Model 5AM73AB58: Input: 110/220 volts, single phase. 60 cyc. Output: 250 Volts, D. C. 1.5 amp. 375 watts. 3450 RPM $78.00
Model 5LY132A4: Input: 440 Volts, 3 ph. 60 cy. 3.5 H.P. 7 amps. 3570 RPM; Output: 105 Volts, D. C. 18 amp. 1.9 K. W...................................$225.00
Model 5AM610A10 Amplidyne Generator. 3 K.W. 125 Volts, DC 24 amp. 1765 RPM. BB, DP......$160.00
Input: 27 VDC, 44 amp. 8300 RPM. Output: 60 VDC, 8.8 amp. 530 watts...................................$11.45

WESTINGHOUSE TRANSFORMERS

399 VA: 115/240 Volts; Brand New.
SPECIAL PRICE $4.65

GENERAL ELECTRIC DC/AC MG SETS

Four Bearing Marine Units: 25 HP 230 Volts, DC coupled to alternator 18.75 KVA; 80% PF; 1800 RPM Output: 115 Volts, AC. Single Ph. 60 cycles. Ball Bearings. 4 bearing set; marine duty. Brand New. $545.00

HERE IS EXCEPTIONAL VALUE

Robbins and Myers Motor Generator Units. Operate at 110 Volts, AC, single phase, 60 cyc. and deliver 32/40 Volts, DC. Can be used with field rheostat to supply 24/28 VDC for the operation of aero equipment from lighting line. Rated at 40 watts but will deliver 200 watts for intermittent operation. Gear head built into one end rotates external shaft at 225 RPM. An exceptional value at $18.75 each. With field rheostat $20.00. Also available for operation at 115 VDC at $12.50 and with rheostat at $13.75 each. Both units have 1/4 HP Motor. Stock up on these sets while they are available. Special price on quantity. Rebuilt.

Electric Specialty High Frequency Converter Units. Primary: 32 VDC, 16 amperes, 3000 R.P.M. Ball Bearings. Secondary: 350 volts, 1500 cycles. .75 amps. 275 V.A. Single Ph. Built-in frequency control. Specially Priced at....$30.00

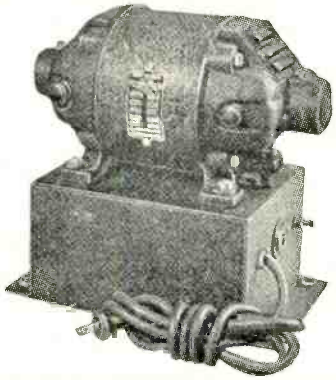
ELECTRIC SPECIALTY FREQUENCY CHANGERS Type BFS52/BFRS354 Input: 220 Volts, 3 Ph. 60 cyc. 3600 RPM. Output: 250 Volts, 20 amp. single ph. 180 Cyc. 5000 VA. 3000 Watts. Brand New. Compact ball bearing units for operation of Hi-cycle equipment. SPECIAL PRICE $160.00
GENERAL ELECTRIC HIGH FREQUENCY UNIT. Operative at 440-3-60 .75 amp. Output: 70 Volts, 3 ph. 148 cyc. 220 Watts, 1.8 amperes. An ideal unit for experimental work or for operation of equipment. SPECIAL PRICE $34.50

INDUCTION VOLTAGE REGULATOR

Type IRT, form M. 1.64 KVA, 3 phase, 60 cycles, cont. duty. Outdoor service. Primary: 208 V., 10.5 load amps. Oil-filled. Wgt. 365 lbs. 33 x 17" x 14"...............$83.00

G. E. MOTOR CONTROLLED VOLTAGE REGULATOR

Cat. #837625, Type 'Tirs', Form — .568 KVA cont. duty, 60 cy., Primary volts 115, Load Amps 16.2. Indoor service. Voltage controlled by mtr. 120/1/60/1/40 HP..............$39.50
Send for list of other sizes in stock.



JANETTE ROTARY CONVERTERS

110 VA. Input: 110 VDC; Output: 110 VAC, single phase, 60 cycles; 3600 speed. With filter for elimination of radio interference. Reliably Rebuilt. Special Price $19.95

PINCOR ROTARY CONVERTERS

300 VA; Filtered; Brand New. Input: 115 VDC, 4.2 Amp. Output: 220 VAC, 1.36 Amp.
SPECIAL PRICE $38.00

KATO ROTARY CONVERTERS

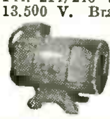
Type 1205A Model 26KA54 Input: 24 VDC, 28A. 1800 RPM. Output: 115 VAC 1 phase 60 cy. 1 KVA. Compact and ruggedly built for cont. duty oper. Filtered. Shock mounted. New $90.00

ONAN HIGH FREQUENCY MG UNITS

ONAN 400 CYCLE MG SETS; 4 KVA—Operative with 110/220 VAC, 1 ϕ, 60 Cy. Motor rep-ind. Output single ph $535.00
With 3 Ph. 220/440 Motor...........................$545.00

500 CYCLE M-G SETS

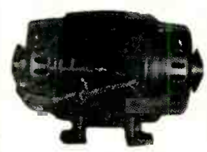
British made motor generator, 8 KW, 2 bearing unit, input 180-240 VDC, output 180 volts, 1 ϕ weight app. 1000 lbs. price......................................$425.00
RAYTHEON HIGH VOLTAGE TRANSFORMERS: Pri. 214/246 Volts; Sec: 5500 Volts, 1.0 amperes; test 13,500 V. Brand New..............................$72.00



ESCO CONVERTERS

Rebuilt like new. Input: 86 VDC 2.85 amp. 3600 R.P.M. Output: 115 VAC, 2.18 amp. .50 P.F. Ball Bearings, Base for table or side mounting. Special $9.80

ESCO DC/AC MG SETS. Motor: 115 Volts, 1½ HP, line start; built in voltage regulator, frequency control. filtered; ideal for television, radar or any application requiring constant voltage and frequency. Output: 115 V.A.C. 1ϕ, 60 Cyc. 460 V.A. Brand New......$120.00



ESCO DC/DC Motor Generator Units

Operate at 220 Volts, DC to deliver 110 Volts, 3.5 amperes. Two of these units can be used on 220 VDC to obtain 110-0-110 Volts DC. **Special Price $18.50**

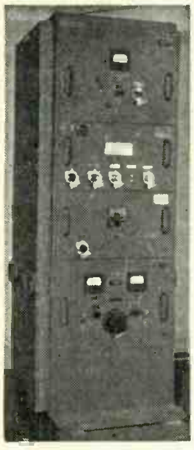
Westinghouse 400 V.A. power factor corrected reactors for mercury vapor lighting. Special Price......$4.65
Jefferson Transformers Trans. 460/230/115. 1 KVA—$16.50; 1½ KVA—$23.50; 2 KVA—$31.00.

IF IT'S FROM ONE FREQUENCY TO ANOTHER; FROM DC TO AC OR AC TO DC; IF IT'S FROM ONE VOLTAGE TO ANOTHER, THEN CALL ON US.

Established in 1922 **WILLIAM I. HORLICK COMPANY** *Tel HAncock 6-2480*

409 ATLANTIC AVE. **BOSTON 10, MASSACHUSETTS**

ARROW has the VALUES!



RADIO EQUIPMENT

RC 100 B

This equipment made by General Electric, was designed for ground use as an identification of friendly aircraft.

CABINET CH-118 is of the Standard 19 inch rack type structural steel frame with runner angles for each of the units. A full length access door with safety interlocks forms the rear of the cabinet..$34.95

TRANSMITTER BC-769 is designed to transmit RF pulsed signals at 470 megacycles with the use of the two type 15E Tubes operating in push-pull with resonant grid, plate and filament lines......$19.95

KEYING UNIT BC-770 furnishes the pulse of the Transmitter..$14.95

RECEIVER BC-768 was used to detect the 493.5 megacycle reply pulses from the interrogated station and to sufficiently amplify these signals for oscilloscope observation............$19.95

RECTIFIER RA-52 produces the high voltage. An 0-15 kilowatt DC Meter is connected across the output of the filter to measure the voltage fed to transmitter BC-769, while an 0-20 milliammeter is connected to the ground return to measure the average current drawn $74.50

AIR COMPRESSOR M-349 together with 12 feet of ¼ inch soft copper tubing and necessary hardware is used to fill and maintain transmission lines with dry air under pressure. Operation is direct from 110 V AC 60 cycles $42.50

OVEN M-348 is furnished for removal of moisture from the dehydrating cylinders of the compressor. It too operates from 110 V AC 60 cycles............$29.50

FREQUENCY METER BC-771 is used for frequency checking and for tuning operations on Radio Transmitter BC-769 and Radio Receiver BC-768. It is a separate unit mechanically and has its own power supply, which requires a 110 to 120 Volt, 50 to 60 cycle source $49.50

TECHNICAL MANUAL TM11-1113B covering entire equipment $5.00

COMPLETE UNITS are available at amazing low price . . . WRITE TODAY!

TUBE SPECIALS!

211	$ .39	803	$2.89	832A	$7.95		
307A	5.50	805	3.29	837	1.19		
703A	1.89	807	1.89	841	.49		
723A/B	12.95	813	6.95	860	4.95		
724B	1.89	832	2.95	864	.24		

CONDENSERS

	Each
1 mfd 6000 VDC, OIL FILLED	$1.98
.00025 mfd. 25000 VDC. OIL FILLED	2.95
1 mfd. 600 VDC. OIL FILLED	.24
	5 for 1.00
50 mmfd—5KV—5 Amp. Vacuum Cond.	1.19

IS-185 Weston Voltmeter Model 433—0 to 150 VAC 25 to 2400 cycles. New **$24.95**

BC-604 TRANSMITTER FM 20-28 MC

11 and 15 meters. Can be operated on 10 meters—10 channel push button crystal. With all tubes and meter but less dynamotor. Excellent Condition....... **$19.95**

Crystals—Set of 80............ **$19.95**

BC 603

Receiver—Good. Used **$24.95**

Complete **SCR-508** Installation available — price and information upon request.

BC 620

Receiver-Transmitter—2 crystal channels—20 to 27.8 MC FM—13 tubes. Metered, Plate and Filament ....Used $9.95

PE 97 or **PE 117** or **PE 120** Power Supply for above 6-12 volt vibrator type.
Used less tubes, vib. & con.........$2.95
Used, complete $6.95

FT 250 Mount for both BC 620 and PE 97 New $1.50

BC 223

Brand new **Transmitter** with all three tuning units, two tuning unit cases, spare tube carrying case, shock mount and brace; but less tubes at new low price of **$29.95**

Set of 5 tubes............$3.95

Tuning units are available separately at Ea. $2.50

PE 125—12-volt Vibrator Pack...New $12.95 Used 8.95

BC 906—Frequency Meter

Range 150-225 MC with modification possible for lower frequencies of TV, etc. Contains 0-500 DC microammeter and uses Battery pack of 1.5 V and 45 VDC.
Like New—Less Batteries...... **$10.95**

All shipments FOB warehouse. 20% Deposit required on all orders. Minimum order accepted—$5.00. Illinois residents, please add regular sales tax to your remittance.

RC 150 EQUIPMENT

Receiver BC 1161 A	New	$29.95
Transmitter BC 1160 A	New	29.95
Control unit BC 1162 A New but less tubes		14.95
Signal Generator I 198 A	New	24.95

AS-138/ARN—10 inch streamline loop as used with direction finding receivers. Fixed position, it is ideal for planes, boats, automobiles. New **$1.95**

SURPRISE PACKAGE

20 lbs. Ass't radio parts. A $25.00 value for only.......... **$1.95**

TEST EQUIPMENT

EV-10	Precision Vacuum Tube Test Set	used	$28.00
No. 772	Weston Multi Tester	used	40.00
No. 492	Radio City Products. Volt-Ohm Meter	used	25.00
No. 471	Radio City Products Output Meter	used	10.00
No. 803	Radio City Products Tube Tester & Set Tester	used	35.00
No. 777	Weston Tube Checker	used	29.00
No. E 200	Precision Signal Generator	used	25.00
No. M-652	Jackson Audio Oscillator	used	30.00
No. 224 A	Dumont Oscilloscope	used	80.00
No. 155 A	RCA Oscilloscope	used	90.00
No. M-840	Triumph Oscilloscope	used	75.00
BC-1287	Oscilloscope	used	75.00
BC-221	Frequency Meter	Like New	90.00
	Others as Low as		49.50

PRICES UPON REQUEST

I-98-A	TS13/AP
I-114 P/O RC-68	TS16/APN
I-135 P/O IE-17	TS19/APQ5
I-167 Weston Anal. #772	TS27/TSM-1
	TS34/AP
I-183 Freq. Meter	TS36/AP
I-185 Oscillator	TS47/AP
I-187 Synchronizer	TS59/APN-1
I-189 Calibrator	TS62/AP
IE-19	TS102A/AP
IS-185 Voltmeter	TS126 AP
TS3/AP	TS-251 Less Xtal
TS10A/APN	

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	Used	New
ASB 7 Indicator Scope	$12.95	——
MN 26 C	17.50	$24.95
RA 10 DA Receiver	17.50	24.95
RT7/APN1 Transceiver	6.95	9.95
APN 1 Complete	——	24.50
BC 347 Interphone Amplifier	——	2.95
I-70 Tuning Meter	——	.89
BC 461 Veeder Root Counter	——	.59
BC 442 Less Condenser	1.49	1.95
APS 13 UHF Antenna, Pair	——	.98
FL 8 Filter		2.95
I-97 Bias Meter	3.95	4.95
RM 29 Remote Telephone Control	7.95	9.95
RL 42 Antenna Gearbox Motor and Reel	4.95	7.50
TS 10—Sound powered phones	6.50	——

BC 1066 B—150 to 225 MC Portable Receiver adaptable to many amateur uses. In Canvas Carrying Bag. Used $5.95

Tuning Units for **BC 375** — Presently most numbers are available in excellent condition with case at............$2.95 ea.

BC 306—Antenna Tuning Unit for BC 375. Excellent condition ....$1.50 ea.

One Tube Interphone Amplifier—Small compact aluminum case fully enclosed. 2¼"x 3¾"x5¾". Less Tube............79¢

96Q1 Complete Autotune assembly with motor and frame as used in **ARC-1** Transmitter. New $35.00

BC 709 Battery operated lightweight interphone amplifier. Complete with tube and shock mount, but less battery....New $3.95

SCR 183 Complete............New $49.50

220 MA Circuit Breaker............New .59

Collins VFO Dial—5 calibrated ham bands from 3.2 Mc to 32 Mc; complete with pointer, gears, logging dial and flywheel. Scale 6" on 8" plate. New.........each .95

C-18—Antenna coil assembly slug tuned used in BC 603 receiver. Frequency range 20-27.9 Mc.—fully shielded ......New. 10 for $1.95

I 82 F—Five Inch 360 degree compass indicator and Selsyn receiver.........New $4.95

A-81-2 Transmitter selsyn for I82 indicator $2.45

(Both I82F & Trans. Selsyn for $7.00)

MC 385A—Headset Adapter.........New 49¢

Information and Prices on Request

BC 639 Receiver with **RA 42** Rectifier
RTA 1B Transceiver
TA 2J24 Transmitter and **MP 10G** Power Pack
SCR 269 Compass Installation
R 5/ARN 7 Compass Installation
MN 26 Compass Installation
I. L. S. Installation (R 89-BC733)
AN APR1 Receiver and Tuning Units
ASB7 Complete Radar Installation

Portable VHF Communication Unit

Two-way radio telephone equipment designed for operation between 152 and 162 megacycles FM. Adaptable for many uses, a complete unit including the rechargeable storage battery weighs but fifteen pounds, and is housed in a sturdy case 11½"x9"x4¼", provided with shoulder straps.

This brand new set of big name manufacture comes complete, with battery, battery tray, and handset but less crystal **$89.50**

Battery charger is extra at............$19.95

Mobile VHF Communication Unit

Adaptable for many mobile uses, this is a compact unit 3½"x8"x15½", operating on 152 to 162 megacycles FM. It is six-volt powered direct from storage battery, and is complete with the tone filter and crystal; handset, control box, antenna and installation kit.

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Extra 18" stub type antenna are available $2.95

ID6/APN4 Scope unit complete with 5CP1 cathode ray tube and shield and all parts except smaller tubes and crystal. Used ....$9.95 ea.

COMMAND (SCR 274 N) EQUIPMENT

	Used	New
BC-453	$12.95	——
BC-454	5.95	——
BC-455	7.95	$9.95
BC-456	——	2.95
BC-457	5.95	——
BC-458	5.95	8.95
BC-696	14.95	24.95
BC-450— 3 Receiver Remote Control	.89	1.95
BC-442		2.95
3 Receiver Rack	1.95	——
2 Transmitter Rack	1.50	——

Complete Command set as removed from aircraft—3 receivers—2 transmitters—Relay unit—control boxes—mounting racks—plugs—modulator and dynamotors—crated Set **$34.50**

Special Relays—

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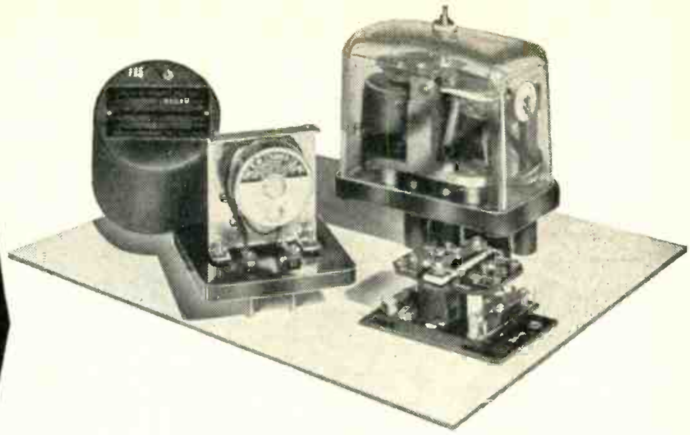

This list represents only a few types of Special Relays. We also have huge stocks of Standard D.C. Telephone Relays, Midget Relays, Contactors, Keying Relays, Rotary and Slow Acting Types as well as many others. Write or wire us about your requirements.

STOCK NO.	VOLTAGE	OHMAGE	CONTACTS	MANUFACTURER & NUMBER	PRICE
R-503	12/32 VDC.	100	3A, 2C	G.E. Ant. Keying 500W 2C6530-653AR1	$ 2.25
R-749	600 VDC.	...	Max. 28 Amps.	Allen Bradley 810 Dashpot	5.95
R-804	550 VAC.	...	1B/38 Amps.	Culter Hammer C-261173A34 Contactor	3.50
R-250	115 VAC.	...	Adj. Cir. Breaker .04-.16A	Westinghouse MN Overload	12.95
R-579	220 VAC.	...	1B	Adlake 60 Sec. Thermo Delay	6.95
R-294	27.5 VDC.	200	1B	Edison 50 Sec. Thermo Delay	4.25
R-686	115 VAC.	...	2C	Leach 1157T-5/20 Sec. ADJ. Delay	4.95
R-246	115 VAC.	...	1B	Cramer 2 Min. Adj. Time Delay	8.95
R-246A	115 VAC.	...	1A	Cramer 2 Min. Aqj. Time Delay	8.95
R-611	24 VAC.	...	1A/30 Amps.	Durakool BF-63	4.25
R-283	12 VDC.	125	AC/10 Amps.	Onan Rev. Current 3H4512/R24	1.00
R-614	18/24 VDC.	60	1A/15 Amps.	Rev. Current Cutout 3H2339A/E1	3.50
R-262	....	200	1C	W. U. Tel. Co. 41C Single Current	3.75
R-245	12 VDC.	25	4 In. Micalex Lever	....	.95
R-527	6/12 VDC.	50/50	In Series	2Z7668 For Scr-274N	.95
R-544	12/24 VDC.	60/60	1C	G.E. Push Button Remote Relay #CR2791-R-106C8	1.65
R-255	....	...	1A	G.E. Pressure Switch #2927B100-C2	.95
R-669	75 VAC.	400 CYC.	1B, 1A	Clare 400	.95
R-660	6 VDC.	...	3/8" Stroke	Cannon Plunger Relay #13672	.95
R-651	24 VDC.	100	Solenoid Valve	....	2.50
R-295	12 VDC.	275	Annuncitar Drop	....	2.15
R-230	5/8 VDC.	2	2A, 1C	Guardian Ratchet Relay	2.15
R-813	12 VDC.	12	Wafer	Ratchet Relay From Scr-522	4.25
R-275	12 VDC.	750	1A, 1B, 1C	Guardian BK-10	2.75
R-716	24 VDC.	70	2A/5 Amps.	BK-13	1.45
R-620	6/12 VDC.	35	2C, 1A	Guardian BK-16	1.05
R-629	9/14 VDC.	40	1C/10 Amps.	Guardian BK-17A	1.25
R-778	8 VDC.	4500	1C/5 Amps.	Kurman BK-24	2.10
R-720	24 VDC.	50	2C, Ceramic	45A High Power	1.35
R-500	12 VDC.	10/10	2C/6 Amps.	Str. Dunn. Latch & Reset	2.85
R-816	12 VDC.	10/15	2C/6 Amps.	Guardian Latch & Reset	2.85
R-811	48 VDC.	8000	1C	Sigma 4R	1.65
R-524	24 VAC/DC.	...	....	Edwards Alarm Bell	.95
R-838	90/120 VDC.	925	2A	Allen Bradley-Bulletin #702 Motor Control	4.50
R-839	100/125 VDC.	1200	3A	Allen Bradley-Bulletin #200E Motor Control	4.50
R-840	115 VDC.	1200	2A	Allen Bradley-Bulletin #209 Size 1 Motor Control W/Type "N" Thermals	5.50
R-841	115 VDC.	1200	4A	Allen Bradley-Bulletin #709 Size 2 Motor Control W/Type "N" Thermals	25.00
R-842	115 VDC.	925	3A	Allen Bradley-Bulletin #709 Motor Control W/Type "N" Thermals	5.50
R-843	115 VDC.	1200	3A	Allen Bradley-Bulletin #200 Motor Control	4.50
R-844	115 VDC.	1200	3A, 1B	Allen Bradley-Bulletin #202 Motor Control	4.50
R-845	220 VAC.	Intermit.	3A	Allen Bradley-Bulletin #704 Motor Control	4.50
R-831	7.5/29 VDC.	6.5	1A/250A, 1000A Surge	Leach B-8	3.50
R-837	110 VAC.	...	2A/30 Amps.	Leach 6104	2.75
R-835	24 VDC.	2800	1A Dble. Brk./10 Amps.	Wheelock Signal, B1/39	1.95
R-836	220 VAC.	...	2A Ddle. Brk./10 Amps.	Wheelock Signal, A7/37	3.45
R-566	115 VAC.	(Coil only, Not a complete relay)		Leach #6104	.75
R-710	....	150-Ohms. Coil Only		Guardian #38187	.50

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AN/APR-4 Receivers and tuning units TN-16 (38-95 MC) TN-17 (76-300 MC) TN-18 (300-1000MC)
AN/APR-5A Receivers. 1000 to 6000 MC Range.

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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 $13.50
U. S. Instrument Co. Navy Type M. Dr. No. A-260 ALT. 1. Complete with 20' cable and navy plug. Brand new $17.50

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
THYRATRON POWER. 400/1600 cy. Raytheon UX-8876. 400/1600 cy. Pri: 115, Sec: 50-0-50V at 0.5A, 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
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

50KVA STEPDOWN. Standard Trans Corp. trans type MD. Pri: 450V111A, Sec: 117V427A. Navy type. Ambient temp. 50 Deg. C. $125.00
FILAMENT. Raytheon Hypersil Core, Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3VO.6A Ins. for 1700V $5.95
Plate. Thordarson #T46889. 1650 VA. Pri: 105-120V. 60 cy. 1 PH. Sec: 5600V. Center tapped. 7.5KV insulation. Brand new................$49.50
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

PULSE TRANSFORMERS

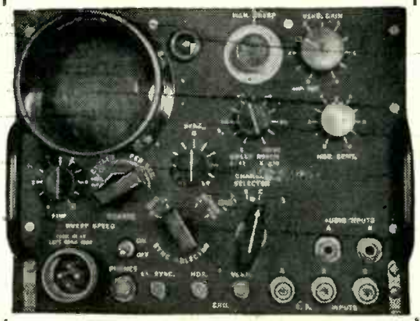
PULSE. WECO KS-9563. Supplies voltage peaks of 3500V from 807 tube. Tested at 2000 Pulses/sec and 5000V peak. Wdg. 1-2=18 ohms. Wdg. 1-3=72 ohms. L of Wdg. 1-3=.073-.082H at 100 cps.........$5.50
PULSE, WECO KS-161310, 50 KC, to 4MC. 1¾" Dia. x 1⅞" high. 120 to 2350 ohms. New.....$3.95

HIGH VOLTAGE CAPACITORS

.25 MFD., 20KV	$17.75
.25 MFD., 15KV	15.75
.5 MFD., 25KV	$26.50
1 MFD., 15KV	$18.50
1 MFD., 7.5KV	$ 7.95

All brand new. Made by prominent manufacturers.

MODEL AN/APA-10 PANORAMIC ADAPTER



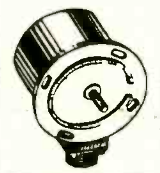
Provides 4 Types of Presentations: (1) Panoramic (2) Aural (3) Oscillographic (4) Oscilloscopic

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, ± 50kc (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

LAVOIE FREQ. METER
375 to 725 MCS

Model TS-127/U is a compact, self-contained, precision (± 1 MC) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-15 minute time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, LS6 and 3S4 Tubes. Complete, new with inst. book, probe and spare kit of tubes. Less batteries. Write for descriptive circular.................................. **$69.50**

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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**

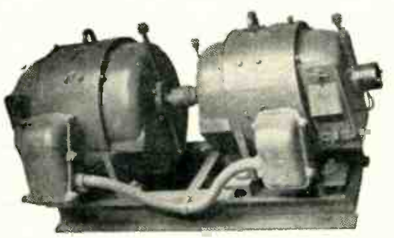
RAYTHEON VOLTAGE REGULATOR

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**

Synchro Differential Generator

Ford Inst. Co. Type 5SDG. Brand New.......$22.50

MOTOR GENERATORS DYNAMOTORS, INVERTERS, ETC.



2.5 KVA MG SET. Diehl Elec. Co. 120V DC to 120V AC. 60 cy. 1 Ph. 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
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MG SET FOR NAVY TBS TRANSMITTER. Type CG-21302. 440V AC, 60 cy, 3 Ph, 1500 VA to 875V 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. 32V DC to 110V AC, 60 cy. 1 Ph, 2.04 Amps. New......................$24.50 Also available for 64 volts input. Same price.
DYNAMOTOR. Elcor. 32V DC to 110V AC, 60 cy. 1 Ph, 0.43 Amps. New......................$17.50
AMPLIDYNE—G. E. Model 5AM31NJ9A. 530 Watts. 7500 R.P.M. Input: 27V DC, Output: 60V. DC. Weight 34½ lbs. New........................$16.50
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—Leland Elec. Co. Model PE206A. Input: 28V. DC. 38 Amps. Output: 80V., 800 cy, 485 VA. New $17.50
INVERTER—G. E. Model 5D-21NJ3A. Input: 24V. DC, Output: 115V. 400 cy, 485 Va. New.....$24.50
PE 218 INVERTER—G. E. J8169172. Input: 28V. DC, Output: 115V, 400 cycles at 1.5 KVA....$50.00
D. C. MOTOR—G. E. Model 5BA 50LJ2A 0.5 HP. Armature: 27V. at 8.3 Amps. Field: 60V. at 2.3 Amps. R.P.M. 400. New...................$16.75
DYNAMOTOR—Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases. $9.50

Radar Antennas in stock. Types SO-1, SO-3, SO-13. Brand New.

All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

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3" scope shield	1.29
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ATC 100 mmfd air trimmer screwdriver shaft	.29
—10 +5 Weston modulation meter Weston 301.	8.95
J37 key	.69
500 watt 12.5 ohm power rheostat	3.49

R·H·S
SPECIALS OF THE MONTH

50 mmfd 5 KV GE vacuum condenser	$1.49
2v, 6v, 12v vibrators any type	.98
Rotary switch GE Mycalex, 2 deck SP3T	.39
1 mfd 5000v oil condenser Micamold	2.98
2 mfd 3000v oil condenser Aerovox	3.25
3 mfd 4000v oil condenser Micamold	3.95
24 mfd 1500v DC 3KV flash. Excellent for speed lamp	3.95

TUBES!! BRAND NEW! STANDARD BRANDS! NO SECONDS! COMPARE! TUBES!!

Type	Price
0A3/VR75	$ 1.05
0B3/VR90	.89
0C3/VR105	.74
0D3/VR150	.48
1B22	2.95
1B23	8.75
1B24	4.95
1B26	2.95
1B27	24.50
1B29	2.75
1B32	1.79
1B36	24.96
1B38	32.50
1N21 Xtal	.59
1N21A Xtal	.89
1N21B Xtal	1.39
1N22 Xtal	.89
1N23 Xtal	.79
1N23A Xtal	.79
1N23B Xtal	2.95
1N27 Xtal	1.69
1N34 Xtal	.79
1N34A Xtal	.85
1P23	2.95
1P24	.79
1P36	2.69
1S21	3.79
2AP1	4.95
2AP5	4.95
2C21/RK33	.35
2C22/7193	.19
2C26A	.19
2C34/RK34	.27
2C39	24.50
2C40	3.45
2C43	8.95
2C44	.98
2C46	6.95
2C51	5.75
2D21	1.25
2E22	1.19
2E24	4.69
2E26	3.39
2E30	2.29
2J21A	7.95
2J22	8.45
2J26	6.50
2J27	10.95
2J30	39.50
2J31	8.49
2J32	12.95
2J33	18.95
2J34	18.95
2J36	97.50
2J37	12.75
2J38	9.95
2J39	19.95
2J40	24.50
2J46	49.50
2J48	15.75
2J49	39.50
2J50	22.50
2J54B	22.95
2J55	69.50
2J61	24.50
2J62	34.50
2K25	19.75
2K28	24.95
2K29	24.50
3AP1	4.59
3B22/ELIC	1.35
3B23/RK22	4.85
3B24	1.59
3B24W	2.89
3B25	4.39
3B26	1.49
3B27	1.95
3B28	7.95
3BP1	2.59
3C22	39.50
3C23	5.95
3C24/24G	$ .39
3C31/C1B	3.49
3C45	12.75
3CP1	1.39
3CP1-S1	2.25
3DP1	3.10
3DP1A	3.95
3DP1-S2A	4.75
3D21A	.98
3E29	9.95
3FP7	1.15
3GP1	4.45
3HP7	2.89
4-65A	14.21
4-125A	26.95
4-250A	29.95
4AP10	3.95
4B22/EL5B	9.95
4B24/EL3C	4.75
4B25/6CF	7.50
4B26/2000	4.95
4B28	2.95
4B32	9.95
4C27/CV92	49.50
4C35	22.50
4D22	9.95
4D32	12.95
4E27/257B	14.95
5AP1	1.79
5AP4	1.79
5BP1	2.29
5BP4	2.39
5CP1	1.39
5CP7	3.49
5C22	49.50
5D21	18.95
5FP7	1.19
5GP1	2.69
5JP1	24.45
5JP2	8.95
5JP4	24.45
5J23	12.95
5J29	12.95
5J30	49.50
5LP1	11.95
5NP1	2.49
6C21	18.95
6F4	5.79
6J4	4.59
7BP7	4.49
9GP7	8.95
9JP1	5.95
9LP1	19.95
9LP7	3.49
10BP4	18.95
7DP4	17.95
10	.25
12DP7	11.95
12GP7	12.75
12HP7	12.75
12LP4	22.50
15E	1.19
15R	.59
16AP4	42.50
16CP4	42.50
19T8	.87
23D4	.19
28D7	.39
30 SPEC	.25
35TG	5.95
45 SPEC	.19
53A	5.95
75TL	5.95
100R	.89
100TH	9.95
121A	2.65
203A	5.95
211	.39
212E	49.50
215A	.19
217C	6.75
227A/5C27	$2.49
249C	1.75
250R	5.95
250TH	18.95
250TL	18.95
274A	5.50
274B	1.95
276A	6.95
293A	2.98
294A	3.95
300B	9.95
304TH	3.65
304TL	1.29
305A	24.95
307A/RK75	6.95
310A	6.95
316A	.45
323A/B	24.50
327A/5C37	2.49
328A	12.95
331A	12.95
350A	1.98
350B	1.69
368AS	2.39
371A	.59
371B	.39
388A	.79
393A	3.49
394A	3.49
417A	8.95
434A	2.95
446A	1.25
446B	1.79
450TH	19.95
450TL	44.50
527	9.75
559	.98
562	97.50
575A	11.95
701A	2.95
702A	2.69
703A	2.39
704A	1.05
705A	.89
706B	24.95
706CY	16.95
706FY	42.50
706GY	42.50
707B	14.95
708A	3.59
709A	3.95
710A/8011	.85
713A	.79
714AY	3.52
715A	6.49
715B	6.85
715C	22.45
717A	.55
721A	2.25
722A	2.95
723A	6.75
723A/B	12.95
724B	2.69
725A	6.45
726A	4.95
726B	29.50
726C	49.50
730A	8.95
750TL	79.50
800	1.69
801A	.25
802	3.89
803	3.10
804	6.45
805	3.65
806	29.95
807	1.49
808	1.29
809	2.25
810	9.55
811	2.10
812	$2.45
812H	6.90
813	6.85
814	2.25
815	2.25
816	1.05
826	.39
828	9.95
829	7.45
829B	9.95
830B	3.19
832	4.95
832A	7.95
833A	33.95
836A	1.25
837	1.35
838	2.35
841	.33
843	.27
845	3.75
849	29.50
851	13.95
852	6.25
860	6.95
861	10.95
864	.29
865	1.45
866A	1.05
866JR	1.05
869B	26.50
872A	1.25
874	.89
876	.35
878	1.69
884	1.39
885	1.39
902	3.39
905	2.59
908	7.95
918	1.49
919	1.95
923	.72
927	1.09
930	.79
931A	3.59
954	.19
955	.24
956	.24
957	.22
958	.22
959	.49
991/NE16	.22
1603	1.98
1613	.49
1614	1.29
1616	.59
1619	.24
1622	1.49
1624	.98
1625	.18
1626	.24
1629	.25
1630	.98
1631	.85
1632	.79
1633	.69
1634	.75
1636	2.95
1638	.65
1644	.98
1654	2.39
1665	1.19
1851	.89
1960	.79
1961	4.99
2050	1.19
2051	.39
8005	4.59
8011	.49
8012	1.29
8013	1.39
8014	$19.95
8020	.89
8025	3.69
9001	.39
9002	.32
9003	.49
9004	.34
9005	1.49
9006	.18
C1JA	9.95
C5B	6.75
C6A	7.95
C6J	4.45
C100D	1.49
CK502AX	2.95
CK503AX	2.95
CK505AX	2.25
CK506AX	2.25
CK507AX	2.25
CK512AX	2.25
CK571AX	8.45
CK1005	.15
CK1006	.63
E1148	.29
EF50	.69
F123A	7.95
F127A	22.50
F128A	89.50
F606	37.50
F660	49.50
F862	397.50
FG17	3.95
FG27A	8.75
FG32	7.95
FG57	12.95
FG81A	3.29
FG105	8.95
FG172	29.50
GL146	8.95
GL434A	2.69
GL451	.89
GL502A	1.85
GL562	49.50
GL592	14.95
HF125	14.95
HF300	19.95
HY114B	.79
HY115	.79
HY615	.19
KC4	37.50
KU610	6.95
ML101	49.50
REL21	.98
RK20	7.95
RK25	4.19
RK33	.24
RK34	.27
RK48A	14.95
RK59	1.49
RK65	24.50
RK72	.59
RK73	.59
RX21A	2.39
RX120	8.95
V70D	7.35
VR78	.29
VR91	1.10
VR92	.69
VT127A	1.98
VT158	14.95
VU29	2.95
VU111	.49
WL468	5.95
WL520	12.75
WL531	1.75
WL532	1.89
WL578	.89
WL616	37.50
WL619	18.95
WL677	34.50
WL681	22.50
0A2	$1.29
0A4G	.95
0B2	1.52
0Z4	.61
01A	.41
1A3	.57
1A4P	1.05
1A5GT	.65
1A6	.78
1A7GT	.72
1AB5	.59
1B3/8016	1.29
1B4	1.19
1B5/25S	.79
1B7GT	1.05
1C5GT	.64
1C6	.74
1C7G	.84
1D5GP	.95
1D7G	.89
1D8GT	.89
1E5GT	1.29
1E7G	1.19
1F4	.72
1F5G	.72
1G4GT	.75
1G6GT	.65
1H4G	.63
1H5GT	.65
1H6GT	.87
1J6GT	.78
1L4	.57
1LA4	.75
1LA6	.95
1LB4	1.05
1LC5	.74
1LC6	.91
1LD5	.79
1LE3	.75
1LG5	.89
1LH4	.79
1LN5	.78
1N5GT	.71
1P5GT	.58
1Q5GT	.75
1R4	.49
1R5	.79
1S4	.82
1S5	.59
1T4	.65
1T5GT	.72
1U4	.72
1V	.65
2A3	.92
2A4G	1.07
2A5	.64
2A6	.69
2A7	.69
2B7	.75
2V3G	.54
2X2	.37
2X2A	.65
3A4	.34
3A5	.95
3A8	1.75
3B7/1291	.29
3D6/1299	.29
3LF4	.79
3Q4	.58
3Q5GT	.67
3S4	.65
3V4	.72
5R4GY	1.25
5T4	.79
5U4G	.72
5V4G	1.05
5W4	.79
5X4G	.57
5Y3GT	.41
5Y4G	.51
5Z3	.52
5Z4	$ .74
6A3	.92
6A4LA	1.09
6A6	.79
6A7	.65
6A8	.75
6AB7	.79
6AC5GT	1.15
6AC7	.98
6AD7G	1.09
6AE6G	.79
6AF6G	.81
6AG5	.74
6AG7	.98
6AH6	1.19
6AJ5	.75
6AK5	1.25
6AK6	.80
6AL5	.75
6AQ5	.65
6AQ6	.59
6AR5	.54
6AT6	.47
6AU6	.69
6AV6	.45
6B4G	.89
6B6G	.72
6B7	.87
6B8G	.59
6BA6	.61
6BE6	.59
6BF6	.54
6BG6G	1.45
6BH6	.59
6BJ6	.59
6C4	.45
6C5	.51
6C6	.57
6C8G	.69
6D6	.48
6D8G	.72
6E5	.69
6F5	.47
6F6	.59
6F6GT	.57
6F7	.65
6F8G	.82
6G6G	.72
6H6	.43
6H6GT	.42
6J5	.47
6J5GT	.42
6J6	.89
6J7	.63
6J7GT	.59
6K5GT	.79
6K6GT	.49
6K7	.46
6K8	.79
6L5G	.85
6L6	1.10
6L6G	.99
6L6GA	.97
6L7	.79
6L7G	.87
6N7	.79
6Q7	.69
6R7	.69
6S7G	.79
6S8GT	.85
6SA7	.49
6SC7	.59
6SD7GT	.44
6SF5	.52
6SF5GT	.49
6SF7	.55
6SG7	.59
6SH7	.49
6SJ7	.52
6SK7	.52
6SL7GT	.52
6SN7GT	$ .89
6SQ7	.47
6SR7GT	.49
6SS7	.49
6ST7	.72
6SU7GTY	1.25
6SV7	.79
6T7G	.89
6T8	.85
6U5G	.62
6U6GT	.63
6U7G	.49
6V6	.89
6V6GT	.57
6W4	.63
6W7G	.77
6X4	.55
6X5GT	.51
6Y6G	.63
6Y7G	.85
6Z7G	1.05
6ZY5G	.59
7A4/XXL	.55
7A5	.59
7A6	.59
7A7	.5[illegible]
7A8	.69
7AG7	.69
7B4	.53
7B5	.65
7B6	.55
7B7	.55
7C4	.34
7C5	.48
7C6	.72
7C7	.59
7E5	.67
7E6	.54
7E7	.59
7F7	.57
7H7	.59
7K7	.89
7L7	.65
7N7	.65
7Q7	.54
7R7	.65
7S7	.85
7V7	.75
7W7	.79
7X7	.79
7Y4	.48
7Z4	.54
12A	.49
12A6	.24
12A7	.89
12A8GT	.49
12AH7GT	.91
12AL5	.79
12AT6	.52
12AT7	1.02
12AU6	.65
12AU7	.98
12AV6	.54
12BA6	.59
12BE6	.59
12C8	.47
12F5GT	.55
12H6	.31
12J5GT	.34
12J7GT	.67
12K7GT	.52
12K8	.55
12Q7	.55
12SA7GT	.67
12SC7	.57
12SF5	.55
12SF7	.49
12SG7	.52
12SH7	.35
12SJ7	.57
12SK7	.67
12SL7	$ .55
12SN7	.57
12SQ7	.59
12SR7	.55
12Z3	.72
14A4	.79
14A7	.59
14B6	.67
14F7	.72
14F8	.79
14H7	.59
14J7	.87
14N7	.85
14Q7	.53
14R7	.65
19	.74
24A	.57
25L6GT	.55
25Z5	.52
25Z6GT	.49
26	.52
27	.46
28D7	.39
30	.49
31	.57
32	.85
32L7GT	.85
33	.65
34	.32
35/51	.52
35A5	.65
35B5	.55
35C5	.59
35L6GT	.62
35W4	.43
35Y4	.47
35Z3	.55
35Z4	.44
35Z5	.49
36	.67
37	.35
38	.39
39/44	.28
41	.49
42	.47
43	.47
45	.49
45Z3	.55
45Z5	.51
46	.64
47	.65
48	1.49
49	.85
50A5	.74
50B5	.63
50C5	.59
50L6GT	.65
50Y6	.59
53	.87
56	.45
57	.44
58	.49
59	.85
70L7	.99
71A	.62
75	.53
76	.37
77	.43
78	.44
80	.43
82	.84
83	.87
83V	.87
84/6Z4	.59
85	.62
89Y	.35
117L7/M7	1.21
117N7	1.29
117P7	1.19
117Z3	.53
117Z6	.69

SELENIUM RECTIFIERS
FULL WAVE BRIDGE TYPE

Input 0-20V AC Type No.	Current	Output 0-14.5V DC Price
20D1	1.2 Amps	$ 2.49
20E1	2.4 Amps	3.49
20F1	6.4 Amps	4.95
20K1	13.0 Amps	8.95
20J1	17.5 Amps	11.95
20K2	26.0 Amps	17.95
20K3	39.0 Amps	24.95
20K4	52.0 Amps	29.95
20K5	65.0 Amps	35.95
0-40v AC	**Current**	**0-34v DC**
40D1	.6 Amps	$ 2.95
40E1	1.2 Amps	3.89
40F1	3.2 Amps	5.25
40K1	6.0 Amps	9.95
40J1	9.0 Amps	12.95
40K2	12.0 Amps	18.95
40J2	18.0 Amps	22.45
40K4	24.0 Amps	32.50
40K5	30.0 Amps	34.95
40J4	36.0 Amps	39.50
0-120v AC	**Current**	**0-100v DC**
40D1A	.6 Amps	$ 7.85
40E1A	1.2 Amps	10.76
40F1A	3.2 Amps	16.65
40K1A	6.0 Amps	24.75
40J1A	9.0 Amps	32.95

CENTER TAPPED RECTIFIERS
Single Phase Full Wave Bridge

10-0-10v AC	Current	0-8v DC
10D1	1.2 Amps	$ 1.89
10E1	2.4 Amps	2.25
10F1	6.4 Amps	3.87
10K1	12.0 Amps	4.95
10J1	16.0 Amps	7.95
10K2	24.0 Amps	10.75
10K3	36.0 Amps	14.75
10K4	48.0 Amps	17.75
10K5	60.0 Amps	19.95
10K6	72.0 Amps	25.57
10K7	84.0 Amps	27.95
10J6	96.0 Amps	32.50
10K10	120.0 Amps	42.50

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TRANSFORMERS—115V 60 CY HI-VOLTAGE INSULATION

6250v or 3850v or 2600v @ .056 arms	$13.95
2700v @ 2 MA; 6.3v @ .6A; 2.5v @ 1.75A	4.95
2500v @ 15 MA	3.49
1600v @ 4 MA; 350-0-350v @ 150 MA; 6.3v @ 9A	4.45
1540v @ 5 MA; 340-0340v @ 300 MA	4.35
1120-0-1120v @ 500 MA; 12v CT @ 14A; 2.5v @ 10A; 17v @ 2.5A; 32v @ 25 MA; 115/230 Pri	16.95
925v @ 10 MA; 525-0-525v @ 60 MA; 2X5v @ 3A; 6.3v CT @ 3.6A; 6.3v @ 2A; 6.3v @ 1A	5.55
700-0-700v @ 300 MA	7.55
500-0-500v @ 175 MA	4.55
430-0-430v @ 340 MA; 6.3v CT @ 6.3A; 5v @ 6A	4.85
425-0-425v @ 75 MA; 6.3v @ 1.5A; 5v @ 3A	3.65
415-0-415v @ 60 MA; 5v CT @ 2A; 115/230 Duel Pri	4.97
405-0-405v @ 150 MA; 6.3v CT @ 2½A; 5v @ 3A; 2.5v CT @ 5A	4.35
400-315-0-100-315v @ 200 MA; 2x6.3v @ 9A; 5v @ 3A; 2.5v @ 2A	5.35
500-385-0-385v @ 200 MA; 3x6.3v @ .6A; 5v @ 3A; 2.5v @ 2A	4.75
325-0-325v @ 12 MA; 255-0-255v @ 240 MA	4.25
300-0-300v @ 65 MA; 6.3v @ 2.5A; 6.3v @ 1A; 2x5v @ 2A	3.25
80-0-80v @ 225 MA; 5v @ 2A; 5v @ 4A	2.97
0-17.4/21.6/25.8v @ 400 MA; 6.4v @ .5A; 2.6v CT @ 2.5A Pri 115/230	3.85
18 or 36v @ 15A . .$8.75 13.5v CT @ 3.25A	2.17
12.6v CT @ 10A; 11v CT @ 6.5A	6.35
3x10.3v CT @ 7A . .$6.95 6.3v @ 1A	.77
6.5v @ 12A; 6.3v @ 2A; 115v @ .1A	3.50
6.4v @ 10A; 6.3v @ .6A	2.77
6.5v @ 8A; 6.5v @ 6A; 2.5v @ 1.75A	4.17
6.3v @ 1A; 2.5v @ 2A . .$2.29 4-0-4v @ 1A	.87
6.3v CT @ 3.5A; 2x2.5v CT @ 3A	2.97
5v CT @ 20A; 10 KV INS	8.95
.6v @ 15A RMS	1.47

TRANSFORMERS—220v 60 Cyc

512.5-0-512.5 @ 427 MA	$ 5.35
3x5v @ 6A; 4v @ .25A	2.95
3x6.3v CT @ 3A; 6.3v CT @ 1.6A	2.95
10v CT @ 6.5A; 6.3v CT @ 2.5A; 6.3v CT @ 1.8A 220/440 Pri	3.95
Step Up/Down 110/220 500 watt	10.95
Step Up/Down 110/220, 220/440 600 watt	14.95

EQUIPMENT SPECIALS

APN-1 Altimeter Xceiver	Like New	$ 7.95
ATR Inverter 12v DC in 110v AC Out 125 w Int. 100 w Cont.	New	14.95
AN/CRW-2 UHF Receiver	New	5.95
BC357 Beacon Receiver	Good	3.45
BC433 Receiver	Good	24.94
BC456 Modulator	Good	1.98
BC434A Control Box/BC433	Used	1.95
BC458 Transmitter	New	8.95
BC602A Control Box/SCR522	Used	.39
BC778 Gibson Girl	Good	3.95
BC958-121 Xmitter 100-156 MC	New	39.50
BC1016 Tape Recorder	New	459.50
BC1206A Beacon Receiver	Good	4.95
CF1 Navy Unit w/200KC Crystal	New	14.95
DM 19 Dynamotor 12v DC in 500v 200 MA Cont. Out	Good	4.95
EE8 Foundation Unit	Good	4.95
MN26C Compass Receiver	Good	24.95
M110 Dynamic Chest Mike	New	3.95
PE94 Dynamotor/SCR522	Good	1.98
PE97A Vibrator Power Supply	New	6.95
PE104 Vibrator Supply	Excellent	24.95
R89/ARN5 Receiver	New	9.95
R89/ARN5 Receiver Less Tubes, Covers	Good	4.95
SCR518 Altimeter Complete	New	39.95
T17 Carbon Mike ....New 1.98	Used	1.29
TU25 Tuning Unit/BC223	New	1.79

FILTER CHOKES HI V INS

.025 HY @ 1.36A	$1.98
.05 HY @ 15A	7.95
.065 HY @ 2.5A	2.49
.1 HY @ 5A	6.95
2 HY @ 175 MA	1.49
3 HY @ 50 MA	.39
3/30 HY @ 250 MA	3.65
5 HY @ 70 MA/.2 HY 350 MA Duel	2.39
5.3 HY @ 775 MA	9.95
10 HY @ 55 MA	.89
10 HY @ 100 MA	1.49
10 HY @ 200 MA	$2.15
10/20 HY @ 85 MA	1.49
13 HY @ 130 MA	1.55
13 HY @ 250 MA	2.95
14/3.5 HY @ 40/400 MA	6.95
15 HY @ 25 MA	.59
15 HY @ 70 MA	1.15
26.5 HY 125 MA	1.98
200 HY @ 10 MA	2.95
325 HY @ 2 MA	2.95
600 HY @ 1 MA	2.95

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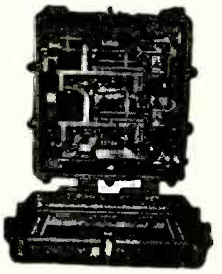
F.O.B. NYC. Minimum order $5.00
20% Deposit Required
All Merchandise Guaranteed

IMMEDIATE DELIVERY • LOW PRICES • FULLY GUARANTEED

BROWN TELEPLOTTER RECEIVER



Model 791X1R

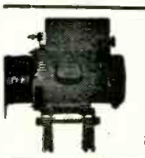
115 volt 60 cycles

Contains a pen driven by two balancing motors which writes on rear of a translucent chart. Pen arm position is in terms of two co-ordinates supplied balancing motors thru two amplifiers. Originally intended for recording plotted or written data from central plotting board. Writes at one half scale on 18 in. chart. Discriminator input circuit designed to operate unit as function of two varying R.F. frequencies varying about mean of approx. 430 KC. Further data on request. (Shipping weight 435 lbs.)

Price $375.00

Aircraft Generator Eclipse NEA-3

Output 115 VAC; 10.4 amps 800 cycles at 2400 rpm. Also 30 VDC at 6 amps. Stock #SA-306. **Price $39.50 each.**



400 Cycle Generators

Homelite 18A120D28-1 400 cycle out at 1 phase 115 v. 39 amps. Also a d-c output of 28 v. and 17.9 amps. Special at $175.00 each.

C-1 Autopilot Amplifier

Three channel servo amplifier for use in C-1 Autopilot. 7 tubes. Stock #SA. 172. **Price $24.50 each.**

Pioneer Servo Motor

Type 10047-2A. 2 ϕ 400 cycle low inertia. 26 v fixed phase. 45 v. max. variable phase. Stock #SA-90. **Price $12.50 each.**

PRECISION AUTOSYN

Pioneer Type AY-150 Control Autosyn. Precision type. 26 v. 400 cycle. Stock #SA-297. **Special low price $14.50 each.**

SYNCHROS

Navy Types

1G, 1CT, 5G, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 7G, etc.

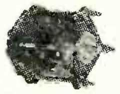
Prices on Request

Compass Indicator

I-82F Compass Indicator. 0-360°-5 in. dial. 26 v. 400 cy. 8-12 v. 60 cy. Ideal position indicator. Stock #SA-284.

Price $6.50 each

SWEEP GENERATOR CAPACITOR



Hi-speed bearings. Split stator. Silver-plated coaxial type. 5-10 mmf.

Stock #SA-167 **Price $2.75 each**

ALSO IN STOCK

C-1 AUTOPILOT COMPONENTS
A-5 AUTOPILOT GYROS
GENERAL ELECTRIC D-C SELSYNS
AC and DC RATE GENERATORS

400 CYCLE AC BLOWERS

E. A. D. J-151—115 v. 400 cy. 22 c.f.m.
Westinghouse Type FL—115 v. 400 cy. 17 c.f.m.

DC MOTORS

Haydon-0666, ½ rpm. 29 v. d-c, 100 ma.
Delco 5069625—120 rpm. Gov. cont. 27 v.
General Electric 5BA50LJ66—½ hp. 27 v. field. Arm. v. 60, Amplidyne controlled.
Delco-A-7155—1/30 hp. 3600 rpm. Gov. cont.
W. E. KS-5603-LO2—1/100 hp. 4 lead shunt.
National Mineral—90600. 1 hp. Int. duty. Fan cooled.
Diehl FDE-53-5—3600 rpm. Gov. cont. 1/30 hp.
G. E. 5BA25MJ109—24 v. 7500 rpm. Cont. duty.
Airsearch—Actuator—25800-24. 2" travel.
Barber Colman—Actuator—YLc-2066-2. 200 in/lb. 135 degrees in 45 seconds.
Airsearch—Actuator (Manual Flap) 25080.
Airsearch—Actuator—(Automatic Flap) 25040.
Holtzer Cabot—RBD-2220—½ hp. 27 v. 3600 rpm.
Arma Latitude Motor — 8413-30 (Step motor)
Elinco B-64—1/165 hp. 3100 rpm. 27 v. f. 80 v. armature. (Thyratron control)
John Oster—A-21E-12R—Split field series reversible. 28 v. 0.4 amps. 2 watts output.
General Electric 5PS56HC18 — Split field series rev. 60 v. 1.4 A. 5500 rpm.

AC SERVO MOTORS

Kollsman—776-01—400 cy. 2 ϕ drag cup type.
Diehl FP-25-3—2 ϕ 60 cy. 20 v. 2.5 watts out.
Pioneer CK-2—2 ϕ 400 cy. 1.05 in/oz. stall.
Pioneer CK-17—2 ϕ 400 cy.
Minneapolis Honeywell G303AY2CA4. Built in gear reduction. 2ϕ 400 cy.

AUTOSYNS (Pioneer)

B-9A—Dual Oil Pressure Indicator (6007-4F-7A)
B-9A—Oil Pressure Transmitter, (4150-3B3)
Pioneer Types—AY-1, AY-14, AY-54, 2320, etc.
C-14A—Fuel Pressure Transmitter.
Pioneer I-81A and I-82A Compass Indicators.

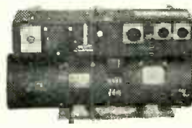
Subfractional Horsepower AC Motors

Eastern Air Devices-J-72B—115 v. 400 cy. 1/50 hp. Cont. duty. 4700 rpm.
E. A. D. J-49B—115 v. 400 cy. 1/250 hp.
E. A. D. J-33—115 v. 3ϕ 400 cy. Int. duty.
Diehl FBF-24-1—115 v. 400 cy. 1/100 hp.
Synchron-600—110 v. 60cy. 1 rpm.
Haydon 36228—115 v. 60 cy. 1 rpm.

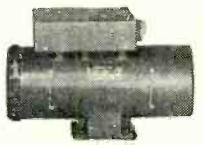
MAGNESYNS

Pioneer Type CL-3, 6 power.
Pioneer 1006-1E-B1 Indicator. AN-5730-2.

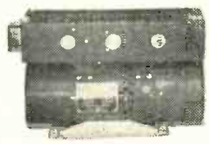
INVERTERS



Wincharger PU-7/AP Input 28 VDC at 160 amps. Output 115 v. 400 cy. 1 ϕ at 2500 VA. Voltage and frequency regulated. Cont. duty. Stock **#SA-164. Price $89.50 each.**

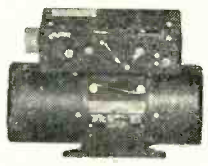


G.E. 5AS131NJ3 (PE-118) Input 26 VDC at 100 amps. Output 115 v. 400 cy. 1 ϕ at 1500 VA. PF 0.8 W.E. Spec. KS-5601L1. Stock **#SA-286. Price $29.50 ea.**



PE-218E Inverters

Russel Electric and Leland. Input 28 VDC at 92 amp. Output 115 v. 400 cycles at 1500 VA. PF 0.9. Stock #SA-112A. Price $49.50 each.



Pioneer 12130-4-B

Input 28 VDC at 14 amps. Output 120 v. 400 cy. Single Phase at 1.15 amps. (140 VA.) Voltage and frequency regulated. Made 1949. Stock #SA-304. **Price $89.50 each.**

JACK AND HEINTZ STARTER

Dwg. 6-950-R

Aircraft engine starter. 28 VDC. Stock #SA-305.

Price $19.50 each

DC SERVO MOTOR

Elinco Type B-64.

1/165 hp at 3100 rpm. Field volts 27.5 Max. armature voltage 80. Ideal for thyratron servo control. Stock #SA-211. Price $12.50 each.

MAGNETIC AMPLIFIER ASSEMBLY

Sperry 661824. Saturable reactor type output transformer. Designed to supply one phase of 400 cycle servo motor. Stock #SA-266. Price $6.75 each

FORD INS'T SERVO MOTOR

115 volt 60 cycle two phase low inertia motor. 15 watts output. BuOrd. 207927. Stock #SA-291. **Price $49.50 each.**

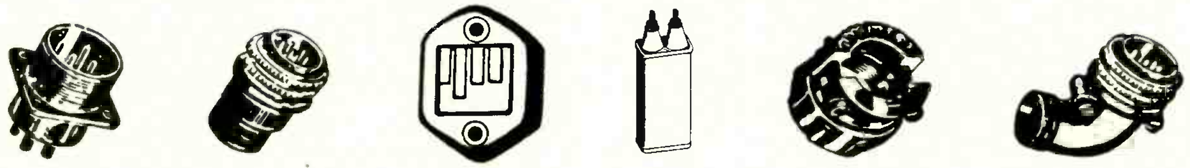
Prices F.O.B. Paterson
Phone ARmory 4-3366
WRITE FOR LISTING

Servo-Tek — products co.
4 Godwin Ave. Paterson, N. J.

SPECIALISTS IN FRACTIONAL HORSE POWER MOTOR SPEED CONTROL

FOR QUICK LIQUIDATION

SEND BEST OFFERS ON ANY ITEMS REQUIRED



Amphenol PLUGS & REC.

AN 3102-12S-3P
AN 3102-13-5P
AN 3102-14S-2S
AN 3102-14S-2P
AN 3102-14-3P
AN 3102-16S-5S
AN 3102-18-1P
AN 3102-18-4P
AN 3102-20-6P
AN 3102-20-7P
AN 3102-22-10S
AN 3102-22-8P
AN 3102-22-12P
AN 3102-28-2S
AN 3102-28-4P
AN 3102-40-5S
AN 3102-40-9S
AN 3102-85-1P
AN 3106-12S-3P
AN 3106-14S-7P
AN 3106-18-5S
AN 3106-18-20S
AN 3106-22-2P
AN 3106-22-6P-101
AN 3106-22-9S
AN 3106-24-19P
AN 3106-28-2P
AN 3106-28-20S
AN 3062-16
AN 3108-12S-3P
AN 3108-14S-4P
AN 3108-16S-5P
AN 3108-18-30S
AN 3108-18-30P
AN 3108-18-31P
AN 3108-W-20-5SP
AN 3108-22-5P
AN 3108-22-8P
AN 3108-22-10S
AN 3108-22-11P
AN 3108-24-3S
AN 3108-28-1S

U 15U
U 101
U 102
UG 103U
UG 104U
NK 12-32S
NK 12-21C
MC 277 10H 701
PLR 56
PL 62
PLS 61
PLP 62
PLO 63
PLF 63
PLP 65
PL 2177
PL 75
PL 90
PL 100
PL 149
PL 152A
PL 153
PL 153A
PL 861
8 Prong Chassis Plug-Galvin
4 Prong Socket tube Cinch Co. 2154
CN 4913 FA
Cannon #2255-28
Cannon SO-46

DYNAMOTORS

24V switch units type 25
Bendix #41-1283-Input 24V output 425V
Winco Input 26.5V output 1100V
Bendix #41-1548
Westinghouse D101
Type DM 53 AZ

WIRE CABLE & CORD ASSEMBLIES

18-3 type S cord 1 shielded conductor 250 ft. coils #CD520

10 Cord #18 rubber cord 250 ft. coils
CD 110
CD 112
CD 113
CD 111
CD 114
CD 518
CD 982
CD 650
MIC T44A
RG 23U
CD 512
Coaxial loom
CO 328 Earphone cords
6-2 S cord 150 reels

FILTERS

Filter #FL 9-3Z1890-9
Capacitor #3DB4-47

SEARCH COILS

Capacitor #26F628
Capacitor #5C1
Power Units PE112A Serial #648RCA
Antenna Switching Unit BC961-A
Relays GE 3 pole K27J852
Relays GE M29U682-1 assemblies
Antenna System #AS97 Aireon Mfg. Corp.
Condensers 23F237

RHEOSTATS

4570808
66-445C
ED28890
130858244
Large assortment of component parts too numerous to list.

35 sets B70P1

Conversion units, complete with generators.
SCR-AO-283 Radio sets

ADDRESS COMMUNICATIONS TO

SAMUEL KASS, INC., 46 Cooper Sq., N.Y.C.

Material located at 8200 Bessemer Ave., Cleveland, Ohio

Reliance Specials

SOUND POWERED HANDSET

Brand New!

Includes 6 ft. cord. No batteries or external power source used.
$8.92 ea. ....$17.60 pr.

CERAMICONS

2 MMF	30 MMF
5.6	35
10	45
12	62
15	82
20	150
22	200

$6.50 per hundred

500 VOLT CERAMIC CONDENSERS

MMF	MMF	MMF	MMF
2	18	56	150
3.44	22	62	180
4.7	27	68	200
8	30	82	220
12	33	91	270
15	40	100	300
16	47	140	1000

$5.50 per hundred

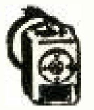
PRECISION CAPACITOR—W.E.

D-161270. 1 mfd @ 200 VDC; −40° to +65°C.....$8.50

SELENIUM RECTIFIERS

Full Wave—200 ma., 115 V......................$1.57
Half wave—100 ma., 115 V...................... .72

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

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2–140Y	$0.10	4–141W	.25	17–141Y	.96
3–140¾W	.15	4–141¾W	.25	3–142	.17
6–140	.20	5–141	.22	3–142Y	.23
9–140¾W	.40	5–141¾W	.30	5–142	.26
10–140¾W	.44	5–141Y	.30	5–142¾W	.37
11–140¾W	.48	7–141	.29	10–142¾W	.71
12–140¾W	.53	7–141¾W	.41	11–142Y	.78
13–140	.40	8–141	.33	2–150	.31
14–140Y	.61	8–141¾W	.47	2–150¾W	.38
2–141	.10	9–141¾W	.52	3–150	.44
3–141¾W	.19	9–141Y	.52	4–150	.57
3–141W	.19	10–141Y	.58		

METERS

Brand New—Guaranteed

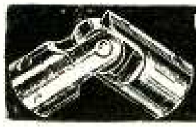
0–1 Amp, RF, 2½″......................$3.29
0–300 V.D.C., 2½″...................... 3.50
0–80 Amp, D.C. 2½″...................... 2.49
0–7.5 V. A. C., 3½″...................... 3.46

VERNIER DRUM (From BC-221)

0-50 in 180°. Black with silver marks............85¢

VERNIER DIAL (From BC-221)

2 ⅝″ Dia. 0-100 in 360°. Black with silver marks. Has thumblock ....85¢



UNIVERSAL JOINT
3/16″ hole x 3/8″ O.D.
1 1/8″ long
Steel or Aluminum
50¢

CAPACITORS

POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MMF	MFD	MFD
5	40	100	250	580	.0013	.0051
8.2	43	110	300	600	.00136	.006
10	47	120	330	620	.0015	.0062
15	50	125	350	680	.001625	.0065
20	51	130	370	750	.002	.0068
22	56	150	390	800	.0025	.007
24	60	160	400	820	.0026	.0075
25	62	175	430	910	.0027	.008
26	75	180	470	MFD	.003	.0082
30	82	200	500	.001	.0033	.009
35	85	220	510	.0011	.0047	.01
39	90	240	560	.0012	.005	

Price Schedule

5 MMF to .0011 MFD............................ 5¢
.0012 MFD to .002 MFD............................ 7¢
.0023 MFD to .009 MFD............................12¢
.01 MFD............................18¢

SILVER MICAS

MMF	MMF	MMF	MMF	MMF	MMF	MFD
10	51	125	300	488	820	.003
18	60	130	325	500	875	.0033
22	62	150	330	510		.0039
23	66	180	360	525	MFD	.005
24	68	200	370	560	.001	.0051
30	75	208	390	660	.001625	.0056
33	82	225	400	680	.0022	.006
39	100	240	410	700	.0023	.0082
40	110	250	430	750	.0024	
45	115	260	466	800	.00282	
50	120	270	470	815	.002826	

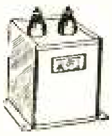
Price Schedule

10 MMF to .001 MFD............................10¢
.001625 MFD to .0027 MFD............................20¢
.00282 MFD to .0082 MFD............................50¢

OIL FILLED

MFD	V. D. C.	Price	MFD	V. D. C.	Price
.25	20,000	$15.75	1	2,000	$.95
.03	16,000	1.95	3	1,000	.80
.375 @	16,000 and		2	1,000	.65
.75 @	8,000	5.95	1	800	.39
.1	7,500	1.55	4	600	.79
.1–.1	7,000	1.55	2	600	.39
.01	6,000	.95			
.03–03	6,000	1.25			
.02–.02	7,000	1.25			
1	6,000	5.25			
2	4,000	2.50			
.25	3,000	1.10			
.2	750 AC	.49			
8	2,000	4.85			
4	2,000	3.95			

2 mfd
4,000
V.D.C.
G.E.
SPECIAL
$2.50



FILAMENT TRANSFORMERS

Pri., 115 V., 60 Cyc.—Sec., 5V., 115 A. 6000 volt insulation ....$9.95 each
Pri., 115 V., 60 Cyc.—Secondary:

$5.95 { 6 V. @ 35 A.
12 V. @ 18 A.
24 V. @ 9 A.

PULSE TRANSFORMERS

X 124 T2, UTAH, marked 9262, 9340, small gray case. Ratio 1:1:1; hypersil core $2.75
D161310, 50 Kc to 4 Mc. 1¾″ dia. x 1⅞″ high. 120 to 2350 ohms.............................. $1.50
352-7178—Spec. 10. 111 Chicago Trans. equivalent to 9262 (above).............................. $1.50
D-166638 Western Electric Permalloy core. Semi-toridal-windings $1.25
KS9800, Ratio, 1:1:1, 2:1, Freq. range 380 to 520 C.P.S. $3.50
D106173, W.E. Freq. resp. 10KC to 2 MC....... $9.80
800 KVA G.E. #2731, 28,000 Volt peak output: Bifilar: one microsecond pulse width..............$28.50

PRECISION CONTROLS

6 WATT

20,000Ω	Muter	314A	$1.70
6,000	De jur	260	1.70
6,000	Muter	314A	1.70
5.000	Muter	314A	2.50
2,000	De jur	260	1.70

12 WATT

10,000Ω	De jur	271T	2.00
10,000	Muter	471A	2.00
5,000	De jur	271T	2.00

4 WATT

500Ω	Centralab	48–501	$1.00
200Ω	GR	301	1.25
50	De jur	292	1.00
20	De jur	292	1.00
12	GR	301	1.10
12	De jur	292	1.00
2	GR	301	1.25

2J1G1 SELSYNS

BRAND NEW
400 Cycle
Can be used on 60 cyc.
$1.85

3AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
⅛	$4.00	1	$2.50	5	$2.50
¼	4.00	1½	2.50	10	3.00
½	4.00	2	2.50	15	3.00
¾	4.00	3	2.50	20	3.00

Fuse Holder—for 3AG Fuse. (Littlefuse or Buss)...25¢

4AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
1/10	$4.00	2	$2.00	10	$2.50
1/4	3.50	3	2.00	15	2.50
1/2	3.50	3.2	2.00	20	2.50
1	2.00	5	2.00	25	2.50
				30	2.50

Fuse Holder—for 4AG Fuse. (Littlefuse or Buss)...18¢

Wrapped—BALL BEARINGS—New

Mfg	ID	OD	Width	Price
Fafnir 33K5	3/16″	1/2″	5/32″	$0.25
MRC.205A	63/64″	2 3/64″	19/32″	1.10
N.D. 5202C13M	1/2″	1 3/8″	1/8″	1.00
Fafnir 7308W	1 37/64″	3 9/16″	5/16″	2.00
SKF466430	6″	8″	1″	5.00
Fafnir 545	2 1/16″	2 5/8″	15/32″	1.00

NEEDLE BEARINGS

B108 1/2″ wide	5/8″	13/16″	30¢
GB34X 1/4″ wide	3/16″	11/32″	25¢

ALLEN SET SCREWS

4–40 x 1/8 8–32 x 1/8 8–32 x 5/16
4–40 x 3/16 8–32 x 3/8
ALL SIZES..............................$1.50 per 100

HAYDON TIMING MOTOR

4 R.P.M., 115 V., 60 Cycle........$1.79

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay..............85¢
T 114—Approx. 2.2 micro sec. delay..............85¢
T 115 Similar to T 114 with tap brought out.......85¢

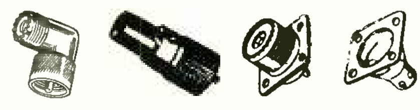
COAXIAL CABLES

GUARANTEED!! NEW!!

	Ohms	Price per 1,000 ft		Ohms	Price per 1,000 ft
RG-5/U	53.5	$70	RG-28/U		160
RG-6/U	76	150	RG-29/U*	53.5	$50
RG-7/U*	97.5	65	RG-34/U	71	175
RG-8/U*	52	65	RG-35/U	71	450
RG-9/U*	51	135	RG-37/U	55	40
RG-10/U	52	125	RG-39/U	72.5	180
RG-13/U*	74	125	RG-41/U	67.5	550
RG-15/U	76	160	RG-54/U	58	65
RG-18/U	52	450	RG-54/AU	54	75
RG-21/U	53	100	RG-55/U	53.5	65
RG-22/U*	95	110	RG-57/U*	95	100
RG-24/U	125	240	RG-58/U*	53.5	55
RG-25/U	48	575	RG-74/U	52	250
RG-26/U	48	75	RG-77/U*	48	100
RG-27/U	48	290	RG-78/U	48	80

*No minimum order—others 250′ minimum
Add 25% for orders less than 1,000 feet

COAXIAL CABLE CONNECTORS



Angle Adapter	Plug	Socket	Hood
15¢	40¢	40¢	9¢
M-359	PL-259A	SO-239	83-1H
83-1AP	83-1SPN	83-1R	

Adapter for PL-259 A for use on small coax.
12¢ each ....$10.00 per 100

83-1AC	$0.42	UG-21/U	.67	UG-61/U	.60
83-1J	.80	UG-22/U	.86	UG-85/U	.88
83-1RTY	.45	UG-23/U	.85	UG-87/U	.79
83-1SP	.40	UG-24/U	.67	UG-103/U	.48
83-1T	1.12	UG-25/U	.60	UG-104/U	.85
83-22AP	1.10	UG-27/U	.68	UG-167/U	2.00
83-22F	1.48	UG-29/U	.83	UG-171/U	1.33
83-22R	.48	UG-30/U	1.20	UG-175/U	.15
83-168	.15	UG-33/U	14.80	UG-176/U	.15
83-185	.15	UG-34/U	16.00	UG-197/U	1.33
UG-7/AP	2.14	UG-36/U	12.80	UG-206/U	.63
UG-12/U	.63	UG-37/U	12.80	UG-255/U	1.22
UG-13/U	.63	UG-58/U	.63	UG-264/U	1.74
UG-19/U	.73	UG-59/U	.60	UG-281/U	.60

WIRE WOUND PRECISION RESISTORS 1% OR BETTER

¼ WATT—25c

6.68Ω	12.32Ω	16.37Ω	125Ω	414.3Ω
10.48	13.02	62.54	147.5	705
10.84	13.52	79.81	220.4	2193
11.25	13.89	105.8	301.8	59,148
11.74	14.98	123.8	366.6	100,000

½ WATT—25c

.250Ω	1.53Ω	75Ω	260Ω	4,000Ω	8,500Ω
.334	2.04	90	270	4,451	14,825
.444	11.1	97.8	298.3	5,000	15,000
.502	13.15	100	400	5,900	15,750
.557	18.75	125	723.1	6,500	17,000
.627	46	180	2,500	7,000	30,000
.76	52	210	2,850	7,500	37,000
1.01	55.1	235	3,427	8,000	79,012
					100,000

1 WATT—30c

1.01Ω	5.21Ω	270Ω	9,000Ω	55,000Ω
2.58	10.1	3,300	18,000	65,000
3.39	10.9	7,000	20,000	60,000

1 WATT—40c

100,000Ω	128,000Ω	320,000Ω	600,000Ω
120,000	130,000	522,000	700,000

1 Megohm—1 Watt 1%—65c; 5%—40c

Orders for 100 precision resistors—10% Discount

1N34 Crystals 69c

BLOWER & MOTOR

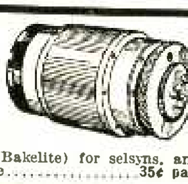
Blower #1½, motor 27½ V.D.C., 1/100 H.P., 8,500 R.P.M. Continuous duty. Has mounting brackets. Navy inspected $3.95

GEAR ASSORTMENT

100 small assorted gears. Most are stainless steel or brass. Experimenters dream!..................Only $6.50

SELSYNS

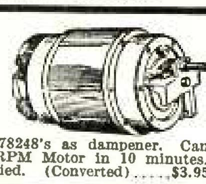
115 V., 60 Cyc.
#C78248
3⅜″ dia. x 5⅜″ long
$8.95 pair



Mounting Brackets — (Bakelite) for selsyns, and differentials shown above..................35¢ pair

DIFFERENTIAL

115 V., 60 Cyc.
#C78249
3⅜″ dia. x 5⅜″ long
$2.95 ea.

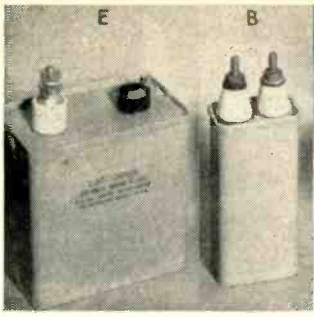


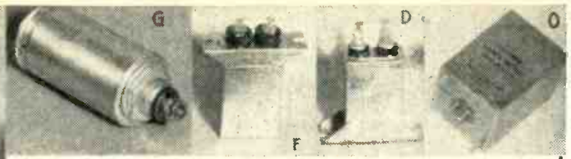
Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted).....$3.95

Get On Our Mailing List! 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—SPECIAL

0-10 Amp DC 3" Sq. Case $3.00
0-3 MA DC 3" Sq. Case 3.25
0-4 RFA 2" Rd. Case 1.75
0-8 RFA 2" Rd. Case 1.75

OIL CONDENSERS—New

Symbol	Capacity	Voltage	Type	Price
B	.001	50KV	14F112	$30.00
B	.005-.005-01	10KV	26F344	3.50
B	.01	3000V		.50
Spec.	.02	20KV		10.50
E	.03	16KV	26F380	7.75
B	.05-.05	2000VAC		.95
B	.1	1500V		.35
B	.1	2000V	1 Terms	.32
F	.1	2500V		.50
G	.1	7000V		.95
E	.1	7500V	25F475	.85
B	.1	7500V	26F469	1.50
B	.1	10KV	23F644	6.95
B	.1	15KV	25F572	10.95
B	.1	25KV	14F52	20.95
B	.2	10KV	25F433	7.95
B	.25	3500V		1.30
E	.25	6000V	25F659	1.50
B	.25	20KV		19.95
B	.4	10KV		8.95
D	.5	400V		.14
D	.5	500V		.18
F	.5	600V		.24
B	.5	750VAC	Porc. Terms	.85
G	.5	1500V		.39
B	.5	2000V		1.50
B	.5	3000V		1.85
B	.5	25KV		29.95
B	.5-.1	2000V	3 Terms	.89
B	.65	12.5KV		10.95
D	.75	1000V		.22
F	1	400V		.20
D	1	500V	23F266	.28
F	1	500V	23F225	.28
F	1	600V		.33
B	1	1000V		.30
B	1	2000V		1.30
B	1	2500V		1.50
B	1	3000V		1.85
D	2	600V	26F407	.45
G	2	600V	TLA	.35
G	2	600V	TLA 2 Terms	.50
B	2	1000V		.70
G	2	1000V		.70
B	2	1500V		1.39
B	2	4000V	23F47	3.95
B	2	5000V		11.50
B	2-2	600V	4 Terms	.70
B	3	600V		.42
B	3	4000V		5.25
B	3-3	150V		.25
B	3-3	600V		.75
B	4	440VAC		.78
B	4	500V	26F796	.65
B	4	600V	23F317	.85
G	4	600V	TLA	.79
B	4	1000V		1.30
B	5	600V		.65
B	5	1500V		2.50
B	6	600V		.79
B	7	600V		.89
B	7	800V		.98
B	8	600V		1.05
O	8-8	600V		1.20
F	8-8	600V		1.35
B	10	600V		1.35
B	15	1000V		3.45
B	42	600V		4.95

BATHTUB CONDS.

Capacity	Voltage	Terminals	Price
2x.01	600	ST	.20
2x.02	600	ST	.20
.02	1500	ST	.35
.025	600	ST	.20
2x.04	600	ST	.20
.05	600	ST	.18
.05	600	TT	.18
.05	1000	TT	.24
.05	1400	ST	.35
2x.05	600	ST	.21
2x.08	600	ST	.21
.1	600	ST	.24
.1	1000	ST	.30
.1	1200	ST	.34
2x.1	400	ST	.20
2x.1	400	TT	.12
2x.1	400	BT	.12
2x.1	600	TT	.28
2x.1	600	BT	.28
2x.1	600	ST	.28
2x.1	1000	ST	.35
3x.1	400	ST	.24
3x.1	400	TT	.24
3x.1	600	ST	.33
3x.1	600	BT	.33
.25	300	ST	.18
.25	600	ST	.25
.25	600	TT	.25
.25	600	Matchbox	.18
.25	1000	ST	.32
2x.25	400	ST	.24
2x.25	600	ST	.30
2x.25	1000	ST	.35
.3	400	ST	.15
.5	400	ST	.22
.5	400	TT	.22
.5	600	ST	.29
.5	600	TT	.29
.5	1000	ST	.35
2x.5	400	ST	.25
2x.5	600	ST	.30
1	100	ST	.12
1	300	ST	.18
1	400	ST	.24
1	600	ST	.32
1	1000	ST	.40
2x1	400	ST	.30
2x1	600	ST	.40
2	400	ST	.42
2	600	ST	.50
2	600	TT	.50
4	50	ST	.23
4	100	ST	.30
25	25	ST	.15

Special Bathtub Kit 12 @ $1.00

RHEOS. & POTS.
See Sept. Issue

MOLDED PAPER CONDS.

.004, .01, .03—600V @ $4.50 per "C"
.01, .03, .05—400V @ $3.50 per "C"
.01—1000V @ $10.00 per "C"

NEW MICA CONDS.

6mmfd to 750 mmfd .... .04
1000 mmfd to 6000 mmfd .... .045
10,000 mmfd .... .06

mmfd	mmfd	mmfd	mmfd	mmfd	mmfd	mmfd	mmfd
6	350	39	600	140	1500	240	
10	390	50	750	150		250	6000
15	400	75	1000	185		300	10,000
25	500	100		200	5000		

Special Mica Kit—100 @ $2.95

CERAMICON CONDS.

10, 56, 100, 500, 1000 and 5,000 mmfds @ $5.00 per "C"

TYPE "J" POTS $.60 & $.70*

SYMBOLS: LS—Locking Type Shaft
S—Screwdriver, R—Round

Ohms	Shaft	Ohms	Shaft
50	1/4S	*25000	1/8LS
*60	1/8LS	*25000	1/8S
300	3/8R	*30000	1/4S
400	1/8LS	*40000	1/8LS
*1000	1/4S	*50000	1/8LS
*1500	1/8LS	50000	1/4S
*2000	1/8LS	50000	1/8S
*2500	3/8S	*75000	3/8R
*3000	1/2R	*100000	1/8LS
5000	1/8S	*100000	1.OR
*5000	1/8LS	*100000	1/8S
10000	1/4S	*100000	3.8R
*10000	3/8R	*150000	1/8LS
*10000	1.OR	*150000	1/8LS
*10000	1/8LS	*150000	2 1/8R
15000	1/8LS	*150000	3/8R
*20000	1/8LS	*200000	3/8S
*20000	3/8R	*250000	1/8S
*25000	3/8R	*1 Meg	1/8S

TYPE "JJ" $1.50

2K	3/8R	300K	1/8LS
1K-5K	3/8R	1 Meg	1/2R
25K	1/8LS		

CONDENSER SPECIAL

5—5 mfd—400 vdc Oil Cond.

3 terms. bot. mntgs flanged type. Dims 3¾ x 3½ x 2. Tested at 1800v. Meets commercial specs. for 600v. operation up to 40 degrees C. Currently being used for power factor correction. Numerous applications for this high quality condenser. See symbol "F".

Price $.55—CARTON of 24 $.45 ea.

BAKELITE TOGGLE SWITCHES

SPST 3A. 250V, 7/16" Bushing, Ball Handle (On-Off) .18
SPST 3A. 250V, ⅜" Bushing, ⅛" SD shaft.... .18
SPDT Type C-H 8800 K4, 7/16" Bushing, Bat Handle (On-Off-On) .... .34
DPST 3A. 250V, 7/16" Bushing, Bat Handle.... .30
DPST Type C-H 8823K4, 7/16" Bushing, Bat Handle .35
DPDT 3A. 250V, 7/16" Bushing, ¾" Shank, ½" Ball Handle .... .44
DPDT Type C-H 8824K4, 7/16" Bushing, Bat Handle .48

COAX CONNECTORS

83—1SP	$.28	83—1J	$.64
83—1SPN	.28	83—1R	.28

FREQ. METER
Type BC—906 C

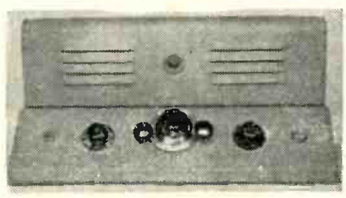
150—225 megacycles. Brand new. Boxed. Price $11.95

NAVY RADIO
RCVR RAK-7

15—600 KC .... Complete $89.00

$59.50 ELECTRONIC RADIO ALARM

Make It Secure



Guaranteed new, functionally perfect and designed by a leading manufacturer. Uses balanced bridge principle. Intrusion operates any external alarm system, (Bell, horn, light, etc.) Automatic reset. Protects any ungrounded object, room or bldg. Safe, cabinet, window screen, screening under window or door. Protection against injury by high voltage, hazardous equip and locations. Added feature includes built in fire detector. Operates alarm at 160 deg. F. Complete with instructions.

Price F.O.B., 25% with order. Balance C.O.D. Minimum order $2.00.
PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

MONMOUTH RADIO LABORATORIES

BOX 159 OAKHURST, N. J.

AVAILABLE FROM STOCK
HUGE INVENTORIES
AT LIFE ELECTRONIC SALES

½—1—2 WATT RESISTORS
5—10—20 WATT POWER RESISTORS
25 AND 50 WATT RHEOSTATS
POTENTIOMETERS

UG CONNECTORS
UHF CONNECTORS
AN CONNECTORS
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LIFE ELECTRONIC SALES
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RECEIVING AND TRANSMITTING TUBES
CRYSTAL DIODES—SOCKETS

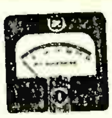
REGULAR AND SILVERED MICA CAPACITORS
TRANSMITTING MICA CAPACITORS
OIL CAPACITORS—ALL TYPES

3AG—4AG—8AG FUSES—FUSE HOLDERS

SENSITIVE SIGMA RELAY
Adjust. From 750 UA to 1.5 MA. 8000 ohm Coil S.P.D.T. 2.29 ea. 10 for 19.50

PEAK ELECTRONICS CO.
COMPONENTS
SELECTED AND GUARANTEED SURPLUS AT A FRACTION OF ORIGINAL COST.
188 WASHINGTON ST., NEW YORK 7, N.Y.
Phone COrtlandt 7-6443 7-6486

POWER TRANSFORMER SPECIAL
740 volt CT @ 185 ma., 6.3 V @ 5 A., 5 V @ 3 A. 110 V 60 cy. pri. $3.49 ea.

PANEL METERS
GE—General Electric
WH—Westinghouse
W—Weston S—Simpson
SU—Sun
*—Special Sale
SQ—Square Case

2" Meters

0-500 UA, WH*	$2.95
0-5 MA, S. SQ*	2.45
0-5 MA, GE*	1.95
0-20 MA, S*	1.75
0-25 MA, SU*	1.75
0-50 MA, SU*, SQ	1.95
0-5 MA, GE	2.45
0-2 AMP RF, S, SQ	1.95
0-4 AMP RF, GE	1.95
0-9 AMP RF, WH.	1.95
0-250 MA, AC, GE	2.95
0-20 VOLT DC, W	2.45
0-30 AMP DC, GE	1.95

6" Meters

0-1.5 AMP DC, GE.	$6.95
0-300 VAC, GE	7.95
0-12 KVDC, GE	12.95

3" Meters

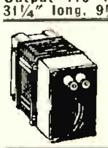
0-20 UA, W*	$12.50
40-0-40 UA, W*	7.95
50-0-50 UA, GE	8.95
0-75 UA, GE	9.95
0-1 MA, S*	4.50
0-2 MA, WH, S	3.95
0-5 MA, GE, SQ	3.95
0-10 MA, WH*	2.95
0-20 MA, S, WH	3.95
0-20 MA, GE, SQ	3.95
0-30 MA, GE, SQ	3.95
0-80 MA, WE	2.95
0-100 MA, GE, SQ	3.95
0-200 MA, GE, SQ	3.95
0-300 MA, GE, SQ	3.95
0-2 AMP, GE, SQ	3.95
0-2 AMP, WH	3.95
0-15 VOLT AC, GE	3.95
0-300 VAC, GE, SQ	3.95
0-30 VOLT DC, DA	2.75
0-2KV DC, GE, SQ	7.95
0-3KV DC, GE, SQ	8.95

POWER TRANSFORMERS
Hermetically sealed. Pri. 110 Volts 60 cy.
1110 volts CT 60 MA, 920 volts CT 160 MA. 6.3V. 18A, 6.3V, 1.25V, 5V2A, 5V2A......4.95 ea.
300 volts CT 300 MA, 2.5V7A, 2.5V7A, 0.3V, 1.5A 2.75
1050 volts @ 20 ma. 20V, 4A, 2.5V, 5A........ 2.75
4400 VC 4.5 MA, 5V 3A, 15 KV INS........ 4.95

FILAMENT TRANSFORMERS
110 V 60 CY Primaries—Full Casings
2.5V 10A, HV INS. .3.95 2.5V 20A, 2.5V 20A. .6.95

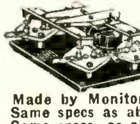
MISCELLANEOUS BARGAINS
.02 400 volt dc........15 for $0.99
Var. cond. 150 mmf 07 spacing........ 2 for .99
50 meg 35 watt Resistor........ .99
2 meg 5 watt Resistor........ .49
250 mmf Midget Var, Ceramic Ins........ .69
15 mmf Midget Var, Ceramic Ins........ .39
4PST Lever Switch........ .89
Ceramic RF Switch SP 11 Pos........ .89

SOLA CONSTANT VOLTAGE TRANSFORMER
2 KVA., 17.4 amps., Input 95 to 135 volts 60 cy. Output 115 volts constant. Type 4, single phase. 31¼" long, 9½" high, 7½" wide.......$137.00 each



RAYTHEON SWINGING CHOKE
2 to 12 Henrys, 1 Amp to 100 Ma, 15 Ohms DC fully cased. High voltage insulation, ceramic insulators. Very conservatively rated. Weight 60 Lbs. $14.95 ea

HIGH WATTAGE ANTENNA RELAY



110 220 volt 60 cycle Solenoid. D.P.D.T. Heavy duty paralleled contacts rated at 5000 Volts @ 15 Amps. Sturdy Construction. Isolantite insulation. Base 8"x -0½".
Made by Monitor Controller........ $18.50
Same specs as above but DPST........ 12.50
Same specs. as above but SPDT........ 12.50

GUARDIAN LATCHING RELAY
SPDT, 110 V 60 cy Coil, 15 Amp Contacts......$1.95

SENSITIVE RELAY
2000 ohm coil, SPDT, breaks at 3 MA, plugs into 6 prong socket........$.99 ea.

CHOKE BARGAINS

O-Open Frame		C-Cased	
6 Hy, 50 MA, O	$0.39	6 Hy, 400 MA, C	$3.69
6 Hy, 80 MA, O	.69	4 Hy, 450 MA, C	3.95
8 Hy, 175 MA, C	1.49	5 Hy, 170 MA, C	1.35

WIRE WOUND RESISTORS
5 watt ohms: 25-50-200-2500........$ .09 ea.
10 watt ohms: 25-40-84-400-1325-2K-4K... .15 ea.
20 watt ohms: 50-70-100-300-750-1K-1.5K 2.5K-2.7K-5K-16K-20K .... .20 ea.

CERAMICONS
MMF: 1.5, 3, 8, 10, 20, 22, 120, 500........ .05 ea.

SILVER MICA CAPACITORS
MMF: 10, 50, 60, 340, 750, 780, 1000........ .09 ea.

METER MULTIPLIERS
2 Meg 1/5 of 1% Cage Enclosed 2 KV........$3.95
2 Meg 1/2 of 1% Tubular 2 KV........ 1.95
4 Meg 1/2 of 1% Tubular 4 KV........ 3.75

100 WATT NON-INDUCTIVE RESISTORS
Ohms: 250, 500, 12,500........$0.75

OIL CONDENSERS

7 mfd 330 vac...$0.69	10 mfd 2000 vdc...$4.95
4 mfd 600 vdc... .59	2 mfd 4000 vdc..... 4.90
6 mfd 600 vdc... .79	1 mfd 5000 vdc..... 4.50
8/8 mfd 600 vdc... 1.39	.1/.1 mfd 7000 vdc.. 2.25
10 mfd 600 vdc... 1.39	.05 7500 vdc........ .85
6 mfd 1500 vdc... 2.95	.1 7500 vdc........ 1.00
10 mfd 1500 vdc... 3.75	2 mfd 6000 vdc..... 9.95
2 mfd 2000 vdc... 2.25	2 mfd 7500 vdc.....12.75
8 mfd 2000 vdc... 3.95	.65 mfd 12.500 vdc..12.95

HIGH CURRENT MICAS
Type G4 Ceramic Case 5¾" High, 5" Diameter Tolerance 5% or Better.

CAP MFD	Amps I Mo	KV DC	Price Each	CAP MFD	Amps I Mc	KV DC	Price Each
08	60	4	$27.50	.009	40	15	$29.50
.1	70	4	29.50	.01	43	15	29.50
.05	60	5	24.50	.002	21	20	27.50
.037	45	6	26.50	.0031	26	20	29.50
.02	40	9	29.50	.001	18	.25	26.50
.0075	39	15	24.50	.0005	9	30	26.50
	TYPE G1			.005	30	20	32.50
.00024	4	6	3.95	.003	.40	25	47.50

BAKELITE CASED MICAS

MFD	VDC	Price	MFD	VDC	Price
.001	600	$ .18	.025	2500	$1.25
.002	600	.24	.002	2500	.45
.01	600	.26	.004	2500	.50
.02	600	.26	.005	3 KV	.90
.027	600	.26	.0001	5 KV	.70
.01	1 KV	.45	.001	5 KV	1.60
.002	1200	.35	.005	5 KV	2.50
.033	1500	.75	.0005	8 KV	2.90
.02	2 KV	.90	.0003	8 KV	2.50
.005	2500	.55			

30 WATT WIRE WOUND RESISTORS
Ohms: 100-2500-3k-4500-5300-18k........8 for .99

ADJUSTABLE SLIDER RESISTORS
20 Watt: 1, 5, 50 Ohms........ .25
50 Watt: 100, 500 Ohms........ .35
75 Watt: 100, 150, 200 Dhms........ .39
100 Watt: 20, 50, 75, 120, 500 Ohms........ .49

1% W. W. RESISTORS
Dhms: 2K, 5K, 8500, 50K, 95K........ .25 ea.

PIGTAIL MICAS
MMF: 5, 20, 50, 60, 100, 250, 300, 400, 500, 750, 800, 1000, 2000, 3000, 4000, 5000, 6000, 10,000.. .09 ea.

CAN'T KINK

3 cond. 5/16" dia. Tough rubber cov. cable. For remote or Ant. Control-Foot switch etc.
Cut to your order Min. 50 ft......... 3½¢ ft.
550 ft. Metal reels Express Collect.... $15.00

RCA 100A

Free Floating Cone Type-Magnetic-Loud Speaker. Removed from rooms of a large N. Y. Hotel. Original cost $32.00..........................$1.85
3 for $5.00

W.E.
24 & 12 volt Telephone lamp..........doz. $1.50

C/H
4 pole 35 ampere 115v. AC relay.......... $4.90

3 ampere G.E. Mercury Switch
½" glass tube......................3 for $2.50

GRAIN OF WHEAT LAMPS

Used for illuminating meters, compass, dials, airplane instruments, etc. Soldering iron removes lamp from base to use in models, doll houses, miniature trains, Xmas trees, etc.
Mazda G.E. 323 3V..19.A   Mazda G.E. 328 6V..2A
Either type, doz. $1.80

MARKTIME 5 HOUR SWITCH

A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE.... $3.90

Also available in 15 min.-30 min.-1 hr. at $5.90

ISOLATION TRANSFORMER $1.95

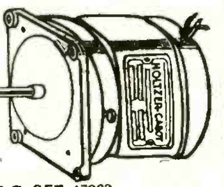
Nat. known Mfgrs. 50 watt 2 windings, 115 V. to 115 V. 60 cy. Ideal to prevent shocks from small radios and medical and electronic devices.
Shipping Weight 5 lbs.
Other sizes and 220-110 in stock.

Kilowatt Demand Meter Totalizer containing heavy duty TELECHRON B-7, 1 RPM motor and hundreds of watch size gears, clutches, springs, etc. Shipping weight 2 lbs.
5 for $10.00 $2.50

RADAR MAGNETS ....$5.00 to $17.50
DPDT 6 volt Battery D.C. 10 ampere Relay .... 2 for $1.95
DPDT H&H Toggle Switches 10 for $4.50

NEW HOLTZER-CABOT TOTALLY ENCLOSED MOTORS

50 R.P.M. Reversible Single Phase Capacitor-Run type. 115 Volts AC 60 cycle 0.3 Amp. Torque 100 oz. Inches. 4¾" shaft ⅜" dia.



$17.50 each

GONIOMETERS CFT-47263 CFT-47372 in stock

We are Authorized Wholesalers for Micro Switch Corp. and carry the largest stock of Allen-Bradley Solenoids. Potter & Broomfield Relays. Guardian Electric Co. Solenoids and Relays and Haydon Clock Motors in all speeds. Electric Counters.

EST. 1923 **BLAN** EST. 1923

Experimenters and Inventors Supplies

64 Dey St., New York 7, N. Y.

WAR EQUIPMENT MAIL SALE!

SAVE up to 70% on Electronic, Radio, Mechanical Equipment!

For home experimenters, laboratories, schools, etc. New fully guaranteed. Fraction of original cost. 100s of items including:

- 2500-w, 60-c, 110-v Plants....... $289.20
- 1500-w, 400-c 110-v (A-C Plant).. 129.60
- 1000-w, 800-c, 115-v generator... 18.96
- General Electric Wall Heater, 3000 watt, 110-220-volt 26.80
- General Electric Selsyns (pair)... 3.39
- Raytheon 110-v Electric Timer..... 8.94
- Meg-A-Lite Continuity Tester.... 1.99
- Resistor, Capacitor Asst. 4 lb..... 1.89
- City Desk Telephones.......... 5.98
- Photo Cell Light Control Kit..... 4.87
- Other bargains—Compressors, Paint Spray Guns, Engines, Pumps, Tools, etc.

18 yrs. in business in Lincoln. Satisfaction Guar. We prepay all shipments.

Card brings catalog, 1000s bargains.

FREE CATALOG **BURDEN SALES COMPANY**

842 "O" St. Lincoln, Nebr.

BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

POWER RHEOSTATS

Ohms	watt	ea.	Ohms	watt	ea.
.5	25	.98	150	50	1.76
2	225	8.10	150	150	3.51
3	100	2.93	200	25	.98
3	225	8.10	200	150	3.51
4	225	8.10	225	50	1.76
5	50	1.76	250	25	.98
5	100	2.93	350	25	.98
5	150	3.71	350	100	2.74
6	25	.98	378	150	3.51
6	50	1.76	400	25	.98
7	25	.98	500	25	.98
8	50	1.24	500	75	4.05
10	25	1.56	585	150	3.51
10	100	2.74	750	25	1.56
12	25	1.56	750	150	3.71
15	25	.98	1000	25	1.76
16	50	1.76	1200	225	8.10
22	50	1.76	1250	50	1.85
25	25	.98	1250	150	3.71
32	300	5.27	1500	50	1.85
50	25	.98	2000	25	1.76
50	50	1.76	2000	50	1.24
50	750	17.75	2500	100	2.93
60	25	.98	3000	25	.98
75	150	3.51	3000	100	2.93
80	50	1.76	5000	25	1.85
80	500	7.61	5000	50	1.95
100	25	.98	7500	50	1.95
100	50	1.24	7500	100	3.32
100	225	8.10	10000	50	1.95
125	25	.98	10000	100	3.51
125	500	7.61	20000	150	6.31

Specify whether shaft required is for knob or screwdriver adjust. (Discount to Quantity Users.)

SELECTOR SWITCHES

Pole	Pos.	Deck	Type	Each
1	6	1	Bak-shtg	.38
1	11	1	Bak-n/shtg	.60
1	21	3	bak-n/shtg	.89
1	24	2	bak-n/shtg	.89
2	2	1	cer-shtg	.50
2	6	2	bak-n/shtg	.60
2	8	2	bak-shtg	.68
2	11	2	bak-shtg	.75
3	4	1	Bak-n/shtg	.53
4	4	2	cer-n/shtg	.98
4	11	4	bak-shtg	1.25
5	3	2	cer-n/shtg	.98
6	11	6	bak-n/shtg	1.95
10	5	5	cer-shtg	2.25
12	2	3	bak-shtg	1.10
16	2	4	bak-n/shtg	1.35

(many other types in stock)

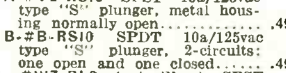
"AN" CONNECTORS

LARGE VARIETY AVAILABLE AT GREAT SAVINGS
Send your specs and let us quote

BIRTCHER TUBE CLAMPS

#926-A, #926-A1, #926-A14, #926-B, #926-B1, #926-B7 **25c.** #926-B22, #926-C, #926-C1, #926-C5, #926-C10, #926-C24

MICROSWITCHES

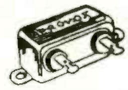


A-#YZ-RS13 SPST 10a/125vac type "S" plunger, metal housing normally open.............. .49
B-#B-RS10 SPDT 10a/125vac type "S" plunger, 2-circuits: one open and one closed...... .49
#WZ-RL8 (not illus.) SPST 10a 125 vac, leaf actuator, norm. closed .... .49
#R-RL2T (not illus.) SPST 10a 125 vac roller plunger, norm. closed .... .49
C-G.E. SWITCHETTE 10a/115voltsAC
#CR1070-C103A3 SPST closed .. .49
#CR1070-C103E3 SPST open .... .49
#CR1070-C103R3 SPST closed .. .49
#CR1070-C123C3 DPST op/cl ... .49
(Many other types in stock)

OIL CONDENSERS

Mfd	VDCW	Each
.1	3000	.75
.1	6000	1.89
.1	20,000	19.95
.25	3000	1.10
.5	1500	.89
1	600	.49
1	2000	1.95
2	400	.49
2	600	.59
2	1000	.79
4	600	.98
6	400	1.05
6	600	1.15
10	600	1.49
14	600	2.49
15	600	2.79
15	1000	3.75
2 x .1	7000	4.95
2 x .5	9000	16.95

BATHTUBS



mfd	vdcw	each
.033	400	.19
.05	200	.19
.05	400	.22
.05	600	.26
.1	400	.24
.1	600	.27
.1	1000	.35
.15	600	.27
.25	200	.22
.25	600	.28
.35	400	.25
.5	400	.28
.5	600	.30
.5	1000	.39
1	200	.35
1	600	.40
2	400	.46
2	600	.69
4	50	.25
8	500	.59
25	50	.31
25	75	.33
40	25	.30
50	25	.31
200	12	.40
300	6	.45
.05-.05	600	.33
.05-.05	1500	.55
.1-.05	200	.25
.1-.1	400	.32
.1-.1	600	.34
.16-.16	600	.34
.2-.2	600	.34
.25-.25	600	.34
.5-.5	600	.39
1.0-.1	300	.35
200-200	9	.55
3 x .05	600	.37
3 x .1	400	.42
3 x .1	600	.47
3 x .25	600	.50
3 x 1.0	100	.49

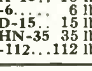
"UG" Connectors

UG-12/U...... $1.10
UG-13/U...... 1.49
UG-18/U...... 1.15
UG-19/U...... 1.18
UG-21/U...... .98
UG-22/U...... 1.05
UG-24/U...... 1.10
UG-25/U...... 1.15
UG-27/U...... 1.75
UG-57/U...... .89
UG-58/U...... .63
UG-123/U..... .40

SHOCKMOUNTS

100P-1	1 lb.	.10
100P2	2 lb.	.10
100PR-2	2 lb.	.10
100P-3	3 lb.	.10
100P-4	4 lb.	.12
100P-6	6 lb.	.15
150P-4	4 lb.	.15
150PH-8	8 lb.	.22
150PH-15	15 lb.	.25
156P-6	6 lb.	.20
200PD-15	15 lb.	.27
200PHN-35	35 lb.	.49
204P-112	112 lb.	.50

TERMINAL BOARDS



5 terminal ...... .59
8 terminal ...... .98
12 terminal 1.49

TYPE "J" POTENTIOMETERS

TYPE "J" .95¢

ohms	ohms	ohms
65*†	2000*	30K†*
100*	2000†	50K*†
200†	4000†	75K†
300†	5000*	100K*
400*	5000†	100K†
500†	10K*	200K*
600†	10K†	200K†
750†	15K*†	250K*
1000*	20K*	250K†
1000†	20K†	1meg*
1500*†	25K*†	2meg*

TYPE "JJ" $1.95

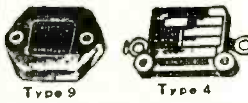
ohms	ohms
100-100*	100K-100K*
200-200†	100K-100K†
500-500*†	150K-150K†
600-600†	250K-250K†
1500-1500†	350K-5000†
2000-2000*	350K-25K†
2000-2000†	500K-8000†
2200-24K†	700K-700K†
20K-2000†	800K-75K†
25K-10K†	1meg-1meg†
35K-5000†	2meg-2meg†
50K-50K†	5meg-5meg†

TYPE "JJ" $2.95

ohms	ohms
20K-200K-20K†	750K-750K-750K†
45K-27K-2500†	800K-800K-800K†
700K-700K-700K†	1meg-1meg-1meg†

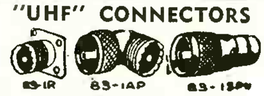
* ⅛" screwdriver slotted shaft.
† Knob type shaft.
(Many other types in stock)

TRANSMITTING MICAS



mfd	vdcw	type	ea.	mfd	vdcw	type	ea.
.00001	600	4	.18	.00162	600	4	.18
.00003	600	4	.18	.002	600	4	.20
.00005	600	4	.18	.002	1200	4	.48
.00005	2500	9	.31	.0022	2500	9	.78
.0001	600	4	.18	.0025	600	4	.23
.0001	2500	9	.31	.003	600	4	.25
.000152	600	4	.18	.0039	600	4	.25
.0002	600	4	.18	.005	600	4	.25
.00025	600	4	.18	.005	1200	9	.60
.0005	600	4	.18	.005	2500	9	1.18
.0051	2500	4	.43	.0062	600	4	.30
.0007	600	4	.18	.01	600	4	.40
.0008	600	4	.18	.01	600	9	.49
.0009	600	4	.18	.01	1200	9	.98
.001	600	4	.18	.0142	600	4	.45
.001	1200	4	.31	.02	600	4	.55
.001	1200	9	.31	.02	1250	9	1.36
.0013	600	4	.18	.027	600	4	.66
.0015	600	4	.18	.043	600	4	.99

"UHF" CONNECTORS



Cat. No.	Army No.	Each	Per C
83-1AC		.42	.39
83-1AP	M-359	.35	.28
83-1D	PL-271	1.25	1.00
83-1F	PL-274	1.10	.90
83-1R	SO-239	.40	
83-1SPN	PL-259A	.40	.35
83-22R	SO-264	.50	.40

Connectors

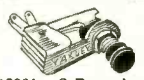
S-304-CCT .... .25
P-306-AB .... .16
P-306-CCT-L .... .33
S-306-FHT .... .24
S-308-AB .... .21
P-312-AB .... .24
P-312-CCT-L .... .42
P-315-FHT .... .40
P-315-EB .... .30
P-315-CCE .... .40
S-315-AB .... .36
S-318-AB .... .43
P-324-FHT .... .74
P-324-EB .... .58
S-330-AB .... .84
S-404-AB .... .33
P-406-AB .... .33
S-406-CCT .... .58
S-408-CCT .... .69
S-2408-SB .... .53
P-2412-SB .... .61
P-502-CE 1.10
S-502-DB .... .97
P-508-CE 2.55
P-510-CE 3.04
S-510-SB 2.64
P-512-CE 3.52

BARRIER STRIPS

2-140-Y .... .13
5-140-Y .... .28
6-140-Y .... .33
9-140 .... .34
10-140-Y .... .53
10-140-3/4W ..... .53
10-240 .... .38
13-140 .... .48
4-141-W .... .30
4-141-3/4W ..... .30
5-141 .... .26
7-141-Y .... .49
11-141-Y .... .76
12-141 .... .58
12-141-Y .... .82
13-141 .... .62
13-141-Y .... .89
15-141-Y 1.02
2-142-Y .... .20
4-142-Y .... .36
8-142 .... .48
10-142-3/4W ..... .85
11-142 .... .65
3-150 .... .53
4-150-Y .... .83
4-151 .... 1.30
5-151 .... 1.60
4-152 .... 1.89

(Many other types in stock)

MALLORY PUSH SWITCH



#2001 S.P. make cont., non-L............33¢
#2003 S.P.D.T., non-lock..............35¢
#2003L S.P.D.T., lock..................35¢
#2004 D.P., make 2 non-L..............40¢
#2004L D.P., make 2 lock...............40¢
#2006 D.P.D.T., non-lock...............49¢

Open a/c to Rated Concerns. Prices net FOB our whse NYC and subject to change without notice.

SEND FOR BARGAINGRAM #503

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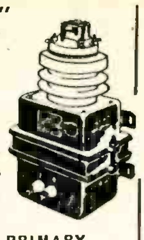
IT'S THE LAST OF OUR LUCKY BUYS!

It's the end! These thousands of other items were bought at a fraction of their true worth—but it's the last of all Surplus buys everywhere because of Gov't. curtailments. When these are gone, there will be no more—so order now while present quantities last. Many items in stock not listed here — so send us your requirements.

TRANSFORMER "BUYS"
Prices Drastically Reduced!

FILAMENT TRANSFORMER



For hi-voltage rectifiers. PRI. 115 V 5/50/60 cycle. SEC. 5V C/T @ 10 Amps. 35 KV R.M.S. Test 12 KV D.C. Operating. Uses 872A Tube or others...
Brand New......$9.95
872A Tube $1.49

110 V. 60 CYCLE PRIMARY TRANSFORMERS

5-V 60-amps, fine for 304-TL's....$9.95
5-V 115 amps, for welding, pipe thawing $14.95
5V 190 amps for welding, pipe thawing $19.95
40-Watt Modulation, Stancor A-3843 $2.95
125-Watt Mod. Thordarson T-19M16 $9.95

UTC LS 184 Power Transformer
7000 V ct. 500 ma Shipping Wt. 102 lbs. $69.50

UTC S-39 Power Transformer, 980 V ct. 175 ma—5V—3A, 6.3V—3A, 6.3V-3A $5.95
UTC S-41 Power Transformer, 1200 V ct —200 ma, tV-3A, 7½V—3A—6.3V —3A $4.95
UTC S-42 Power Transformer, 1200 V.6 ct-300 ma, 5V-3A, 7½ V-3A—6.3V —3A $6.25
UTC S-47 Power Transformer, 3000 ct, 2500 ct. 2000 ct at 300 ma......$9.95

MIDGET VARIABLE CONDENSERS
priced at a fraction of cost

Hammerlund MC-20-MX 20 MMF Double Spaced ....79¢
Hammerlund MC-50-SC 50 MMF Double Spaced ....79¢
Hammerlund MCD-50-M 50 MMF Split Stator $1.49
National SSD-50, 50-50 Split Stator.....$1.49

BIG SAVINGS ON CHOKES
Send us your requirements. Prompt replies.
Thordarson Swinging Choke T-19 C38, 5-20H 500 ma $8.95
Thordarson 17C OOB, 12H, 200 ma......$1.95

Big Shipment Just Received!
IMPULSE COUNTERS
Operates on 6 to 110 V., DC
$12.95

Used by laboratories and experimentors all over the world. Three separate dials count impulses from 1 to 10,000 in units of 1, 100 and 1000's. Excellent condition —priced to go fast! Hurry!

COAXIAL CABLE CONNECTORS
M-358 T Connector............98¢
M-359 Angle Adaptor............39¢
PL-274 Feed Through............98¢
PL-275 Twin Feed-Thru............89¢
UG-106U Twin Junction............69¢

BARGAINS ON NOISE FILTERS
Made especially for industrial use
Miller 7841, 5-amps............$4.95
Miller 7842, 10-amps............$5.95
Miller 7843, 20-amps............$6.95
Maximum 220 vo.
Check and compare these prices anywhere.

Brand New
Famous Standard Brands
OIL CONDENSERS

2 mfd 2500 v...$2.49	12 mfd 1500 v..$3.49
2 mfd 4000 v... 3.95	1 mfd 6000 v... 7.95
4 mfd 2500 v... 3.95	1 mfd 5000 v... 3.95
10 mfd 2500 v.. 4.95	1 mfd 3000 v... 2.49
4 mfd 4000 v... 5.95	.5 mfd 5000 v... 2.49

OHMITE POWER TAP CERAMIC SWITCHES
Non-Shorting type ceramic tap switches for high current use
Available in 5, 6, 7, 8, 9, 10, 11 and 12 contacts. Your choice............98¢ ea.
Ohmite 212-12 switch. 12 taps. Rates at 15 amps ....$1.49 ea.

Just Received! Large Quantity of Brand New AMPHENOL AN CONNECTORS @ 75% off list! Write for complete listing!

Just Unpacked! Full Library of
INSTRUCTION MANUALS

SCR 300A $1	BC-312 ....$1
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BC 191 ....$1	BC-1335 ....$1
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Teletype Manual ...$2	BC-79 ....$1
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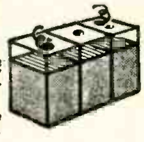
All of the above shipped postpaid

T-85/APT5 TRANSMITTER
Here's a real bargain! Priced complete with tubes. Used, but in excellent condition.......... $39.50

Galvin TS-143/CPM-1 Synchroscopes
Outstanding precision instrument for any electronic lab.
$175

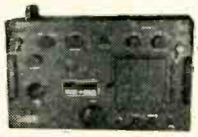
TS 164/AR Frequency Meter
Airborne version of BC-221. With original calibration book.
$75

WILLARD MIDGET 6V STORAGE BATTERY
$2.49



3 amp. hr. rating. Transparent plastic case. 3⅝" x1 13/16" x2⅜" high. New. Use standard electrolyte.

SIGNAL GENERATORS
Choice of 3
$77 ea.



I-222-A RF. Covers 2 bands— 8 to 15 mc., 150-230 mc. Can use up to third harmonic. Built-in 110 v. 60 cycle pwr. supply. Good condition.....$77
I-126 15-26 mc, 95-130 mc. with built-in powr. supply. Good condition............$77
I-126. 15-26 mc. 180-235 mc. with built-in power supply. Good condition............$77

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Prompt shipment of all orders. Cash with order. Minimum order $3.00. 35% deposit on all C.O.D. orders. Shipments by truck or RR Express collect. California buyers please add state sales tax. All prices subject to change. All merchandise subject to prior sale.

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LARGE QUANTITIES of *RADIO TUBES*

TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE
5U4G	6AG5	6D6	6K6GT	6SH7	42	813
5V4G	6AL5	6H6	6K7GT	6SN7GT	803	866A
6AB7	6C4	6J7	6N7GT	12SG7	805	1622
6AC7	6C5GT	6J5GT	6SG7	12SK7	807	9005

Packed in Original Cartons. Prices on request.
SUBSTANTIAL DISCOUNTS ON LARGE ORDERS

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NORMAN RADIO DISTRIBUTORS INC.
94-29 MERRICK BOULEVARD JAMACIA, N.Y.- REpublic 9-4651

MIRROR — front surface aluminized on optical glass 1 3/16" diameter 3/32" thick ....$.50

PRECISION LEVEL — interior ground tube level with 4 adjusting screws. Overall length 1⅝", diam. 15/32". One end with shoulder ½" diam. $.85

DELCO BLOWER — sirocco type D.C. Flange diameter 3½" blade 3-3/16" RPM @ 12 volts 3400 RPM @ 6 volts 1600 ....$3.95

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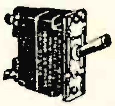

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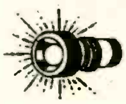

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Type No.	Current	Price
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B1-30	30.0 Amp.	24.95
B1-40	40.0 Amp.	27.95
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B2-300	300 Ma.	1.50
B2-2	2.0 Amp.	4.95
B2-3X5	3 5 Amp.	6.95
B2-5	5 0 Amp.	9.95
B2-10	10 0 Amp.	15.95
B2-20	20.0 Amp.	27.95
B2-30	30.0 Amp.	36.95
B2-40	40.0 Amp.	44.95

Input: 0-115 VAC — Output: 0-90 VDC

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B6-600	600 Ma.	5.95
B6-750	750 Ma.	6.95
B6-1X5	1.5 Amp.	10.95
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B6-5	5.0 Amp.	24.95
B6-10	10.0 Amp.	36.95
B6-15	15.0 Amp.	44.95

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Input: 10-0-10 VAC — Output: 0-8 VDC

Type No.	Current	Price
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C1-30	30.0 Amp.	14.95
C1-40	40.0 Amp.	17.95
C1-50	50.0 Amp.	20.95

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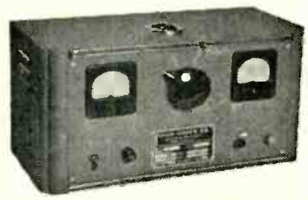

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CF-16	2000 MFD	50 VDC	3.25
CF-21	1200 MFD	90 VDC	3.25
CF-9	200 MFD	150 VDC	1.69
CF-10	500 MFD	200 VDC	3.25

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TXF36-5	36	5	8 lbs.	6.50
TXF36-10	36	10	12 lbs.	9.95
TXF36-15	36	15	20 lbs.	11.95
TXF36-20	36	20	25 lbs.	17.95
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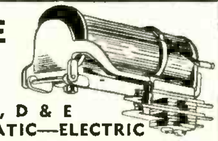

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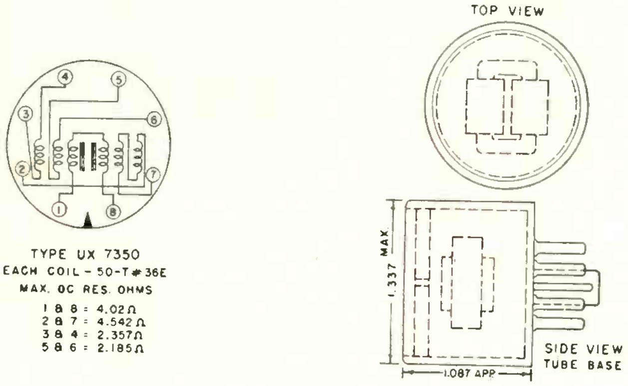

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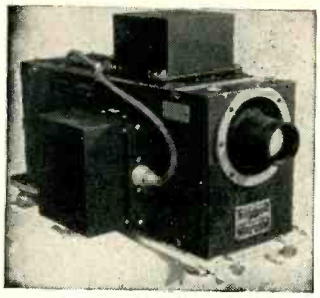

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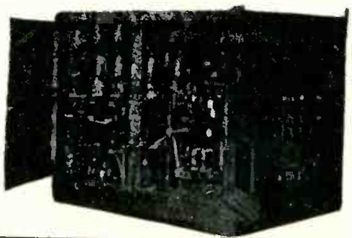

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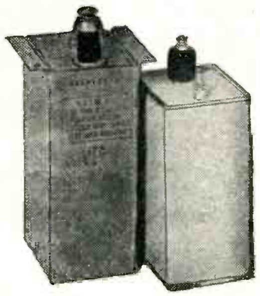

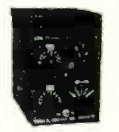
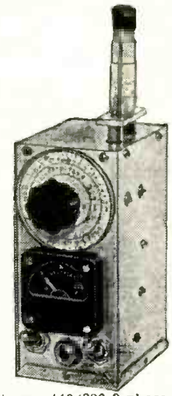

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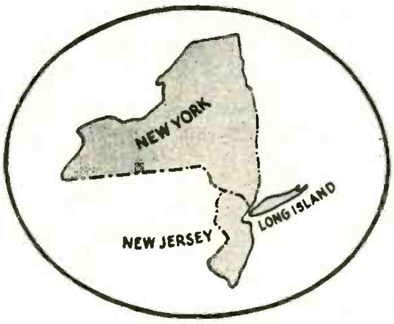

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Will measure RF signals from 80 to 3000 MCS and pulse rates from 50 to 8000 cycles. It can also locate transmitted signal sources by visual and aural indicators.

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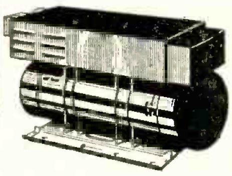

Output: 115 VAC; Single phase; PF .90; 380/500 cycle; 1500 V.A. Input: 25-28 VDC; 92 amps; 8000 rpm; Exc. volts 27.5; Leland Electric mfg.

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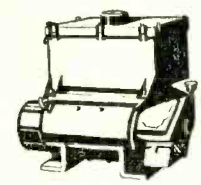

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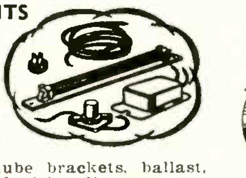

Now . . . build your own black light lal equipment at a new low cost with these easy - to - assemble components. Kit contains: Ultra-Violet tube brackets, ballast, starter, wire, plug and wiring diagram.
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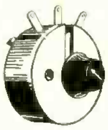

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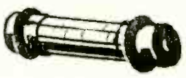

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(Continued from page 290)

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14E7 1.33
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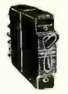

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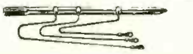

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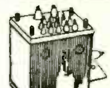

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