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A McGRAW-HILL PUBLICATION

APRIL • 1947

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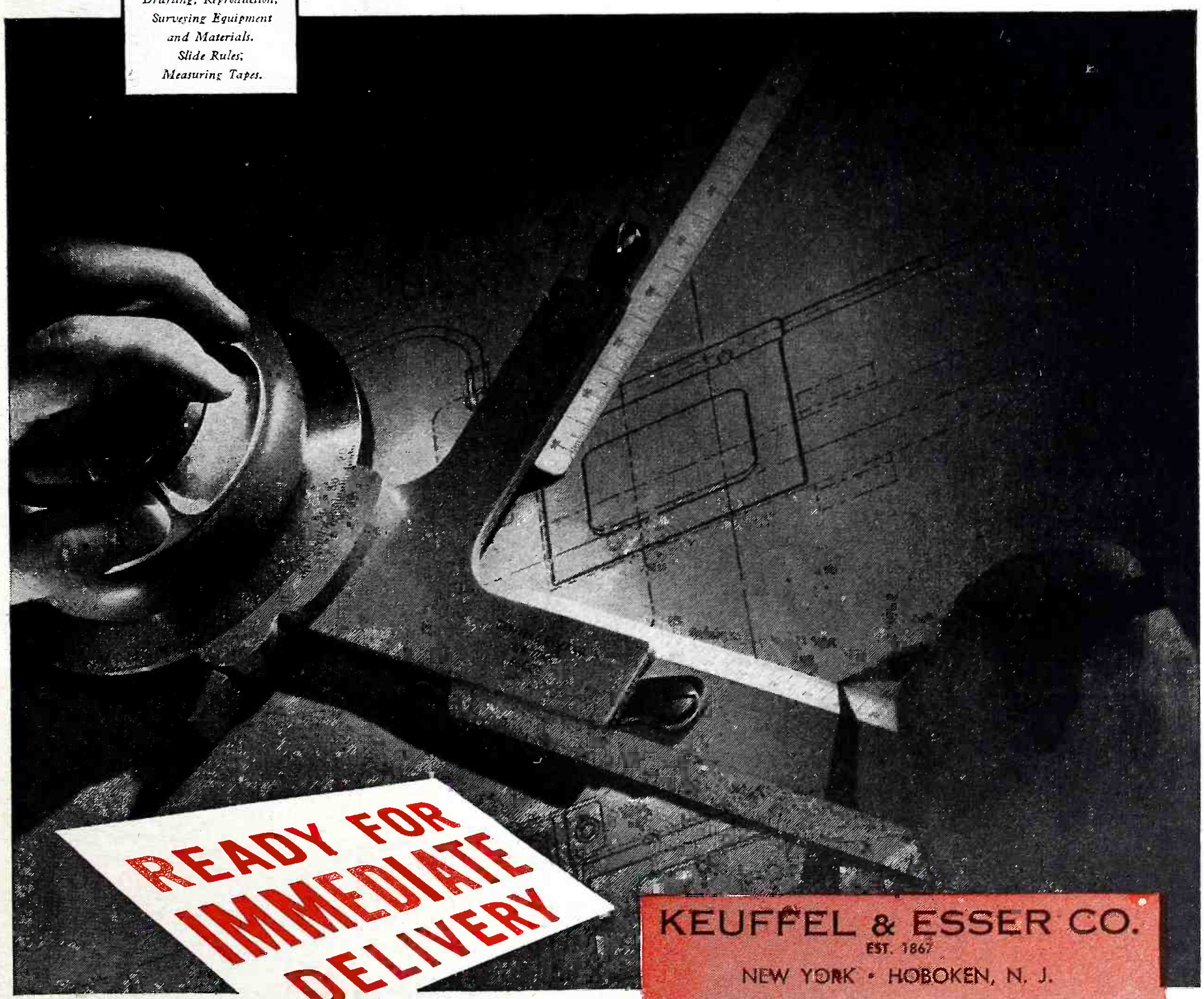

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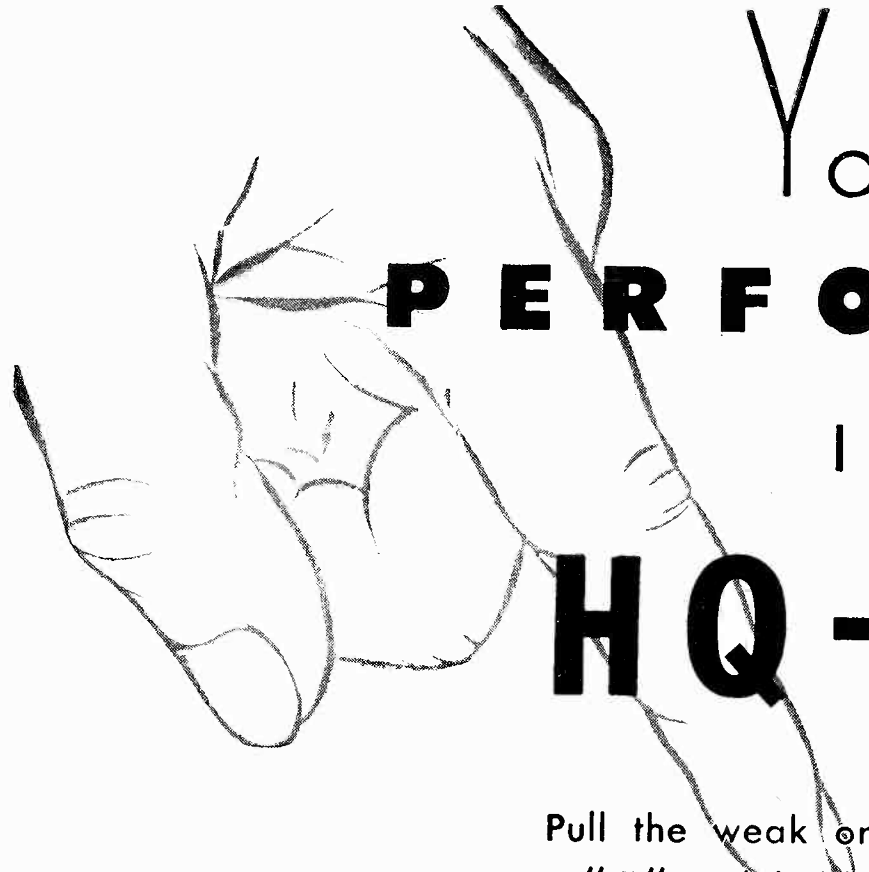
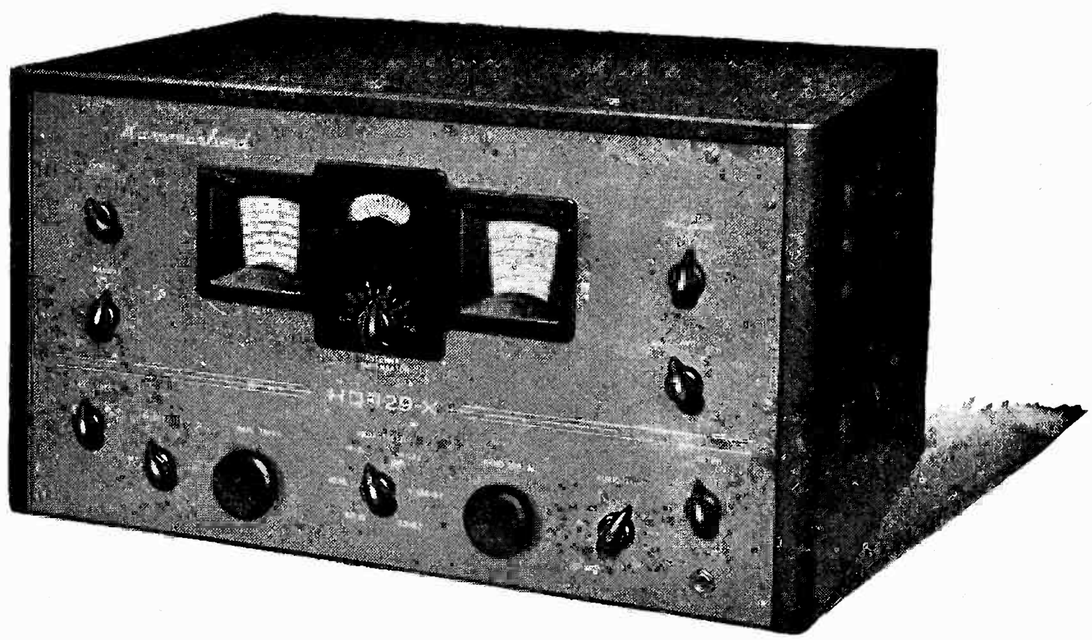


YOU BUY PERFORMANCE IN THE HQ-129-X

Pull the weak ones out of the QRM—Tune in a "ZL" and hold on to him—Turn on the noise limiter and really kill ignition noise—That is what thousands of hams are doing every day with the **HQ-129-X**



BACKED BY 36 YEARS OF KNOW HOW

see

the **HQ-129-X** at your dealer's

THE SIGN OF QUALITY

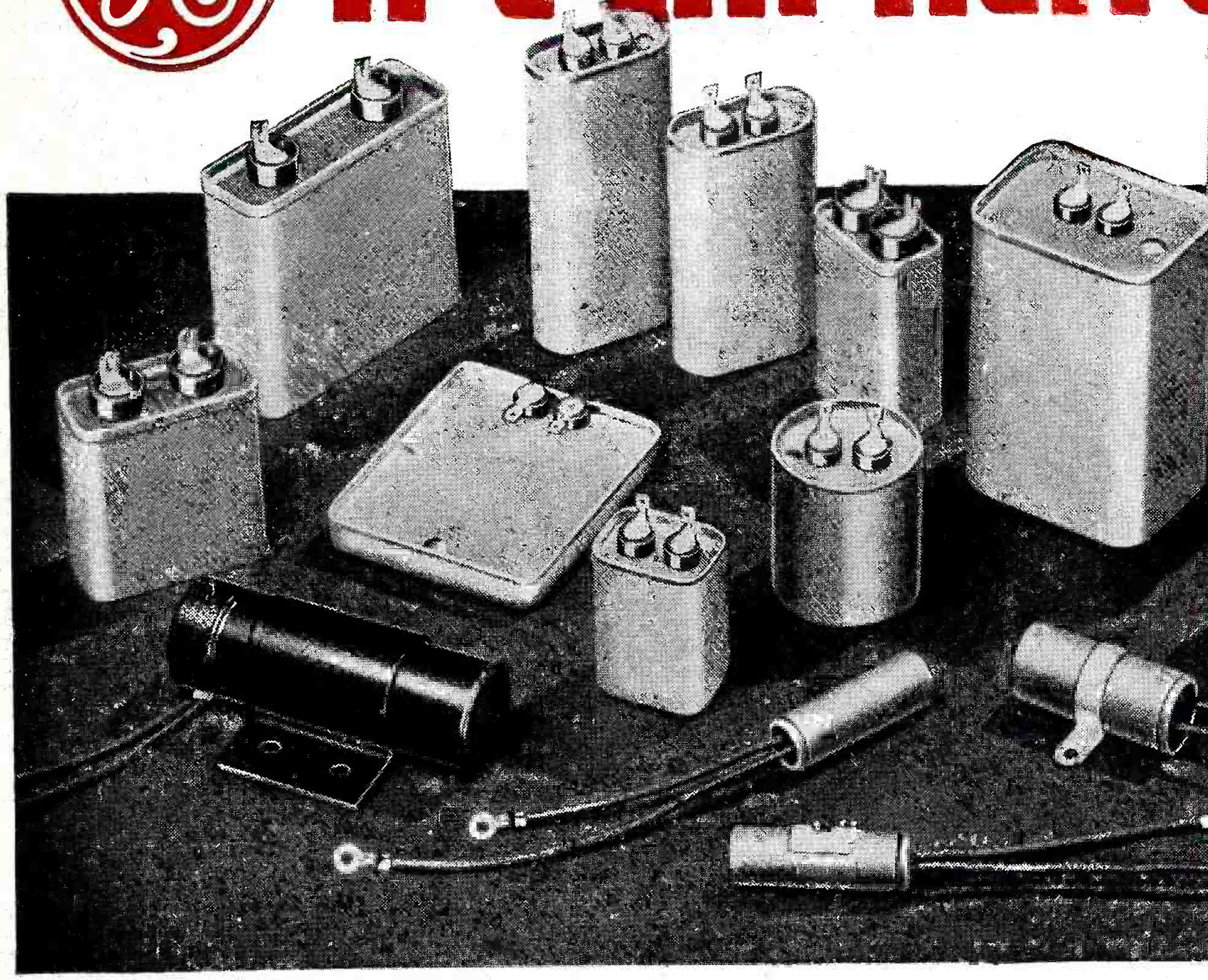
ESTABLISHED 1910

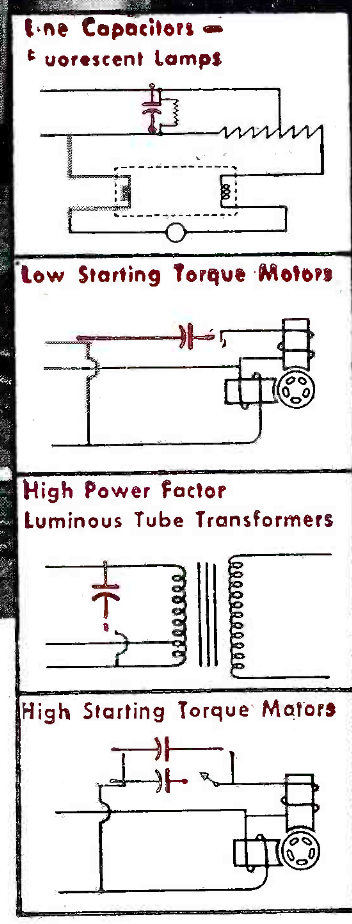
HAMMARLUND

THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., NEW YORK 1, N.Y.

MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

A-C CAPACITORS





THEIR STRENGTH ADDS "STAYING POWER" TO YOUR PRODUCTS

Capacitors needn't be the weak link in your product—they can have just as much "staying power" as any other component in your equipment.

G-E capacitors have long life. One reason for this is that they are Pyranol* impregnated. Practically all moisture, air, and gas have been withdrawn from the capacitor before the Pyranol treatment takes place. The use of Pyranol also means that these capacitors can operate at high temperatures—up to 75 C (167 F) case temperature. This eliminates one of the main causes of capacitor breakdown.

Casings, available in all standard shapes, are double-rolled, or roll-crimped and soldered, sealing the capacitor hermetically. Plastic bushings, of high dielectric strength, bring out the hot-tin dipped soldered terminals.

If you are building a quality product, here's a quality a-c capacitor that you'll never have to worry about. They're available in a broad range of voltage ratings and capacities. Write for the latest Bulletin GEA-2027C. *Apparatus Dept., General Electric, Schenectady 5, N. Y.*

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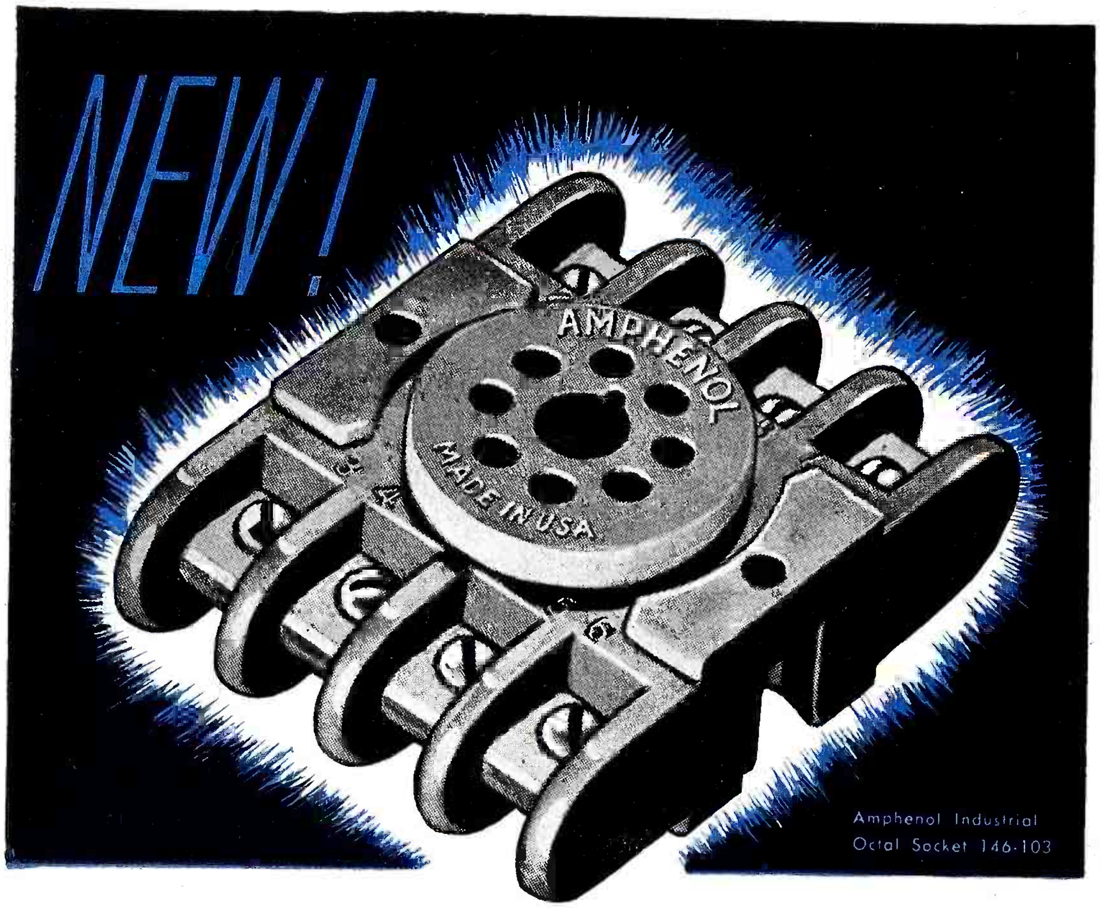
Why Manufacturers Like G-E Capacitors

1. Their price is right.
2. You can get fast shipments.
3. The range of ratings is broad.
4. Designed for small size and light weight in all ratings.
5. Their quality is unexcelled.

GENERAL ELECTRIC

407-111-5700



Amphenol Industrial Octal Socket 146-103

- First to comply with N.E.M.A. and Underwriters' specifications for industrial equipment.
- Rugged insulating barriers prevent flashover and arcing in humid and dusty industrial applications.
- Reversible binding screw terminals simplify wiring and maintenance.
- Cloverleaf contacts . . . four full length lines of contact with each tube pin.

AMPHENOL ELECTRONIC TUBE SOCKETS

designed for INDUSTRIAL applications

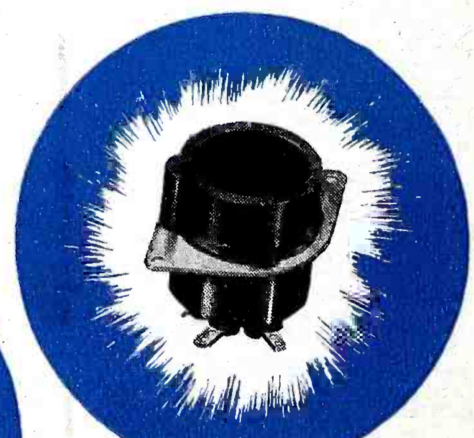
Amphenol Electronic Tube Sockets are specially designed for industrial applications. Ruggedly built for utmost dependability and peak performance, they were the first industrial tube sockets to comply with N.E.M.A. and Underwriters' specifications for industrial equipment.

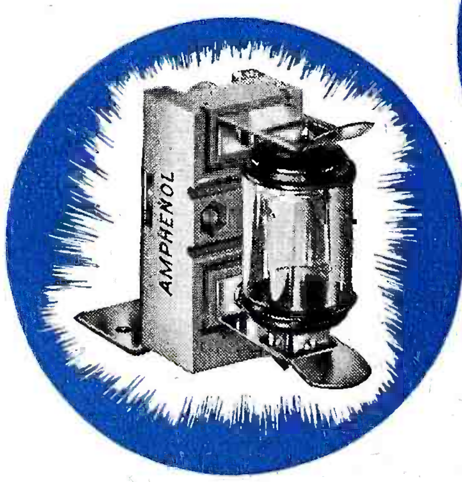
Amphenol sockets are molded of melamine resin or bakelite for strength as well as high arc-resistance and reduced carbon tracking. Utilization of the latest developments in spring bronze has insured the highest degree of contact conductivity and long spring life. Maximum spacing between contacts and chassis is maintained. Heavy insulating barriers prevent flashover between contacts under the adverse conditions found in industrial usage. Screw type terminals provide for quick connect and disconnect, ideal for testing and replacement. No soldering is required.

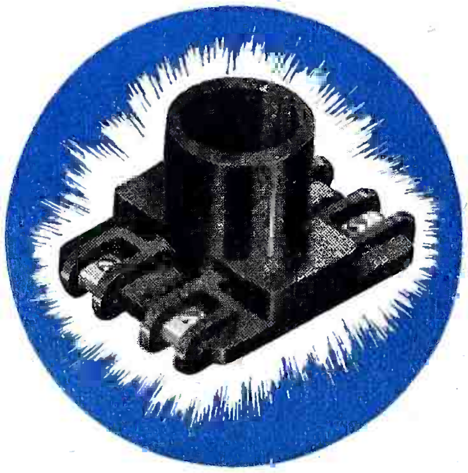
Amphenol sockets are available in types for practically all industrial electronic tubes. Write today for complete information.

AMPHENOL

AMERICAN PHENOLIC CORPORATION
1830 SOUTH FIFTY-FOURTH AVENUE
CHICAGO 50, ILLINOIS







A few of Amphenol's complete line of industrial tube sockets are illustrated

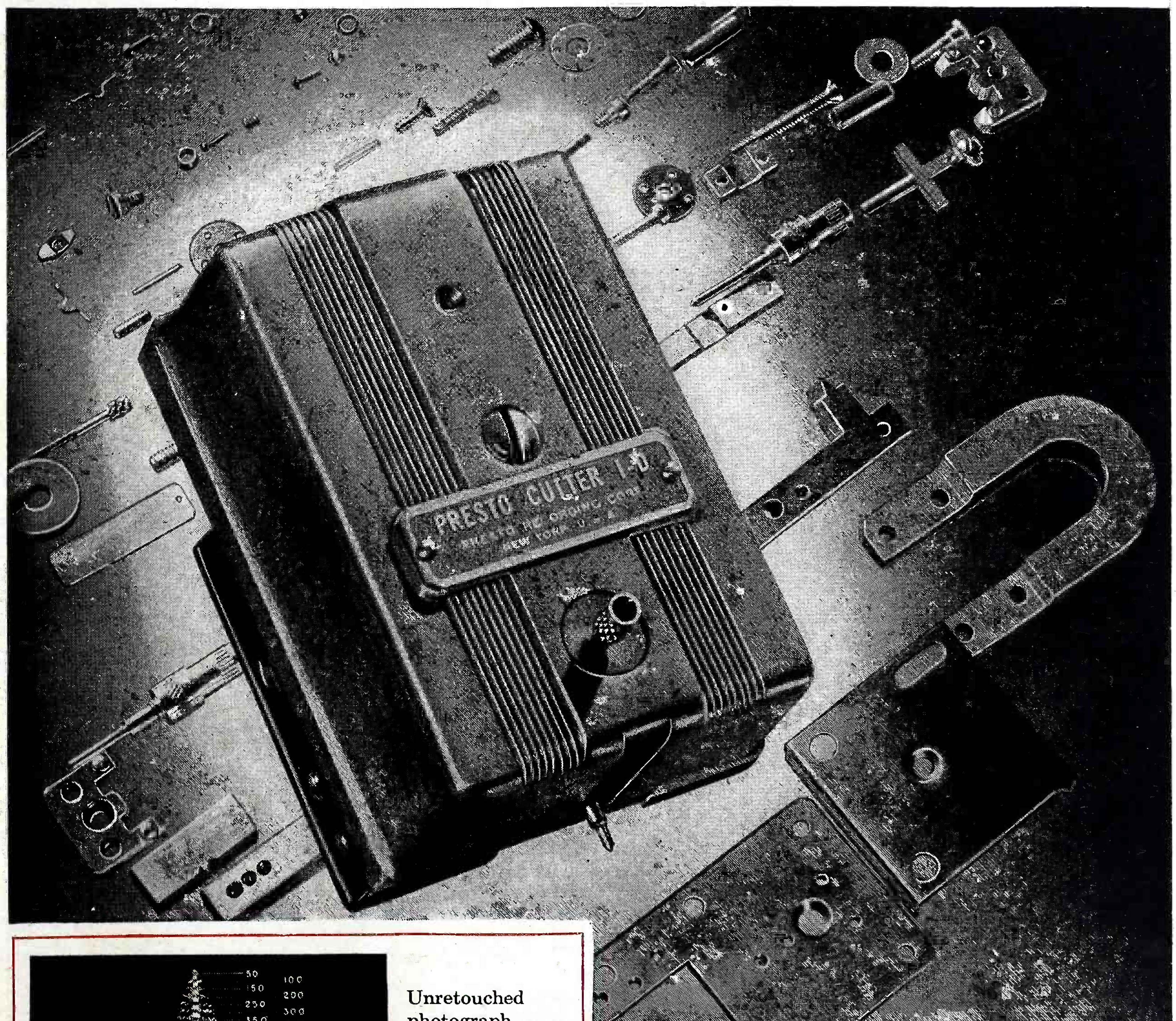
COAXIAL CABLES AND CONNECTORS • INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT • ANTENNAS • RADIO COMPONENTS • PLASTICS FOR ELECTRONICS

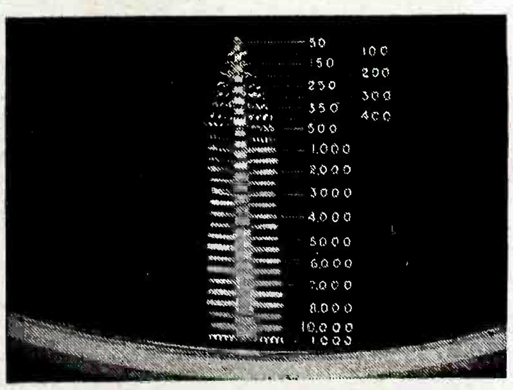
NOW! a new standard of performance in cutting heads

THE PRESTO 1-D

▶ The new Presto 1-D Cutting Head offers: *wide range, low distortion, high sensitivity* and *stability through a temperature range of 60°-95° F.* The Presto 1-D Cutting Head is a precision instrument made entirely of precisely machined parts, expertly assembled and carefully calibrated. These factors, plus its sound basic engineering design, produce a cutter unequaled in performance by any other mechanically damped magnetic device.

▶ Note from the light pattern below: The correct location of the cross-over point at 500 cycles, the 6 db per octave slope below this point, and flat response above 500 cycles, which is free from resonant peaks. The range of the cutter is 50-10,000 cycles. The Presto 1-D is damped with "Prestoflex" which is impervious to temperature changes between 60 and 95 degrees Fahrenheit.





Unretouched photograph showing the light pattern. Notice correct location of the cross-over point at 500 cycles.

PRESTO

RECORDING CORPORATION

242 WEST 55TH STREET, NEW YORK 19, N. Y.

Walter P. Downs, Ltd., in Canada

WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT & DISCS the one dependable source of supply for everything in electrical insulation

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VARNISHES

VARNISHED TUBINGS, SLEEVINGS and TAPES

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FIBERGLAS TUBINGS, SLEEVINGS and TAPES

FIBERGLAS-MICA COMBINATIONS

WAXES · COMPOUNDS · ETC.

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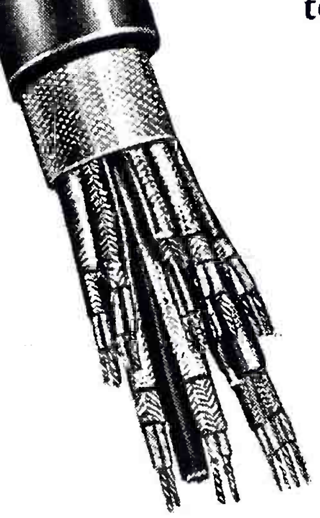
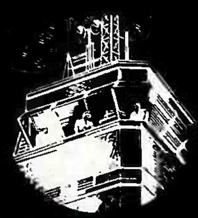
A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH · INSULATING PAPERS AND TWINES · CABLE FILLING AND POTHEAD COMPOUNDS · FRICTION TAPE AND SPLICE · TRANSFORMER COMPOUNDS · FIBERGLAS SATURATED SLEEVING · ASBESTOS SLEEVING AND TAPE · VARNISHED CAMBRIC CLOTH AND TAPE · MICA PLATE,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



Efficient electronic designing can begin with

CHATHAM RECTIFIERS

TELEVISION



COMMUNICATION

BEAMS & BEACONS

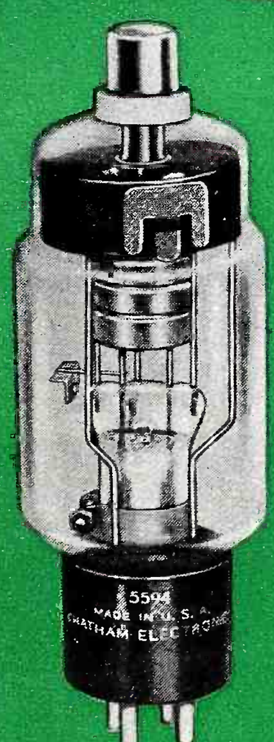
For example, the three tubes illustrated are typical CHATHAM Xenon-filled rectifiers now affording simple solutions to difficult high voltage power supply problems. Available in a wide range of types that meet practically any rectifier requirement, CHATHAM Xenon rectifiers and thyratrons operate efficiently in ambient temperatures from −75° C to +90° C. Within these temperatures no heaters, blowers or other temperature controls are required to maintain bulb temperature. Xenon gas and excellent design afford complete freedom from arc back, providing tube ratings are not exceeded.

In addition to Xenon rectifiers, CHATHAM manufactures a complete line of Mercury Vapor rectifiers and thyratrons, high vacuum rectifiers and special purpose tubes. Complete facilities are available for collaboration in the development of rectifiers of special design. Inquiries are invited; phone, write or wire your requirements.

CHATHAM ELECTRONICS

475 WASHINGTON ST., NEWARK 2, NEW JERSEY

SEND FOR YOUR COPY OF THE NEW CHATHAM CATALOG TODAY



5594 THYRATRON—

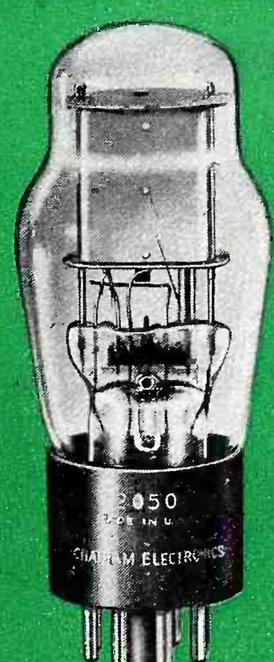
PEAK FORWARD ANODE VOLTAGE: 2500 VOLTS

PEAK INVERSE ANODE VOLTAGE: 5000 VOLTS

AVERAGE ANODE CURRENT 0.5 AMPERES

PEAK ANODE CURRENT: 2.0 AMPERES

FIL. VOLTAGE: 2.5 VOLTS



2050 THYRATRON—

PEAK FORWARD ANODE VOLTAGE: 650 VOLTS

PEAK INVERSE ANODE VOLTAGE: 1300 VOLTS

AVERAGE ANODE CURRENT: 100 MILLIAMPERES

PEAK ANODE CURRENT: 500 MILLIAMPERES

HEATER: 6.3 VOLTS

2D21 THYRATRON—

PEAK FORWARD ANODE VOLTAGE: 650 VOLTS

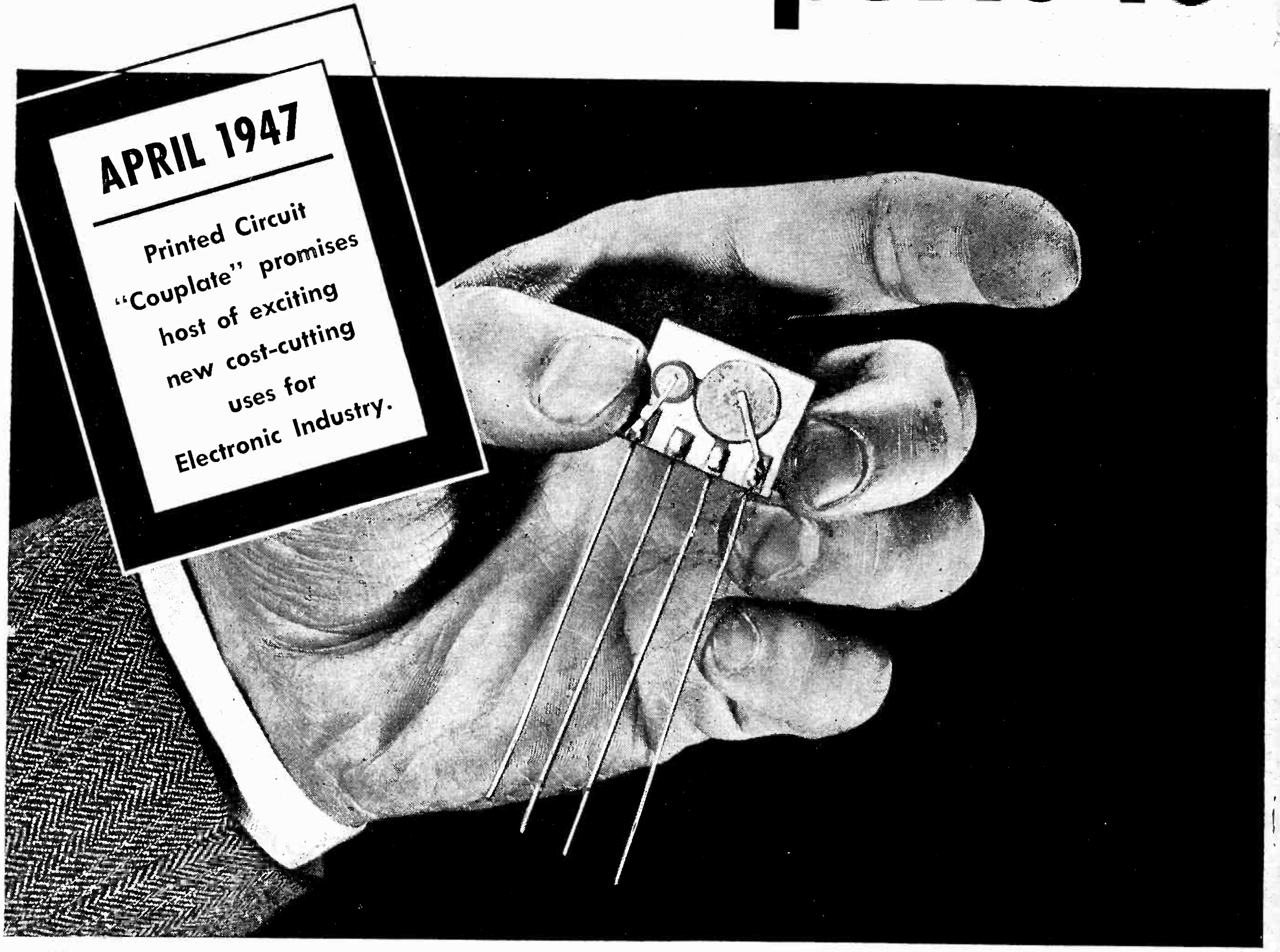
PEAK INVERSE ANODE VOLTAGE: 1300 VOLTS

AVERAGE ANODE CURRENT: 100 MILLIAMPERES

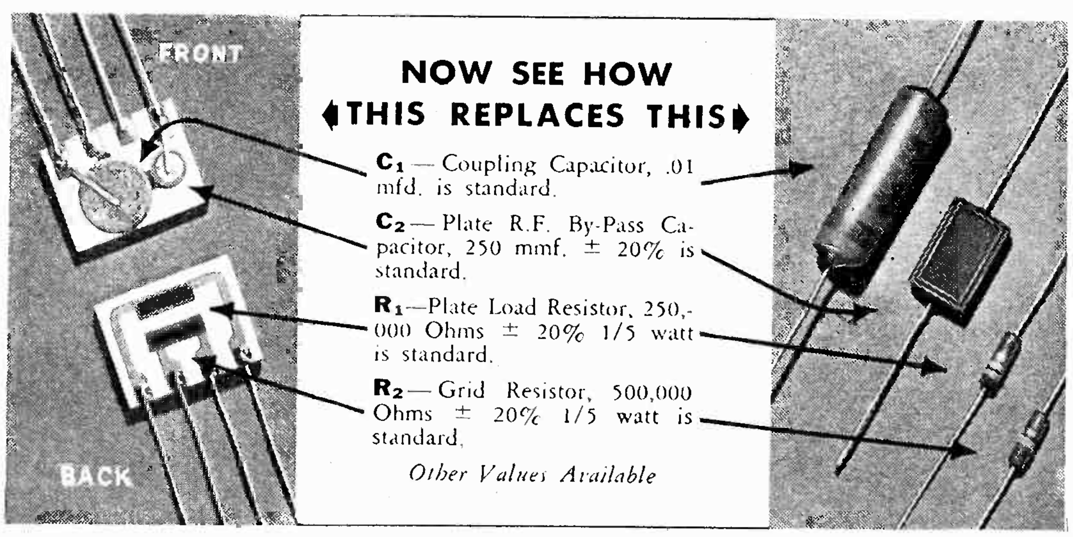
PEAK ANODE CURRENT: 500 MILLIAMPERES

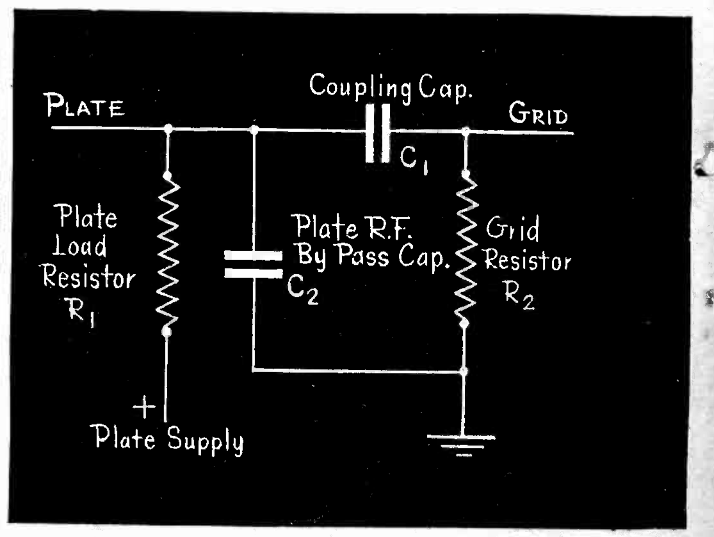
HEATER: 6.3 VOLTS

Centralab reports to



1 As revolutionary as the multi-purpose tube—that's what electronic engineers are saying about Centralab's new *Couplate.* Now available for the first time, the *Couplate* is a complete interstage coupling circuit which combines into one unit the plate load resistor, the grid resistor, the plate by-pass capacitor and the coupling capacitor. For today's manufacturers, the *Couplate* saves up to five soldered connections, increases labor efficiency 50%, assures fast, precision wiring on interstage couplings.

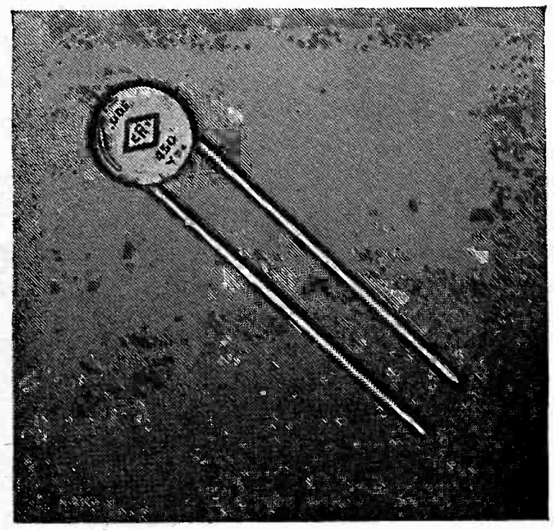




2 Integral Ceramic Construction: Each *Couplate* is an integral assembly of "HI-KAP" capacitors and resistors closely bonded to a steatite ceramic plate and mutually connected by means of metallic silver paths "printed" on the base plate. Think of what that means in terms of time and labor saving . . .

3 Only four soldered connections are now required by the *Couplate* instead of the usual eight or nine (see above). That means fewer errors, lower costs!

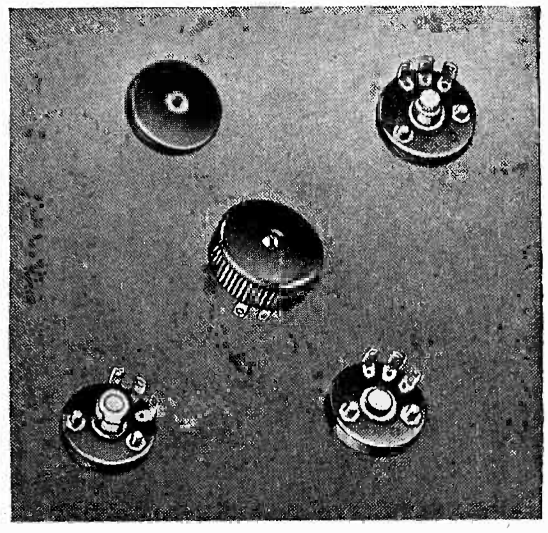
Electronic Industry



Look at "HI-KAP" Performance, Ratings, Convenience of Design!

Diameter (Max. O. D.)	5/8"	
Thickness (Maximum)	5/32"	
W. V. D. C.	450	
Guaranteed Min. Capac.	.005	
Flash Test V. D. C.	900	
Weight (Average)	1 gm.	.035 oz.

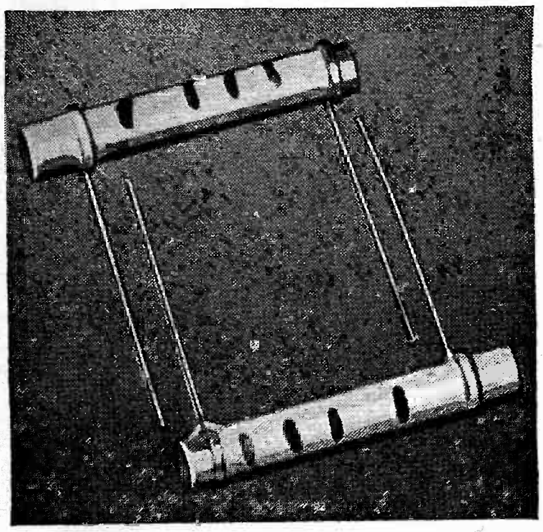
Other capacity values available. Inquire now!

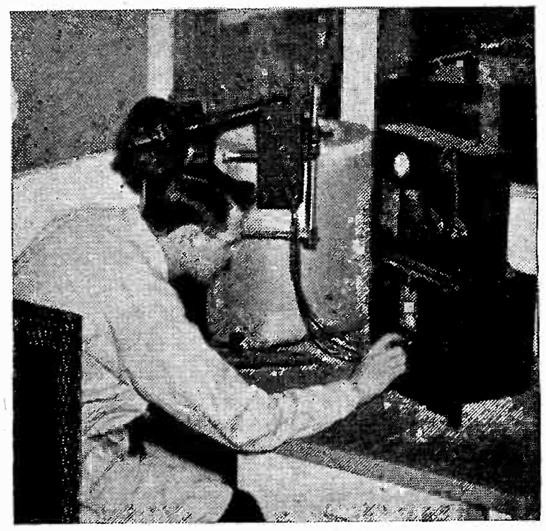


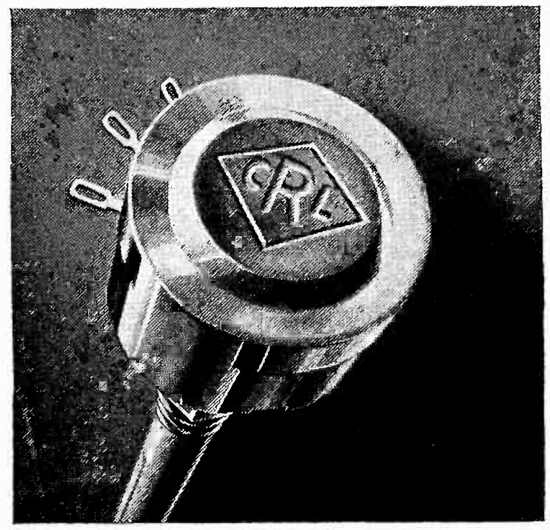
4 In addition — Centralab has just announced a sensational new quality line of miniature ceramic disc capacitors impervious to moisture . . .

5 Hi-Kap's permanent Ceramic-X stability assures utmost reliability in small physical size and low mass weight. Write for Bulletin 933.

6 Here's Centralab's newest control for miniature receivers, amplifiers. No bigger than a dime, high quality performance is assured.







7 More news! The recognized dependability and high quality of ceramic by-pass and coupling capacitors is now available at a new low price . . .

8 Made from Centralab's original Ceramic-X—result of our continuing research in high dielectric constant ceramics. Write for Bulletin 943.

9 When you see this CRL monogram on electronic components, you're assured of tested performance, quality and dependability. Look for it!

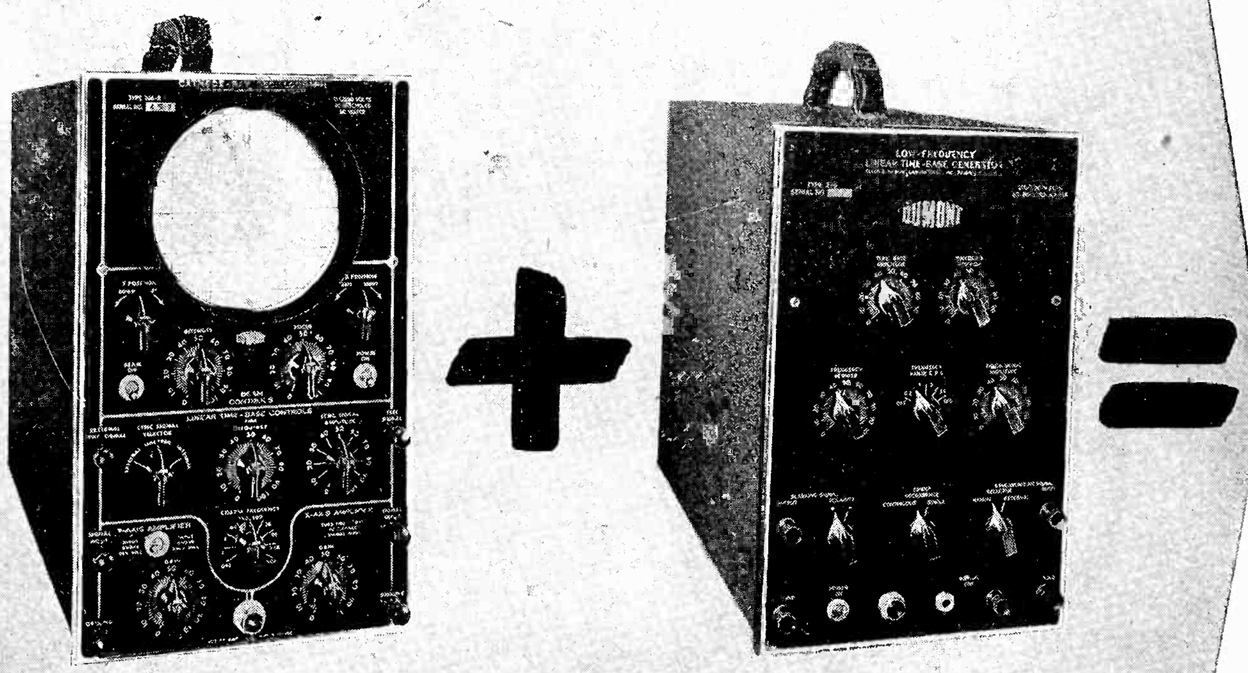
Look to Centralab in 1947! **First in component research that means lower costs for the electronic industry. If you're planning new equipment let Centralab's sales and engineering service work with you. Get in touch with Centralab!**

Centralab

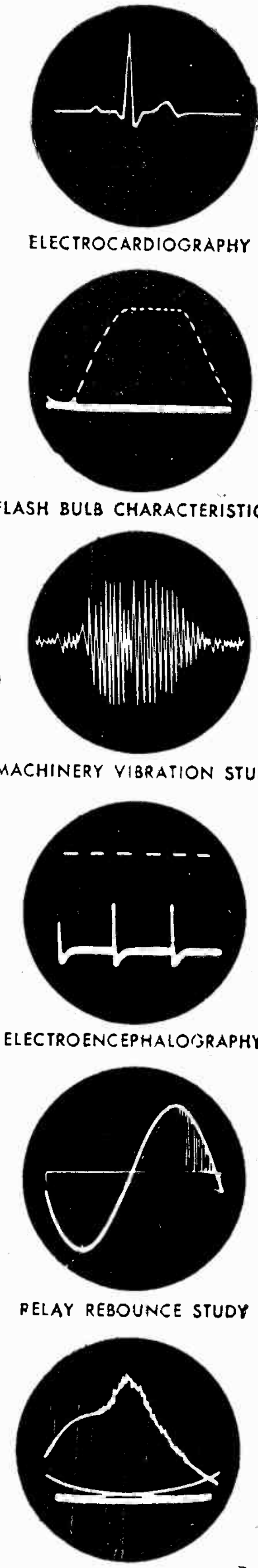
CRL

DIVISION OF GLOBE-UNION INC., MILWAUKEE, WIS.

Does your oscillograph have single or recurrent sweep frequencies as low as 0.2 cycles per second? *IT CAN . . .*



with the DuMONT Type 215 LOW-FREQUENCY LINEAR-TIME-BASE GENERATOR



Here's the means for *vastly increasing* the usefulness of your already useful oscillograph.

This accessory instrument provides a 450 v. d.c. or peak-to-peak *undistorted* linear-time-base signal voltage of a frequency variable from 0.2 to 125 cycles per second! Special compensating circuit assures linearity.

The single sweep can be initiated either manually or by observed signal. The oscillograph-screen pattern can usually be spread out to three times' full scale deflection. Return trace blanking signal of either positive or negative phase.

• • •

For single sweep, and for low-frequency recurrent-sweep studies, the DuMont Type 215 Low-Frequency Linear-Time-Base Generator used in combination with the DuMont Type 208-B general purpose oscillograph, or equivalent, provides excellent results. Note the typical studies herewith. Definitely "must" equipment.

Descriptive literature on request.

DuMONT *Precision Electronics & Television*

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • *CABLE ADDRESS:* ALBEEDU, PASSAIC, N. J., U. S. A.

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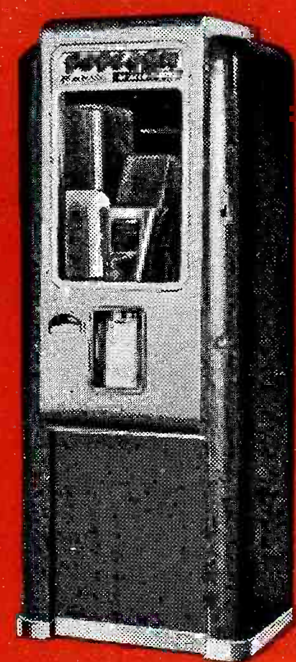
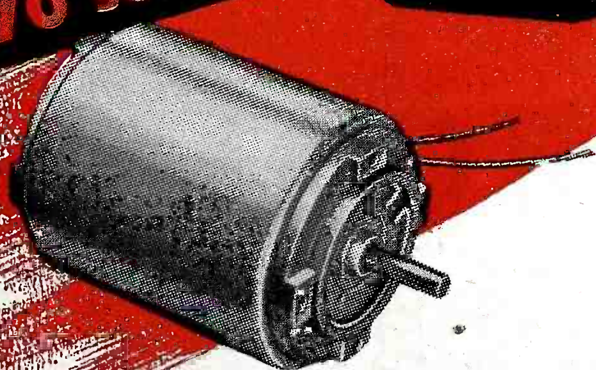
VOICE-O-GRAPH
International Mutoscope Corp.
Long Island City 1, N. Y.



MINIT POP
The Viking Tool & Machine Corp.
Belleville 9, N. J.

PEA-MOR PHONOGRAPH
Packard Manufacturing Corp.
Indianapolis 7, Ind.

70 series

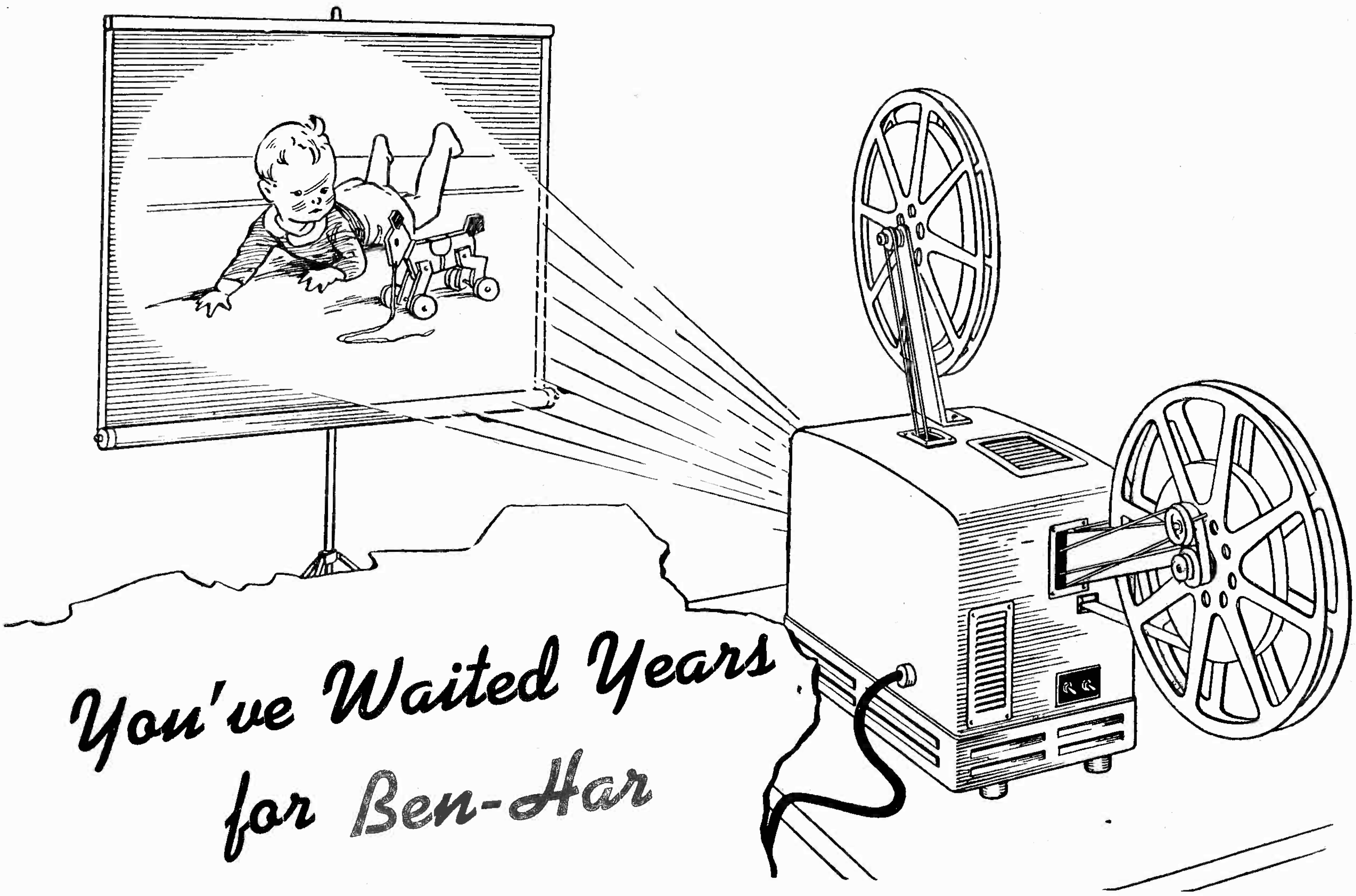


EASTERN AIR DEVICES motors have won wide acceptance for their efficient performance and ease of maintenance in automatic vending machines such as those illustrated. Their construction includes such desirable features as: squirrel cage motor without switches or brushes resulting in no commutator trouble or creation of radio interference; replaceable "capsule" bearings; snap ring construction for easy disassembly and improved cooling means, insuring long life and quiet operation with minimum size and weight. Let us fit an E.A.D. motor to your application.

TYPE NO.	TYPE	H.P.	SPEED
LS71TCJ-1	Synchronous	1/75	1800
L731M-1	Capacitor	1/40 High Torque	1600
L73LC-1	Capacitor	1/30	1600

EASTERN AIR DEVICES, INC.
585 DEAN STREET • BROOKLYN 17, N. Y.

LET BENTLEY, HARRIS WAR-TIME RESEARCH PAY DIVIDENDS FOR YOU TODAY.



You've Waited Years for Ben-Har

A manufacturer of home-type movie projectors recently brought this problem to Bentley, Harris: Provide an insulation that will withstand intense heat without stiffening and cracking, that will not fray or split under rough handling, and will remain unaffected by minor, but constant, vibration.

After testing a sample of Ben-Har Special Treated Fiberglas Tubing under actual production and operating condition, this is what the manufacturer found: Ben-Har gives consistently superior results. It has solved the problems of heat, rough handling, and other common causes of insulation breakdown. The great flexibility of Ben-Har has aided production considerably, since much of the work is done in cramped places and the insulation must spread to cover knobs and terminals.

Non-fogging, non-corrosive Ben-Har is not affected by heat conducted through the wire and will not burn, even in direct contact with flame. Its extreme flexibility and high dielectric strength prove the value of this insulation by daily use in a wide variety of applications—from hearing aids to electric motors, from watt-hour meters to television receivers.

Try Ben-Har Special Treated Fiberglas Tubing in your plant, in your own product—under actual service conditions. Learn why America's leading manufacturers of home appliances and industrial equipment say "never before a tubing like Ben-Har".

BENTLEY, HARRIS MFG. CO., CONSHOHOCKEN, PA.

BH *Fiberglas** SLEEVINGS

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

USE COUPON NOW

Bentley, Harris Mfg. Co., E-9, Conshohocken, Pa.

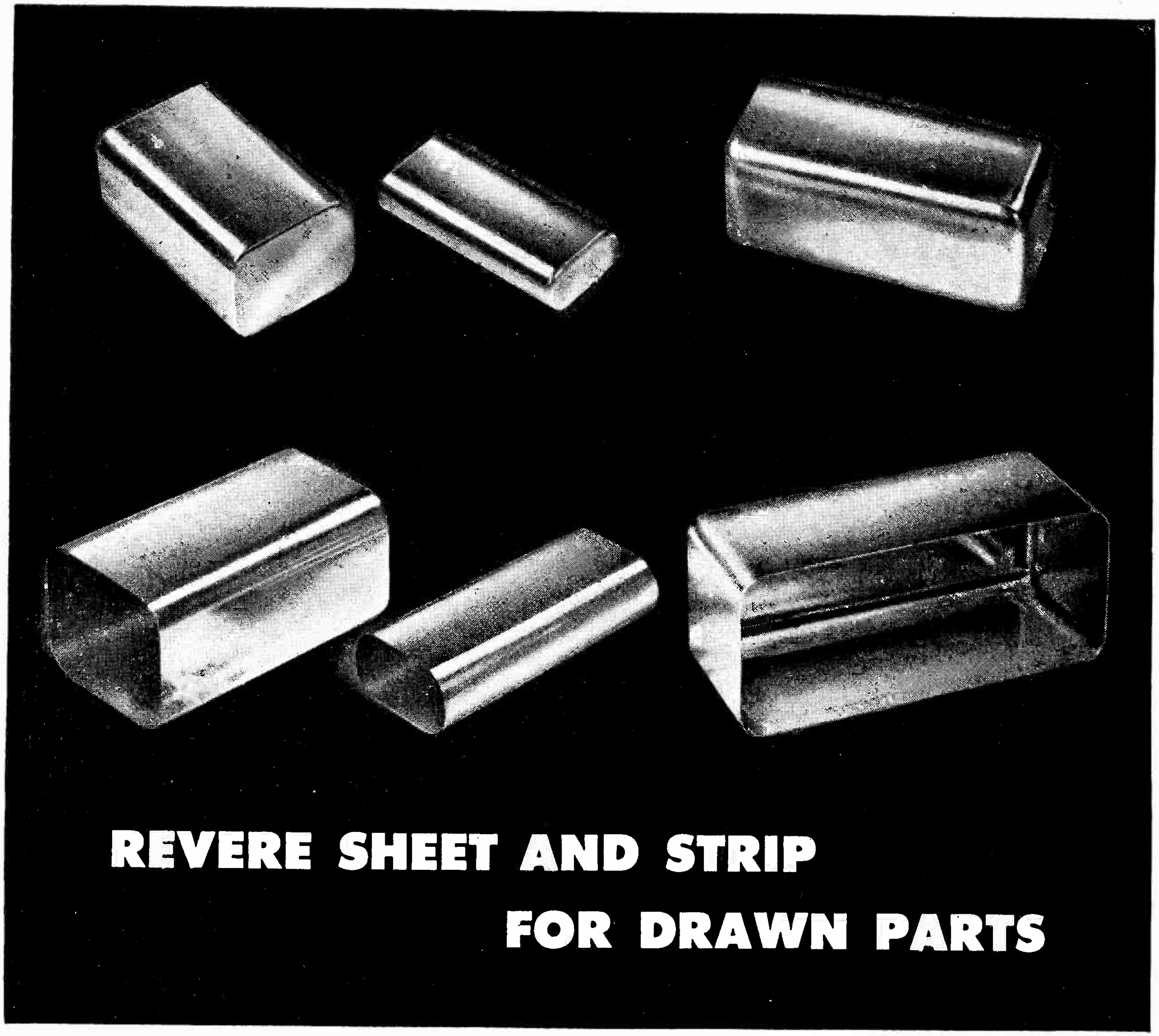
I am interested in Ben-Har Special Treated Fiberglas Tubing _____ (size) for _____ (product) operating at temperatures of _____ °F. at _____ volts. Send samples so I can see for myself how Ben-Har will not crack in a bend, will not support combustion.

NAME _____ COMPANY _____

ADDRESS _____

Send samples, pamphlet and prices on other BH Products as follows:

- ☐ Cotton-base Sleeving and Tubing
- ☐ Non-fraying Fiberglas Sleeving



FOR all products to be made by drawing, stamping and similar sheet metal operations, Revere sheet and strip of copper or brass offer maximum ease of fabrication. Not only are these metals naturally ductile, but they benefit further from the metallurgical skill which Revere has gained in 145 years of experience.

In composition, mechanical properties, grain size, dimensions and finish, you will find Revere metals highly uniform. They enable you to set up economical production methods and adhere to them. They can help you produce better products at faster production rates, with less scrap and fewer rejects.

Revere copper, brass and bronze lend themselves readily to the widest variety of finishing operations—polishing, lacquering, electro-plating. With these superior materials it is easy to make radio shields and similar products beautiful as well as serviceable.

That is why wise buyers place their orders with Revere for such mill products as—*Copper and Copper Alloys:* Sheet and Plate, Roll and Strip, Rod and Bar, Tube and Pipe, Extruded Shapes, Forgings—*Aluminum Alloys:* Tubing, Extruded Shapes, Forgings—*Magnesium Alloys:* Sheet and Plate, Rod and Bar, Tubing, Extruded Shapes, Forgings—*Steel:* Electric Welded Steel Tube. We solicit your orders for these materials.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md., Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in Principal Cities, Distributors Everywhere

SINCE 1895

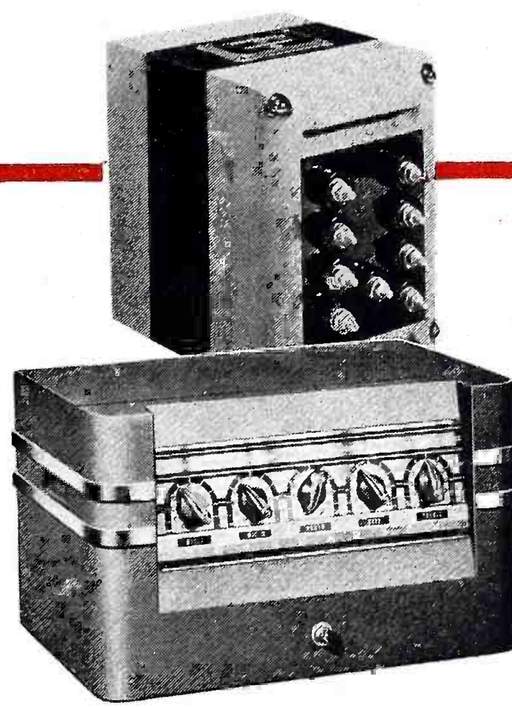
THORDARSON

THE OLDEST MANUFACTURER OF QUALITY TRANSFORMER EQUIPMENT IN THE UNITED STATES

For well over fifty years Thordarson has been turning out the finest in amateur and industrial transformer equipment. Founded in 1895 by Chester Thordarson, designer of the first amateur transmitting transformer, this company has pioneered many new developments, including the superior coil and core materials now used in its entire line. Describing quality transformers for every ham requirement, the Thordarson catalog is still regarded as the "bible" of the radio amateur.

In the industrial field, Thordarson was first to design and build transformers for specific applications. To this day, when there is a question of correct transformer design, Thordarson is usually consulted first. Thordarson Amplifiers, a logical outgrowth of this vast transformer manufacturing experience, are regarded by experts as the finest in present-day sound equipment.

In the future, as in the past, Thordarson Transformers and Amplifiers will continue to be manufactured to the same high standards which have distinguished their production from the beginning. When you specify Thordarson you will always be sure of obtaining a product which is as perfect as a half century of electronic manufacturing experience can make it.



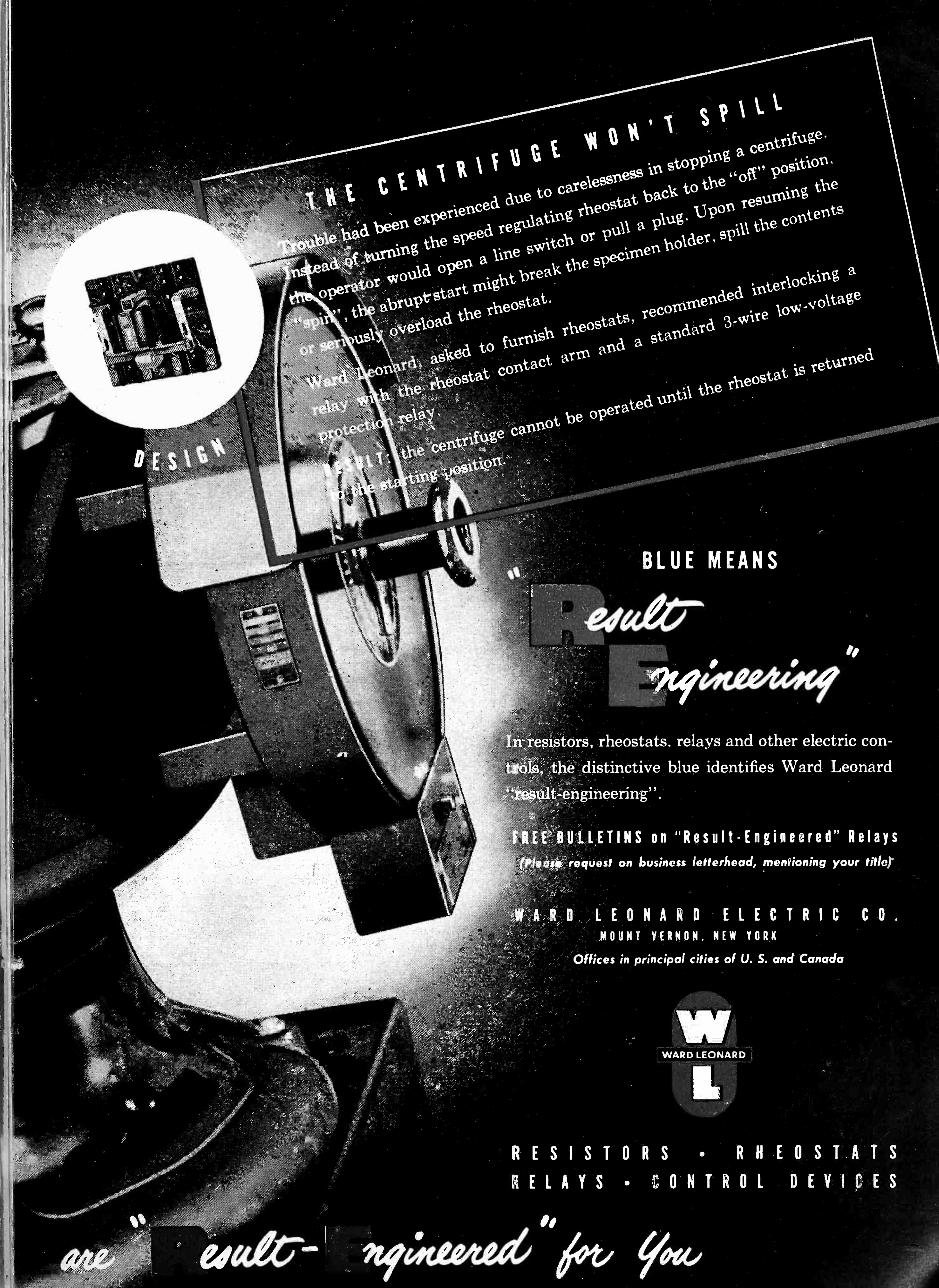
Thordarson Transformers and Amplifiers are designed for every electronic application

THORDARSON

ELECTRONIC DISTRIBUTOR AND INDUSTRIAL SALES DEPARTMENT

MAGUIRE INDUSTRIES, INC. 936 NORTH MICHIGAN AVENUE CHICAGO 11, ILLINOIS

EXPORT SALES DIVISION • SCHEEL INTERNATIONAL INCORPORATED 4237-39 N. LINCOLN AVENUE, CHICAGO 18, ILL. CABLE ADDRESS HARSCHEEL


THE CENTRIFUGE WON'T SPILL
Trouble had been experienced due to carelessness in stopping a centrifuge. Instead of turning the speed regulating rheostat back to the "off" position, the operator would open a line switch or pull a plug. Upon resuming the "spin", the abrupt start might break the specimen holder, spill the contents or seriously overload the rheostat.
Ward Leonard, asked to furnish rheostats, recommended interlocking a relay with the rheostat contact arm and a standard 3-wire low-voltage protection relay.
RESULT: the centrifuge cannot be operated until the rheostat is returned to the starting position.
DESIGN
BLUE MEANS
"Result Engineering"
In resistors, rheostats, relays and other electric controls, the distinctive blue identifies Ward Leonard "result-engineering".
FREE BULLETINS on "Result-Engineered" Relays
(Please request on business letterhead, mentioning your title)
WARD LEONARD ELECTRIC CO.
MOUNT VERNON, NEW YORK
Offices in principal cities of U. S. and Canada
WARD LEONARD
RESISTORS • RHEOSTATS
RELAYS • CONTROL DEVICES
are "Result-Engineered" for You

low-cost television projector

. . . . available for immediate delivery

Simplicity of operation, proved dependability, and low cost are the highlights of this new television tool.

With it you can take full advantage of the excellent program material now available on 16mm sound films. Newsreels, shorts, documentaries, and sound films on countless other subjects can be worked into your daily schedules to add program variety and to keep down costs.

The TP-16A Television Projector is a completely self-contained, streamlined unit designed especially to meet the exacting requirements of television stations. Features include:

- High-intensity optical system providing brilliant reproduction of pictures.
- Stabilized sound unit assuring unequaled sound quality.
- Simple, foolproof, film-feed system permitting quick, easy film threading.
- Dependability assured by using precision-made parts of design similar to those used in RCA's outstandingly successful sound film projector—the famous PG-201.

As shown by the diagram below, an ingeniously simple system is used to permit the required 60 field-per-second television scanning of standard 24 frame-per-second sound film. The 60 light flashes which must pass through the film every second are easily obtained with only three major parts: a 1000-watt projector lamp, a slotted rotary shutter to interrupt the light beam, and a large-size motor that acts as a shutter drive. There is no need for expensive pulse-forming circuits. The incandescent lamp furnishes plenty of brilliance for 16mm film. Perfect synchronization with the television system is assured by using the common power source to drive the shutter motor. No external synchronizing connections are required.

For better, easier film programming it will pay you to investigate this simplified projector. We'll be glad to send you complete price and descriptive data. Write: Dept. 30-D, Radio Corporation of America, Camden, New Jersey.

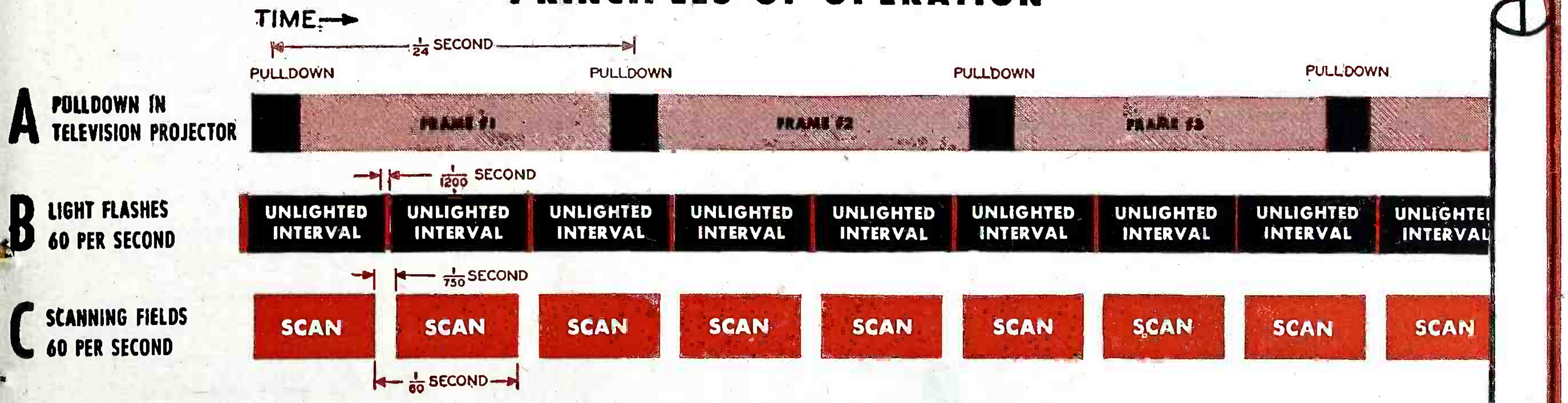
TELEVISION BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

PRINCIPLES OF OPERATION



Line A illustrates how, by using a special intermittent mechanism, the "pulldown" time in the TP-16A is reduced to 1/8 the "frame cycle." *Line B* indicates the duration and repetition rate of the short intervals during which light passes through the film. *Line C* shows the scanning intervals. Note that scanning takes place during the unlighted interval following each flash. This is made possible by the "storage" property of the film camera pick-up tube. The first frame is scanned twice, the second frame three times, the third frame twice, etc., for an average rate of 2½ scannings per frame. This rate multiplied by 24 frames per second provides the required 60 scanned fields per second.

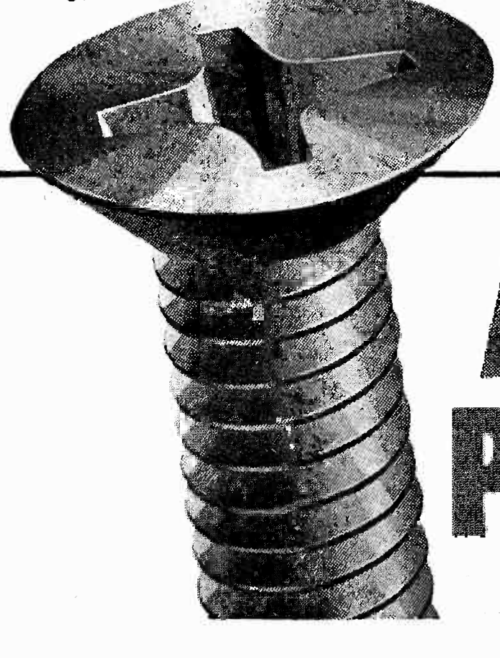
Many Sunlamp Makers
(and users, too)
are "Seeing the Light"

...by insisting on AMERICAN PHILLIPS SCREWS

PRODUCTION-WISE – add sunlamp manufacturers to the host of stove, refrigerator, furniture and other modern-minded makers who are cutting production costs via American Phillips Screws. How? By straight, sure-fire, speedy, *automatic* driving that's proof against scars, scuffs, work spoilage. No matter what the pace, the 4-winged American Phillips Driver "stays put" — can't harm or hinder work or worker . . . and you can count on *time savings up to 50%!*

PROMOTION-WISE – American Phillips Screws lend a modern touch — step up the "sell" of whatever you make. They can't snag clothes but they *do* snag *orders!* Showmanship and serviceability both say "specify American Phillips."

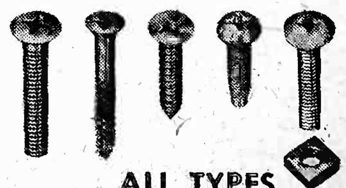
4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS



AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND

Chicago 11: **589 E. Illinois St.** *Detroit 2:* **502 Stephenson Bldg.**

AMERICAN PHILLIPS *Screws*



ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

ALSIMAG INSULATION

TRADE MARK

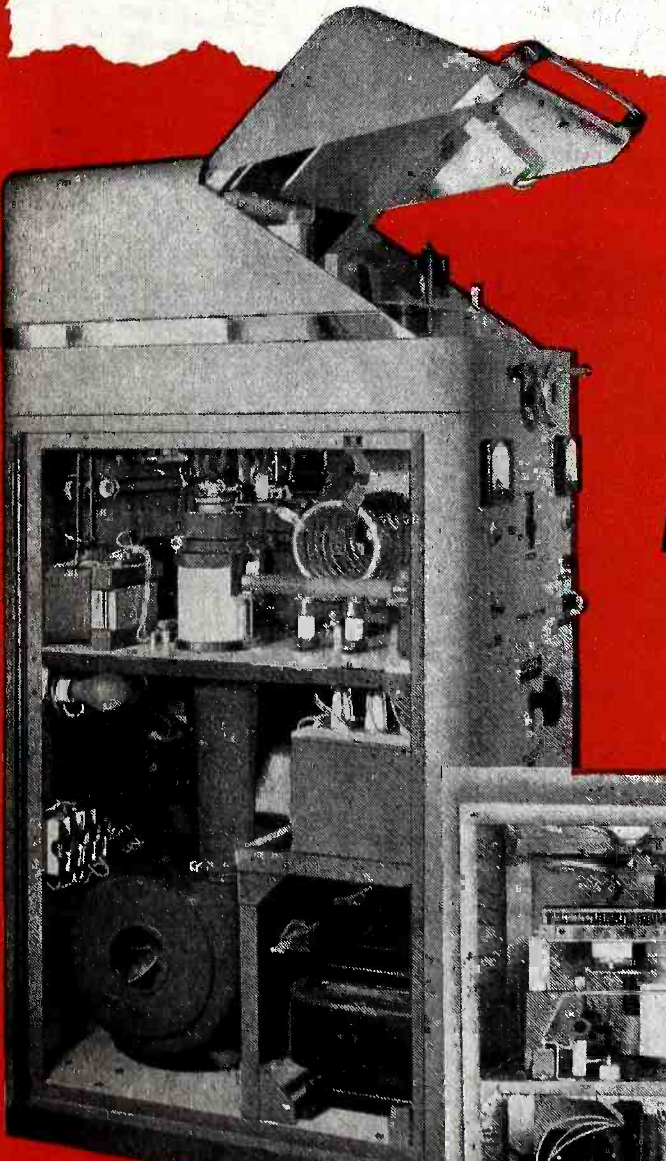
FOR ELECTRONIC HEATING DEVICES

LOW LOSS FACTOR . . . HIGH DIELECTRIC STRENGTH AND RESISTIVITY

Electronic heating devices require the best insulation. That is why you find AlSiMag custom made technical ceramic insulation at the critical points in practically all the leading makes of dielectric and induction heating equipment. AlSiMag is also widely employed in work holders, fixtures, gang run devices, locators, spacers and jigs to hold products during electronic heating.

AMERICAN LAVA CORPORATION
CHATTANOOGA 5, TENNESSEE
46th YEAR OF CERAMIC LEADERSHIP

SALES OFFICES: ST. LOUIS, Mo., 1123 Washington Ave., Tel: Garfield 4959 • NEWARK, N. J., 671 Broad St., Tel: Mitchell 2-8159 CAMBRIDGE, Mass., 38-B Brattle St., Tel: Kirkland 4498 • CHICAGO, 9 S. Clinton St., Tel: Central 1721 • SAN FRANCISCO, 163 Second St., Tel: Douglas 2464 • LOS ANGELES, 324 N. San Pedro St., Tel: Mutual 9076 • PHILADELPHIA, 1649 N. Broad Street



WHY THERMATRON USES ALSIMAG INSULATION

RADIO RECEPTOR COMPANY, INC.
RADIO AND ELECTRONIC PRODUCTS SINCE 1922
AIRWAY AND AIRPORT RADIO EQUIPMENT
SELENIUM RECTIFIERS
Thermatron ELECTRONIC HEATERS
CENTRALIZED RADIO SYSTEMS
251 WEST 19TH STREET • NEW YORK 11, N.Y.
TELEPHONE WATKINS 9-2900 • CABLES: RECEPTRAD N. Y.

January 14, 1947

American Lava Corporation
Chattanooga 5, Tennessee

Gentlemen:

Of prime importance in the efficiency and stability of high frequency circuits employed in our line of THERMATRON electronic dielectric heaters and sealers is the exceptional low loss factor, high dielectric strength and resistivity of the ceramic insulators used.

The THERMATRON is generally used in electronically sealing thermoplastic films and in preheating thermosetting plastic preforms materials and operates at frequencies around 27.5 megacycles. It is necessary, at the high voltages and frequencies used, that the insulators employed to support and isolate the radio frequency circuits must have extremely low loss characteristics.

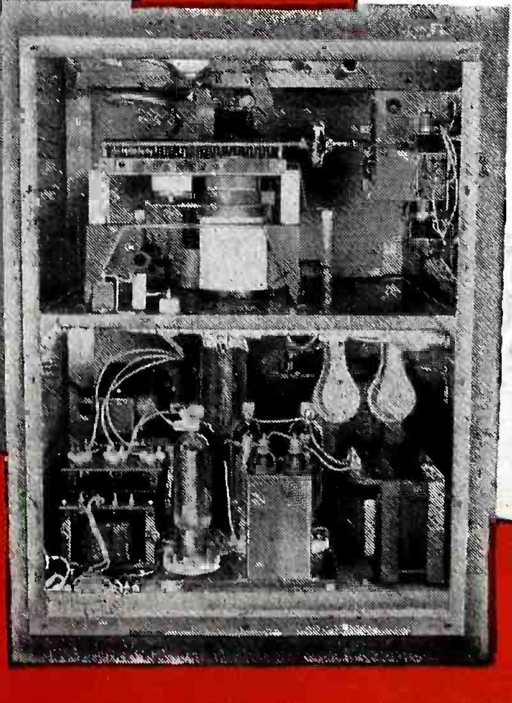
AlSiMag ceramic insulators were chosen to meet these exacting requirements in THERMATRON design and construction.

The accompanying interior views illustrate the many applications of your insulators in this equipment.

Very truly yours,

General Manager
THERMATRON DIVISION

JNT:MW



Right side view (Panel removed)
5 KW Thermatron Heatmaster

Left side view (Panel removed)
25 KW Thermatron Heatmaster Jr.

Photo courtesy Radio Receptor Co., Inc.
251 West 19th Street, New York 11, N. Y.

Now MORE ACCURATE FM-AM RECEIVER TUNING BY MEANS OF KEN-RAD'S REVOLUTIONARY NEW TUBE!

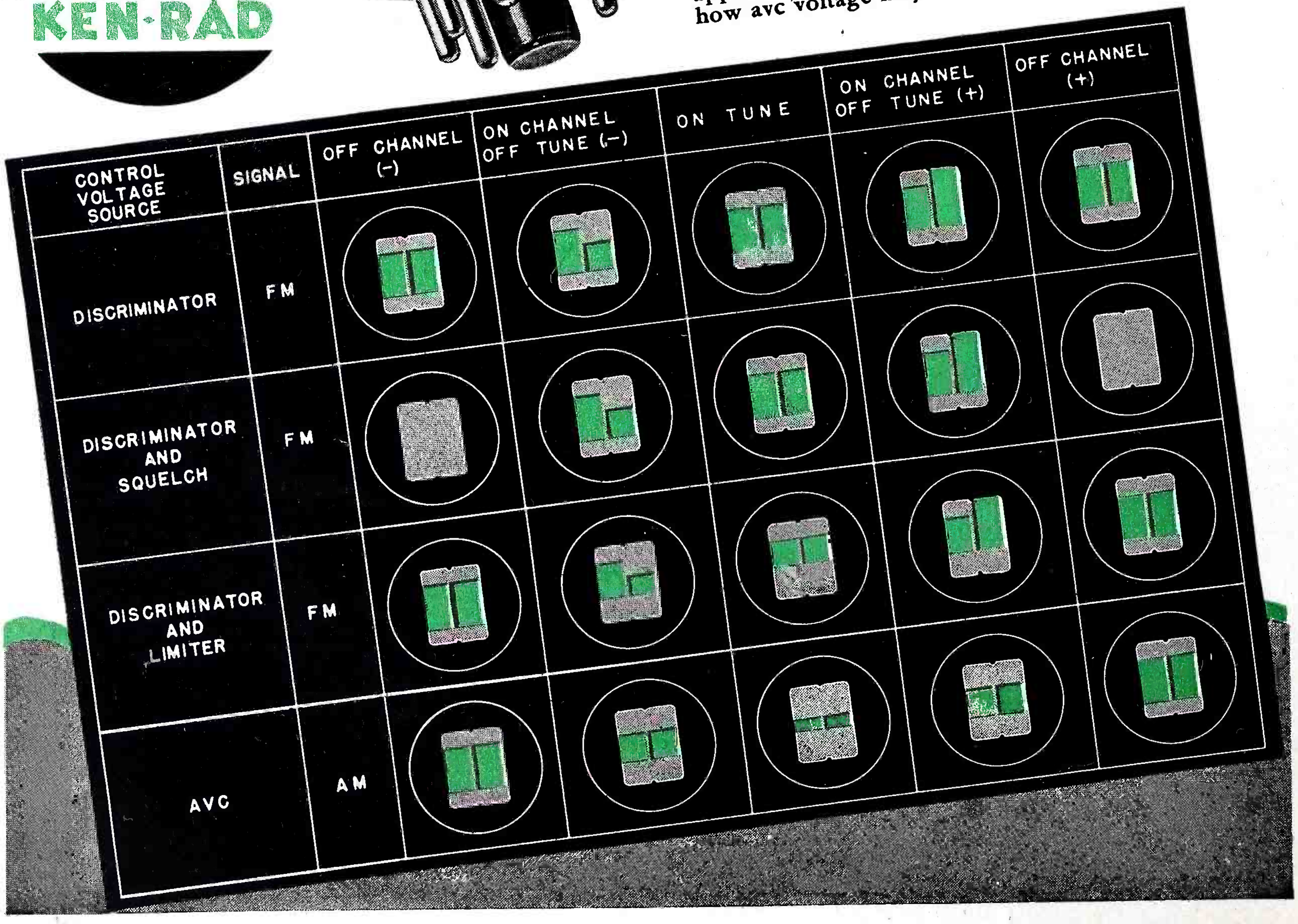
THE 6AL7-GT ELECTRON-RAY INDICATOR TUBE

General Electric research, plus Ken-Rad development work, are responsible for the brilliant new 6AL7-GT indicator tube—most modern step in the direction of fast, accurate receiver tuning, FM and AM.

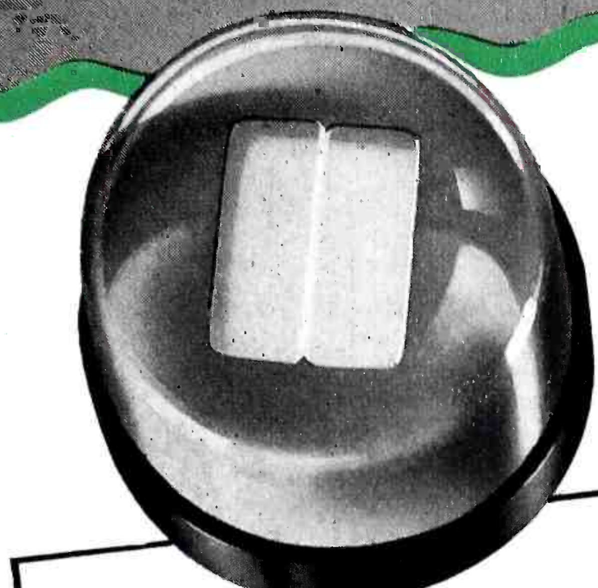
An electron-ray tube, twin light patterns appear on a fluorescent screen at the end of the glass bulb. These take the form of green bands which vary in depth according to changing voltages brought about in the process of tuning.

Extremely close FM discriminator tuning may be accomplished by matching depths of the 6AL7-GT's light patterns. How the patterns appear to the eye under various off-channel, on-channel, off-tune, and on-tune conditions, is diagrammed below. Three FM circuit applications are shown. A fourth—AM—illustrates how avc voltage may be used for tuning purposes by

K
KEN-RAD



New IN PRINCIPLE IN SIMPLICITY AND RELIABILITY!



checking the depth of the two light patterns working as a unit.

Easy to see and read . . . Previous indicator tubes, developed for AM, have had reflecting targets, giving poor visibility because cathode and deflecting plates were placed in front of the screen, making it necessary to mask out the center. The fluorescent screen of the new Ken-Rad FM-AM 6AL7-GT is transparent, with electron-ray mechanism located *behind*, not before the image, thus offering no obstacle to vision.

Ken-Rad is consistently ahead with new tube developments—meaning that Ken-Rad dealers, and servicemen installing Ken-Rad tubes, march in the van of radio progress. Pioneering work by Ken-Rad, as typified by this great new 6AL7-GT indicator tube, enables you to serve *all* your clients better, whether their radio sets be AM or FM, old-style or new, portables or console models. . . . Install Ken-Rad tubes for greater owner satisfaction, and resulting bigger profits!

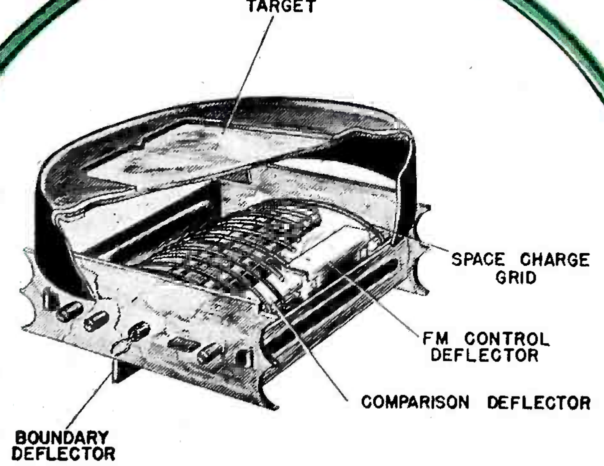
TYPICAL OPERATING CONDITIONS
(Indicator service)

Heater voltage	6.3 v
Heater current	0.150 amp
Target voltage	315 v
Voltage, deflection electrodes 1, 2 and 3	0 v
Cathode resistor (approx)	3,300 ohms
Deflector sensitivity (approx)	1.0 mm/v
Fluorescence cut-off, grid volts (approx)	—6.0 v

KEN-RAD'S OUTSTANDING NEW INDICATOR TUBE WILL BE ON VIEW AT THE CHICAGO PARTS SHOW, MAY 13 THROUGH 16. SEE HOW IT TUNES CIRCUITS TO HAIRLINE ACCURACY WITH EASE AND PRECISION! YOUR VISIT TO THE KEN-RAD DISPLAY WILL BE ONE OF THE HIGHLIGHTS OF YOUR CHICAGO TRIP. A CORDIAL WELCOME AWAITS YOU!

● The 6AL7-GT's principle of operation is unique and effective. In the cutaway drawing at the right, note that the three deflection electrodes are close to the cathode, with this whole assembly in turn separated from the target by the grid. The latter operates either at cathode potential, or at a few volts negative with respect to the cathode. Because electrons move slowly in the area between cathode and grid, the 6AL7-GT's deflectors easily control the position of the electron beams on the target. Increasing the negative voltage on the grid slows down the electrons still more, augmenting their response to the deflectors' pull and thus heightening the tube's sensitivity.

More detailed technical information and performance data on the 6AL7-GT will be furnished promptly on request. If you manufacture electronic equipment, Ken-Rad tube engineers gladly will work with you to apply the new Indicator Tube to radio receivers or test equipment you may have on your drawing-boards. Communicate direct with Ken-Rad at the address below.



CUTAWAY VIEW OF A KEN-RAD 6AL7-GT, SHOWING SCREEN TARGET, GRID, ELECTRON-RAY DEFLECTORS, ETC.

178-F15-8850

Behind KEN-RAD radio tubes stands Electronics' first and greatest name — GENERAL ELECTRIC

KEN-RAD

DIVISION OF GENERAL ELECTRIC COMPANY SCHENECTADY, NEW YORK

READY NOW

IN ANSWER TO HAMS' DEMANDS

EST. 1914

Hams around the world have been National's collaborators in creating the NC-173—ready now after five years of intensive research. Here are some of the advantages this 13-tube superheterodyne receiver offers:

- The NC-173's newly designed adjustable threshold double diode noise limiter—working on *both phone and CW*—has an extremely high limiting efficiency because of the short recovery time.

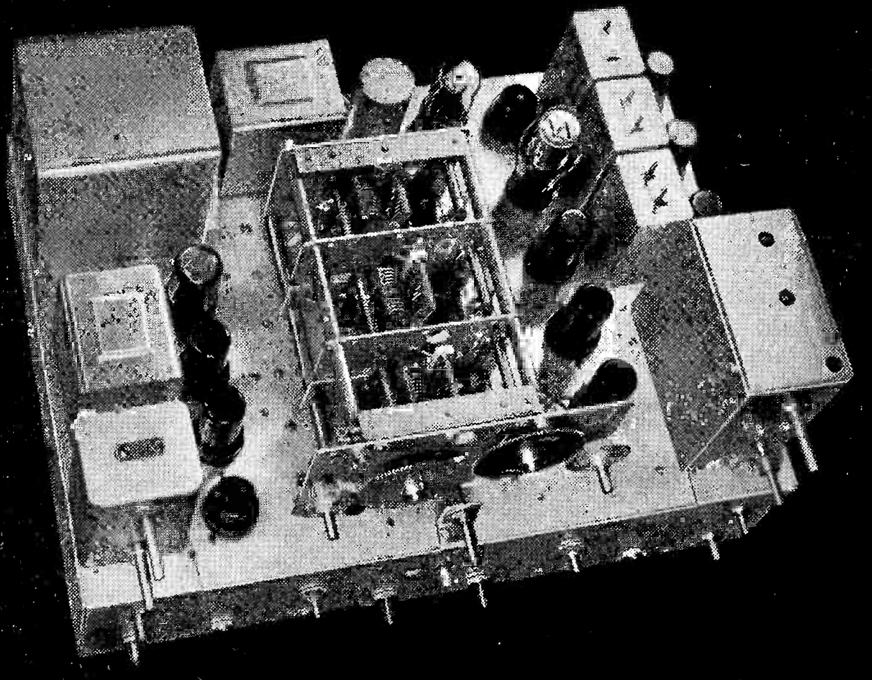
- Voltage regulated circuits give the NC-173 high stability and less drift for changes in powerline voltage. The pitch of code characters barely changes—even over extended listening periods.

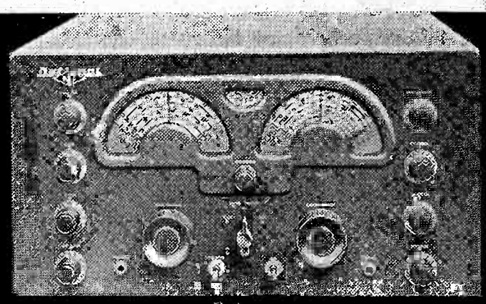
- The S-meter circuit allows signal strength recordings to be taken on either *phone or code*.

- Works equally well on coaxial feed-line, single-wire, directional or balanced antenna.

- AC powered. Will also operate on battery for portable or emergency use—110/120 or 220/240 volts, 50/60 cycle. Frequency range .54 to 31 and 48 to 56 MC. (Includes calibrated band spread on 5, 10, 11, 20, 40 and 80 meters).

- Ask your dealer to let you see and hear the new moderate-priced NC-173.





THE NATIONAL NC-173

NATIONAL

COMPANY, INCORPORATED

MALDEN, MASS.

THE MOST DISTINCTIVE NAME IN RADIO COMMUNICATIONS

Remove obstacles like these...

Have you a problem which graphite in a liquid carrier can solve? "**dag**" colloidal graphite dispersed in many liquids has offered novel solutions to many vexing problems for scores of industries.

You know many of "**dag**" colloidal graphite's successful applications, but you will discover other equally helpful applications by reading the booklets listed below. Acheson Colloids Corporation's technical research and advisory service is continuously studying industrial problems and developing new uses of "**dag**" colloidal graphite to remove these problems. Return the coupon and find out how you can satisfactorily deal with *your* problems.

ACHESON COLLOIDS CORPORATION, PORT HURON, MICHIGAN

This new literature on "**dag**" colloidal graphite is yours for the asking:

- **460** A data and reference booklet regarding "**dag**" colloidal graphite dispersions and their applications. 16 pages profusely illustrated. ☐
- **421** Facts about "**dag**" colloidal graphite for ASSEMBLING AND RUNNING-IN ENGINES AND MACHINERY. ☐
- **422** Facts about "**dag**" colloidal graphite as a PARTING COMPOUND. ☐
- **423** Facts about "**dag**" colloidal graphite as a HIGH TEMPERATURE LUBRICANT. ☐
- **431** Facts about "**dag**" colloidal graphite for IMPREGNATION AND SURFACE COATINGS. ☐
- **432** Facts about "**dag**" colloidal graphite in the FIELD OF ELECTRONICS. ☐

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OUR PRESENT OIL SUPPLIER IS____________________

(Lubricants containing "**dag**" colloidal graphite are available from major oil companies.)

IT'S NEW...it's the...

CONTROL CENTER FOR WIRED MUSIC PROGRAM DISTRIBUTION SYSTEMS

Here's the new program console that will form the heart of a wired music distribution system, audition system, or control center for P.A. systems in schools, hospitals, factories and hotels.

It consists of the following completely packaged units, ready for plug-in operation with no additional wiring. Units may be obtained separately if desired:

ORIGINATING UNIT (left in above photograph)—equipped with a two-speed turntable, reproducer which plays both vertical and lateral recordings, equalizing transformer, pre-amplifier, main amplifier, repeating coils, and necessary controls.

CONNECTING UNIT (center)—provides desk space—includes a volume indicator and an electric clock. (Volume indicator and clock are included with the Originating Unit when it is ordered separately).

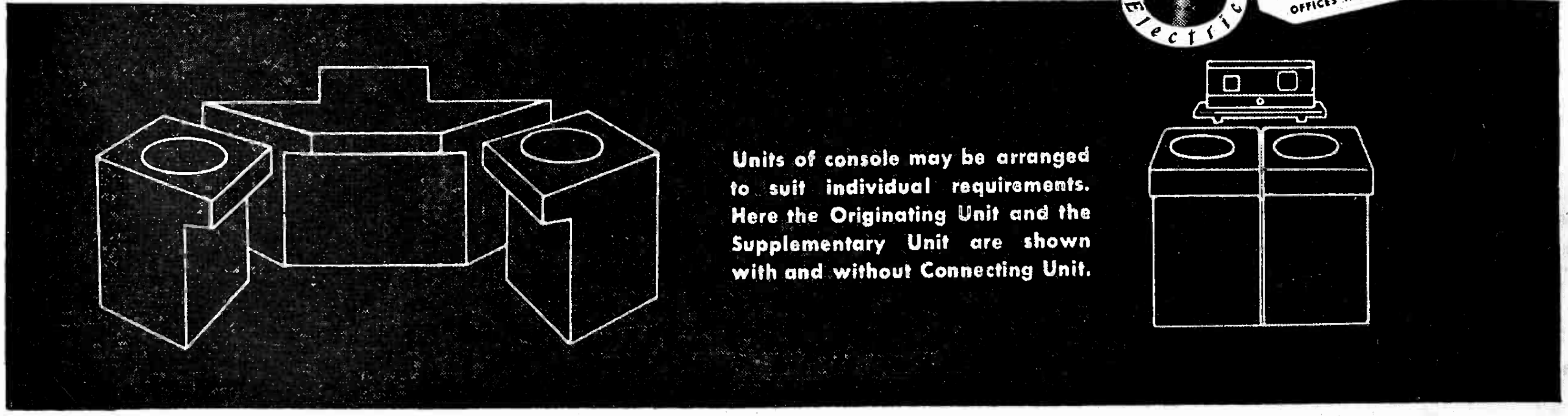
SUPPLEMENTARY UNIT (right)—same as the Originating Unit, except that it does not contain a main amplifier or repeating coils.

This console may be ordered equipped for network operation—where all subscribers receive the same program—or for private line use where subscribers are given a choice or may make specific requests. For both network and private line operation, a number of standardized accessories, panels and bays are available. Ask your local Graybar representative for complete details or write Graybar Electric Co., 420 Lexington Avenue, New York 17, N. Y.

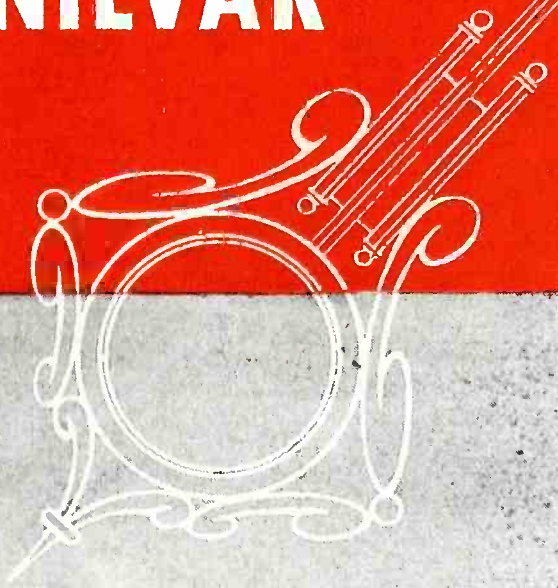
Western Electric

—QUALITY COUNTS—

Distributed by Graybar
OFFICES IN 95 PRINCIPAL CITIES



This Modern *Miracle* Clock keeps "In the Swing" with DRIVER-HARRIS NILVAR*



GRANDFATHER'S CLOCKMAKER didn't worry about the effect of temperature on the length and arc of a clock's pendulum — a minute lost or gained didn't matter. Today it does — and today we have the alloy Nilvar.

Nilvar is a remarkable alloy which has identical microscopic length at widely varying temperatures. For that reason, Barr Manufacturing Corporation selected it for the pendulum of its new "miracle" Executive Clock which depends for its accurate operation upon the unvarying characteristics of the pendulum arc — at any temperature.

This unusual clock provides synchronous motor accuracy, yet operates from a self-contained power supply. In operation, as the pendulum momentum gradually lessens, its arc decreases until, at a pre-determined point a tiny weight is released which imparts fresh momentum to the pendulum. Thereupon the weight is instantly retrieved by a small-battery-energized electro magnet, in preparation for another cycle. No alloy but Nilvar could permit such critical pendulum arc control, for *Nilvar has the lowest T. C. of expansion of any alloy yet developed* — even lower than that of quartz.

Somewhere in your engineering or production operations — or in the operation of your product — the critical dimensional stability of Nilvar may help to solve a problem of long standing. Why not call on Driver-Harris engineers for their recommendations.

D H SPECIAL PURPOSE ALLOYS SINCE 1899

*Trade Mark Reg. U.S. Pat. Off.

Driver-Harris COMPANY
Exclusive Manufacturers of Nichrome
HARRISON, N. J.

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

BRANCHES: Chicago • Detroit • Cleveland • Los Angeles • San Francisco • Seattle

Where there is Horsepower–

There is Wire

Man has always wanted news—and felt a frantic urge to "get the message through." There were shouters on the hilltops—a runner to announce the Persian loss of Marathon. Then horses sped the mails; but they were yet too slow—too slow for instance to prevent a battle after the peace was signed.

The telephone was a novelty in 1902—when Belden Manufacturing Company was founded. The story of instantaneous communications reads on from there.

Words have conquered space and time—because the products of the wiremakers have harnessed horsepower.

Belden

WIREMAKER FOR INDUSTRY

1 MILLION

INSTALLED IN RADIO RECEIVERS IN LESS THAN A YEAR

*AIRLOOPS' . . . *back panel and loop antenna in one unit*

It was less than a year ago that large scale production of **AIRLOOPS** began to feed radio set assembly lines and in this short time more than a million receivers, fitted with **AIRLOOPS,** went into service throughout the world.

The enthusiastic acclaim and acceptance of the **AIRLOOP** is well earned. It has demonstrated that its many superior features improve set performance and lower the cost of radio assembly and manufacture. Time and use have proved the **AIRLOOP** the most significant post war development in radio components . . . no set builder can afford to overlook the values **AIRLOOPS** contribute to set performance.

FRANKLIN Airloop

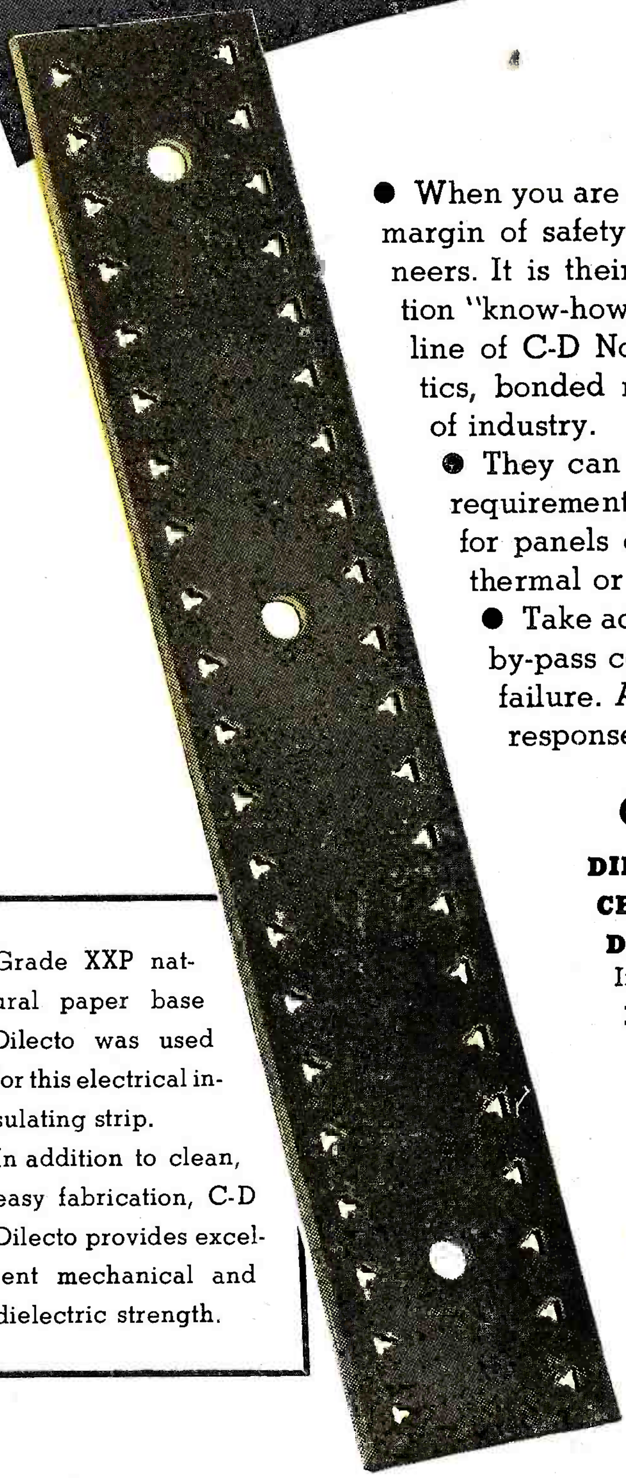
. . . . . . flat sheets of copper die-stamped into perfect super sensitive loops . . . are air dielectric throughout . . . are lower in cost . . . are back panel and loop in one unit . . . have high uniform "Q" over entire band . . . have low distributed capacity . . . have 27% greater effective loop area . . . have electrical and mechanical stability . . . increase set sensitivity . . . eliminate individual loop adjustment . . . eliminate haywire.

FRANKLIN AIRLOOP CORPORATION

43-20 34th ST. LONG ISLAND CITY 1, N. Y.

If it's an Insulation Problem . . . this is the name to know.

Continental · Diamond
C-D
Engineered Non-Metallics



Grade XXP natural paper base Dilecto was used for this electrical insulating strip.
In addition to clean, easy fabrication, C-D Dilecto provides excellent mechanical and dielectric strength.

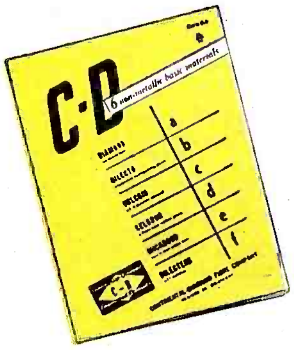
● When you are looking for better product performance . . . a greater margin of safety in electrical equipment—discuss it with C-D engineers. It is their application experience, coupled with C-D production "know-how", that has led to the development of the complete line of C-D Non-Metallics: molded macerated and laminated plastics, bonded mica and fibre products to meet the specific needs of industry.

● They can advise you which materials best meet high voltage requirements, which should be used for high frequencies, which for panels or instrument cases, as well as those best suited for thermal or moisture conditions.

● Take advantage of this specialized, practical experience and by-pass costly errors in your planning that may cause product failure. A call to our nearest office will find a ready, helpful response from C-D engineers.

C-D NON-METALLIC PRODUCTS

DILECTO—Thermosetting Laminated Plastics.
CELORON—A Molded Phenolic Plastic.
DILECTENE—A Pure Resin Plastic Especially Suited to U-H-F Insulation.
HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.
DIAMOND Vulcanized FIBRE.
VULCOID—Resin Impregnated Vulcanized Fibre.
MICABOND—Built-up Mica Electrical Insulation



STANDARD & SPECIAL FORMS

Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

DESCRIPTIVE LITERATURE

Bulletin GF gives Comprehensive Data on all C-D Products. Catalogs are also available.

D-2-47

BRANCH OFFICES: NEW YORK 17 • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES
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Continental-Diamond FIBRE COMPANY

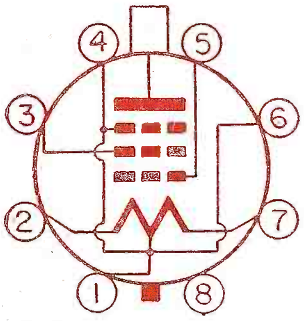
Established 1895.. Manufacturers of Laminated Plastics since 1911—NEWARK 16 • DELAWARE

NEW 5516 INSTANT-HEATING VHF BEAM PENTODE

18 WATTS — **USEFUL POWER OUTPUT FOR MOBILE F-M WITHOUT NEUTRALIZATION** — **165 MC**

IT WAS NOT EASY . . . Compact though it is, the new 5516 is a far cry from the cathode-type tubes previously used in mobile vhf equipment. Design and production headaches for instant-heating vhf beam pentodes increase in geometric progression with the operating frequency. A glance at 5516 constructional advantages discloses unusual measures taken to solve such problems. Yes, the 5516 of necessity costs more, but it does a *real* job at 165 mc.

WHAT THE 5516 DOES FOR YOU . . . 5516 useful power outputs at 165 mc of 18 watts f-m, 12 watts a-m (more at lower frequencies) are not theoretical but are based on actual tested transmitter designs. Low internal tube drop gives high output at low plate potential, with simplified power supply requirements. Instant-heating filament permits tremendous savings in battery drain — mobile or aircraft. One 2E30 doubler or tripler drives a 5516 in plate-modulated class C to full output at 165 mc. Ratings — designed for mobile use — are CCS and equally suitable for the fixed station. Also the 5516 requires no neutralization in properly designed circuits. Write today for complete data sheet.



BASING — BOTTOM VIEW

Pin	Connection	Pin	Connection
1	Fil. center tap & beam plates	5	Control grid
2	Filament	6	Same as pin 1
3	Screen grid	7	Filament
4	Same as pin 1	8	No connection
		Cap	Plate

HYTRON TYPE 5516
INSTANT-HEATING VHF BEAM PENTODE

GENERAL CHARACTERISTICS

Filament	oxide-coated, center-tapped
Potential (a-c or d-c)	6.0 ± 10% volts
Current	0.7 ampere
Grid-plate capacitance	0.12 max $\mu\mu f$
Input capacitance	8.5 $\mu\mu f$
Output capacitance	6.5 $\mu\mu f$
Maximum overall length	3-21/32 inches
Maximum diameter	1-7/16 inches
Base	low-loss, medium-shell, 8-pin octal

ABSOLUTE MAXIMUM CCS RATINGS

		Mod.*	Unmod.	
D-c plate potential	80 mc	475	600	v
	135 mc	395	500	v
	165 mc	355	450	v
D-c plate power input	80 mc	30	45	w
	135 mc	26.5	40	w
	165 mc	23.5	35	w
D-c plate current		75	90	ma
D-c screen potential		250	250	v
Plate dissipation		10	15	w

USEFUL POWER OUTPUT (CCS) — TYPICAL OPERATION#

Service	*Up to: 165*	*135*	*80*	*mc*
Class C unmod. or f-m	18	24	30	w
Class C plate-modulated	12	16	20	w

*Carrier condition with max modulation percentage of 100. #Useful power output to load equals plate power output less circuit and direct radiation losses.

5516 CONSTRUCTIONAL ADVANTAGES

- Zirconium-coated plate, gold-plated control grid, carbonized screen grid enable maximum possible vhf ratings, despite compact size.
- Special, rugged filament suspension avoids short circuits and burn-outs in rigorous mobile applications.
- Three separate base-pin connections to filament center tap provide for lowest possible cathode lead inductance.
- Dishpan stem and compact structure give short, heavy leads with low inductance and capacitance.

SPECIALISTS IN RADIO RECEIVING TUBES SINCE 1921

HYTRON RADIO AND ELECTRONICS CORP.

HYTRON RADIO TUBES

MAIN OFFICE: SALEM, MASSACHUSETTS

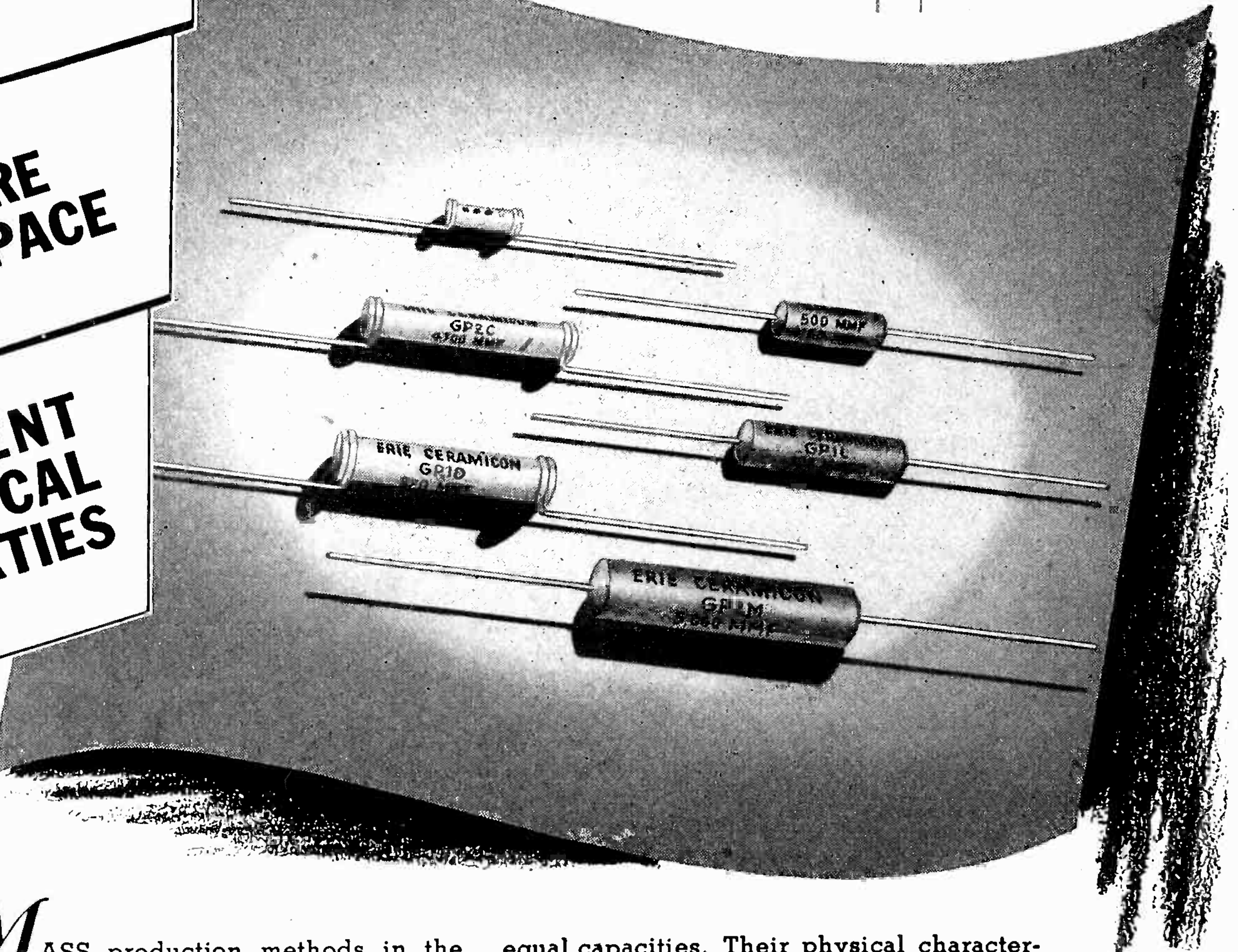
Reasons why . . .

The Trend is Toward ERIE "GP" CERAMICONS for By-Pass and Coupling Applications

ECONOMICAL

REQUIRE LESS SPACE

EXCELLENT ELECTRICAL PROPERTIES



MASS production methods in the manufacture of ERIE "GP" Ceramicons make possible mass production prices. Available in popular capacities, quantity production, with strict adherence to quality standards, bring new price economies in ceramic condensers for practically all applications in which the condenser is not directly frequency determining.

High capacities are available in extremely compact sizes. Because they are tubular in shape, they require less area than many types of rectangular shaped condensers of equal capacities. Their physical characteristics make them easy to handle in the assembly line.

Because of their basic, simple construction ERIE "GP" Ceramicons have higher resonant frequencies. This factor is increasingly important as the higher frequencies used in FM & Television are reached.

The trend is toward ERIE "GP" Ceramicons. They are made in insulated styles in popular capacity values up to 5000 MMF, and in non-insulated styles up to 10,000 MMF. Write for full details and samples.

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND • • TORONTO, CANADA

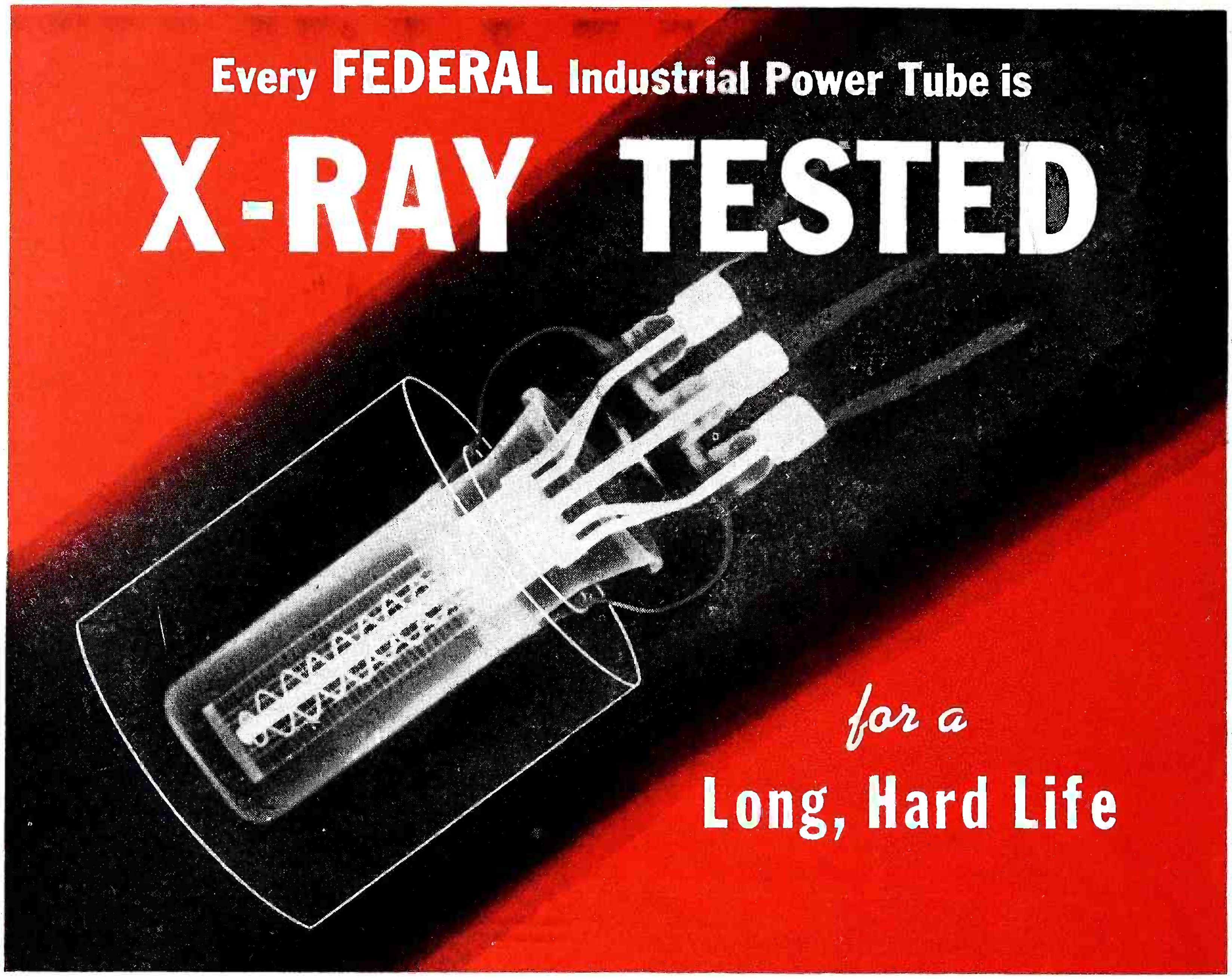
Continuously VARIABLE

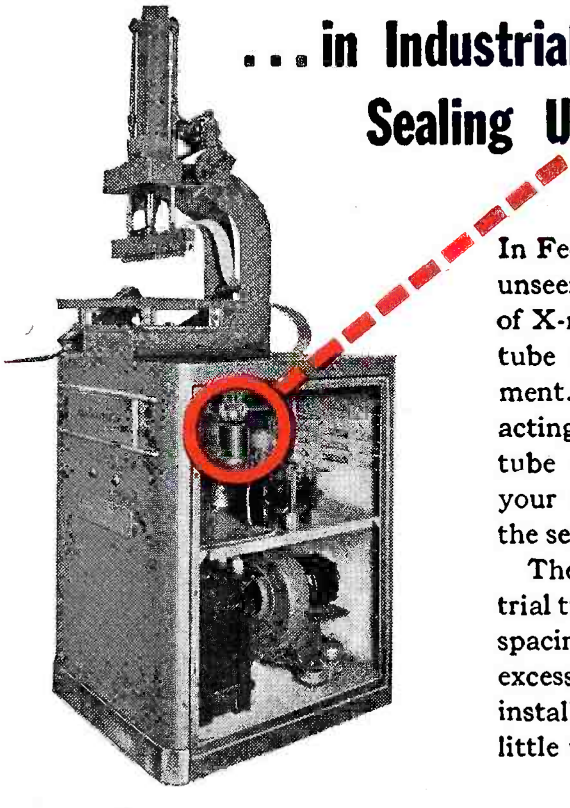
CAPACITANCE "ON-THE-NOSE" FOR HIGH CURRENT, HIGH POWER ELECTRONIC CIRCUITS

The variable capacitance feature of Lapp Gas-Filled Condensers permits you to "tune-to-a-whisker," with power on, to get the most out of any high current, high power circuit. And once set, this gas-dielectric unit delivers uniformly—no "warm up," no change of capacitance with change in temperature. Non-deteriorating, too, the Lapp unit is truly puncture-proof and will outlast almost any other components of any circuit of which it is a part. In addition to the variable unit, there are adjustable units, continuously adjustable within their range but not designed for frequent "tuning dial" adjustment, and fixed capacitance units. Current ratings range up to 500 amperes R.M.S.; power ratings to 60 Kv peak load. Capacitance to 60,000 mmf. (for fixed units); to 16,000 mmf. (variable and adjustable units). Higher ratings on special design order.

Lapp

LAPP INSULATOR COMPANY, INC., LE ROY, NEW YORK





. . . in Industrial Electronic Equipment like this 2½-KW Dielectric Sealing Unit made by the RADIO RECEPTOR CO. INC., N. Y. C.

In Federal Power Tubes, there can be no unseen flaws — because the searching eye of X-ray tells the "inside story" of *every* tube not once, but *twice*, before shipment. This test, together with other exacting requirements, means that each tube must be perfect in every detail — your assurance of longer tube life under the severe conditions of industrial service.

The 7C25, like all of Federal's industrial tubes, is built to take a beating. Wide spacing of internal elements fortify against excessive vibration. Flexible leads simplify installation and reduce strains. And very little unshielded glass is used, minimizing the possibility of breakage in handling or in service.

For complete information, write to Dept. L313.

DATA FOR 7C25 TUBE

Filament Voltage	11.0 volts
Filament Current	27.5 amp.
Maximum Ratings for Maximum Frequency of 50 Mc	
DC Plate Voltage	4500 volts
DC Plate Current	1.25 amp.
Plate Dissipation	2500 watts
Overall Height	App. 7 inches
Maximum Diameter	3½ inches
Type of cooling	Forced Air

Federal Telephone and Radio Corporation

In Canada: — Federal Electric Manufacturing Company, Ltd., Montreal.
Export Distributors: — International Standard Electric Corp. 67 Broad St., N. Y.

AN IT&T ASSOCIATE — FEDERAL TELEPHONE & RADIO FTR

100 Kingsland Road, Clifton, New Jersey

Arnold presents:

another step towards a complete line of permanent magnet materials . . . . .

SINTERED ALNICO

- CAST ALNICO I
- CAST ALNICO II
- CAST ALNICO III
- CAST ALNICO IV
- CAST ALNICO V
- CAST ALNICO VI
- CAST ALNICO XII
- **SINTERED ALNICO**

In general SINTERED ALNICO MAGNETS do not compete with, but rather supplement, magnets produced by the cast method to widen the scope of potential permanent magnet applications.

Alnico magnets weighing roughly one ounce or less should be produced by the sintered method.

Heavier magnets of more intricate shapes can be produced. For some applications Sintered magnets are more economical because:

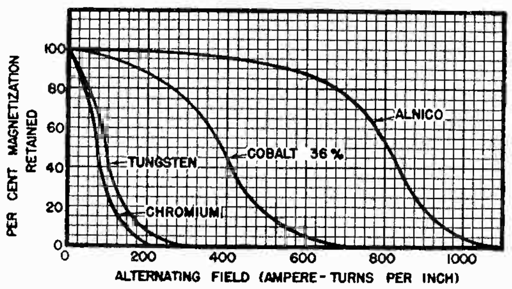
1. Magnetic characteristics are practically the same as Cast Alnico.
2. Sintered Alnico is a fine-grain, homogeneous material which has more uniform flux density, is easier to grind, and provides better surface finish.
3. Sintered Alnico magnets can be produced to closer dimensional tolerances:

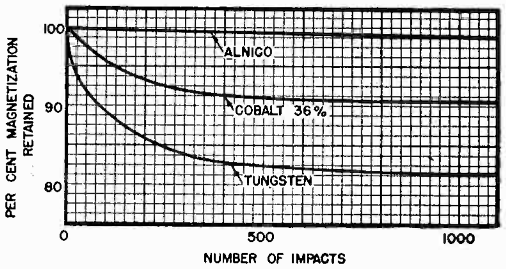
SINTERED ALNICO II	CAST ALNICO II
0.000 to 0.125 — + .005	0.000 to 2.00 — ± 1/64
0.126 to 0.625 — + .010	2.0 to 4.0 — ± 1/32
0.626 to 1.250 — + .015	4.0 to 6.0 — ± 3/64
1.251 to 3.000 — + .062	

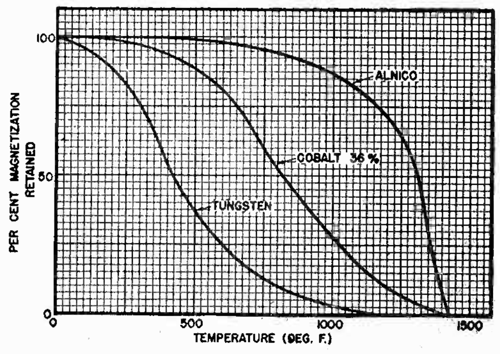
   Grinding can in many applications be eliminated.
4. More intricate shapes, including holes, inserts, etc., are more feasible.
5. Transverse modulus of rupture is several times greater.

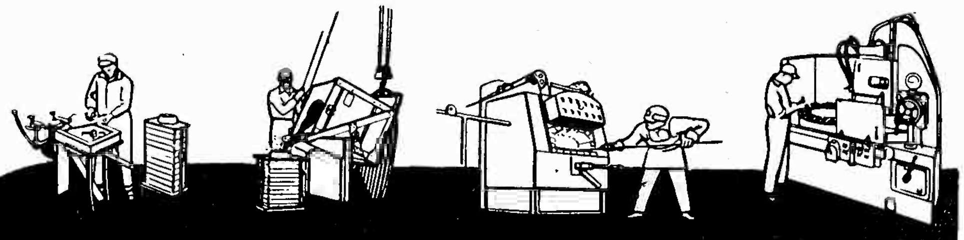
All Alnico, and particularly Sintered magnets, have very high values of Coercive Force (which is the capability of resisting demagnetization or loss of magnetism due to stray fields and from heat and vibration).

The curves show roughly the effect of these demagnetization factors on Alnico compared to other alloy steels.









THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS

Specialists in the manufacture of PERMANENT MAGNET MATERIALS

profit engineering with C-D Capacitors

Perhaps you're starting from scratch with a completely new product. Maybe you're sprucing up an old one. Or possibly you'd like to tighten assembly costs—bring your soaring break-even point back to earth. Regardless of what your specific problem may be, if capacitors play a part in your plans, C-D engineers can do a job of profit engineering for you.

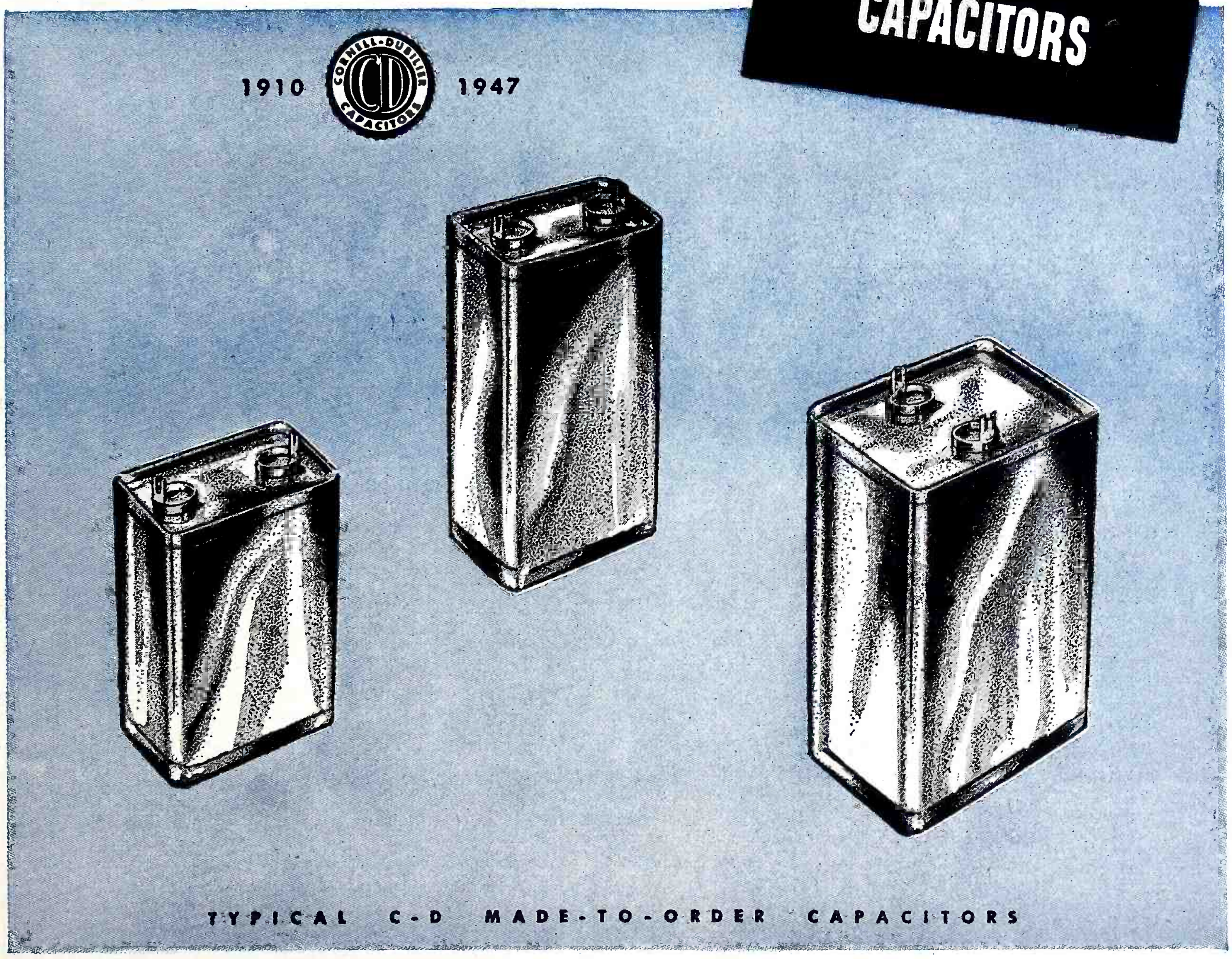
Unequalled specialization has enabled us to design and build over 250,000 different types of capacitors. Typical of this experience are the capacitors shown below—designed by C-D engineers to meet the specific production and profit problems of manufacturers like yourself.

CATALOG OF STANDARD TYPES AVAILABLE ON REQUEST

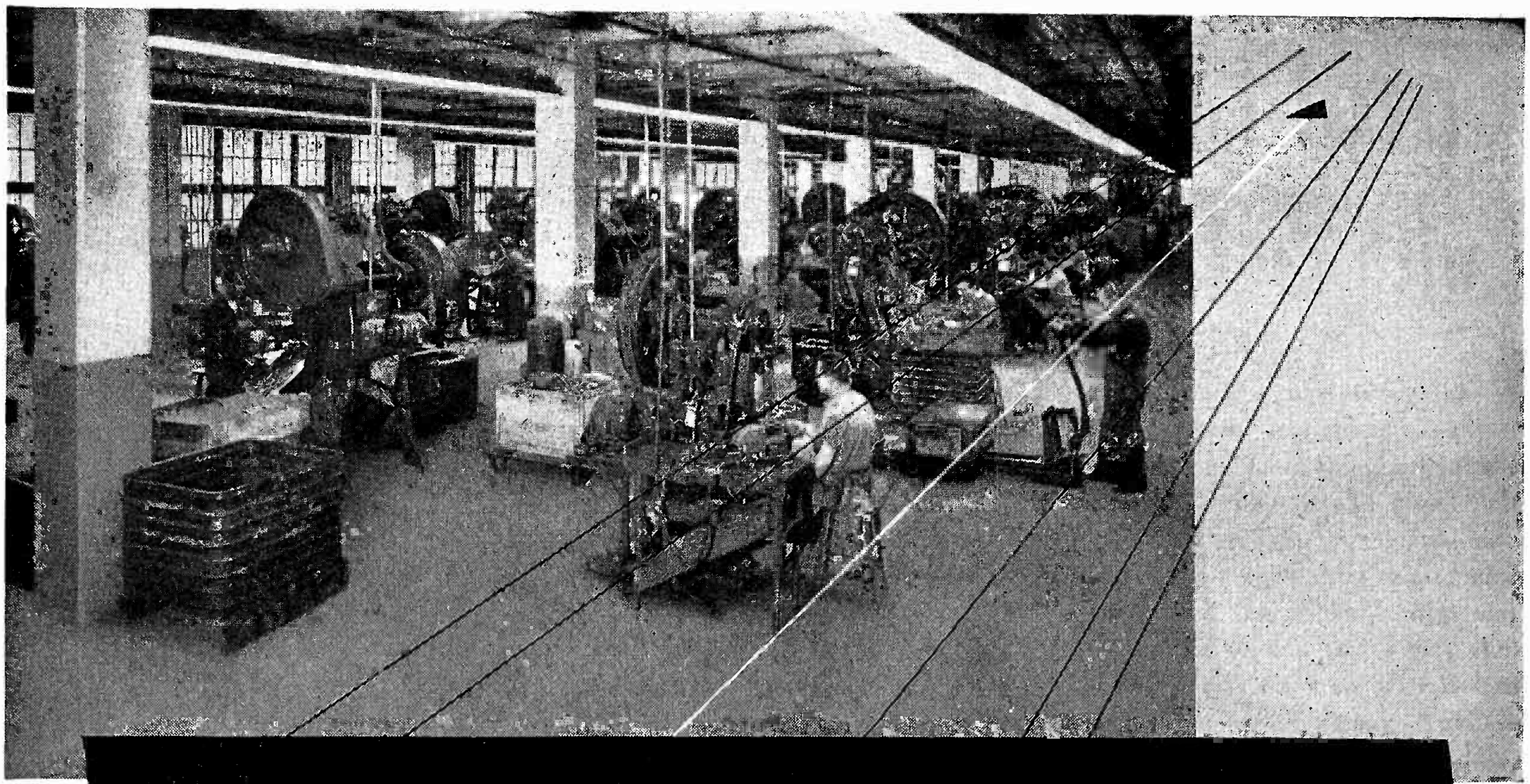
Cornell-Dubilier Electric Corporation, Dept. K4, South Plainfield, New Jersey. Other large plants in New Bedford, Worcester and Brookline, Mass., and Providence, R. I.

CORNELL-DUBILIER
world's largest manufacturer of
CAPACITORS

MICA • DYKANOL • PAPER • ELECTROLYTIC

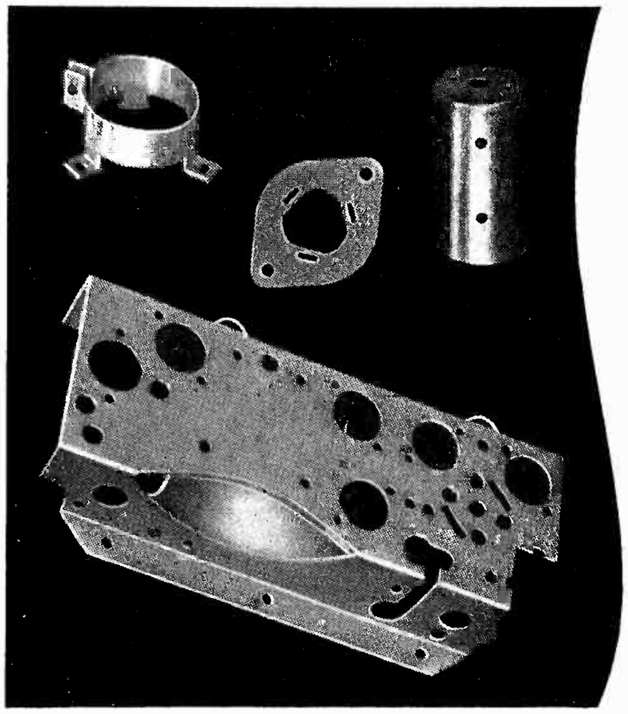


DESIGNATED AS THE TYPE HKG SERIES, these hermetically-sealed capacitors are available in a wide range of capacities at 2,000 and 2,500 V.D.C. Ruggedly constructed, they embody the research experience of over 37 years devoted exclusively to capacitors.



How to Lengthen your Production Line

with **NO** capital investment



The ability to increase or diversify production without additional investment for plants and machinery puts you a long step ahead of competition. One way to do that . . . to make your production line longer without investing in new equipment . . . is to make use of Paul and Beekman Service.

Paul and Beekman Division specializes in large-scale production of precision metal parts. We have the men, the machines and the organization to turn out parts for you . . . to turn them out fast, and at a cost that will help you remain in a good competitive position.

We'd like to tell you more about our services, and how we'd apply them in your particular case. Write us . . . our engineers are available for consultation with no obligation to you.

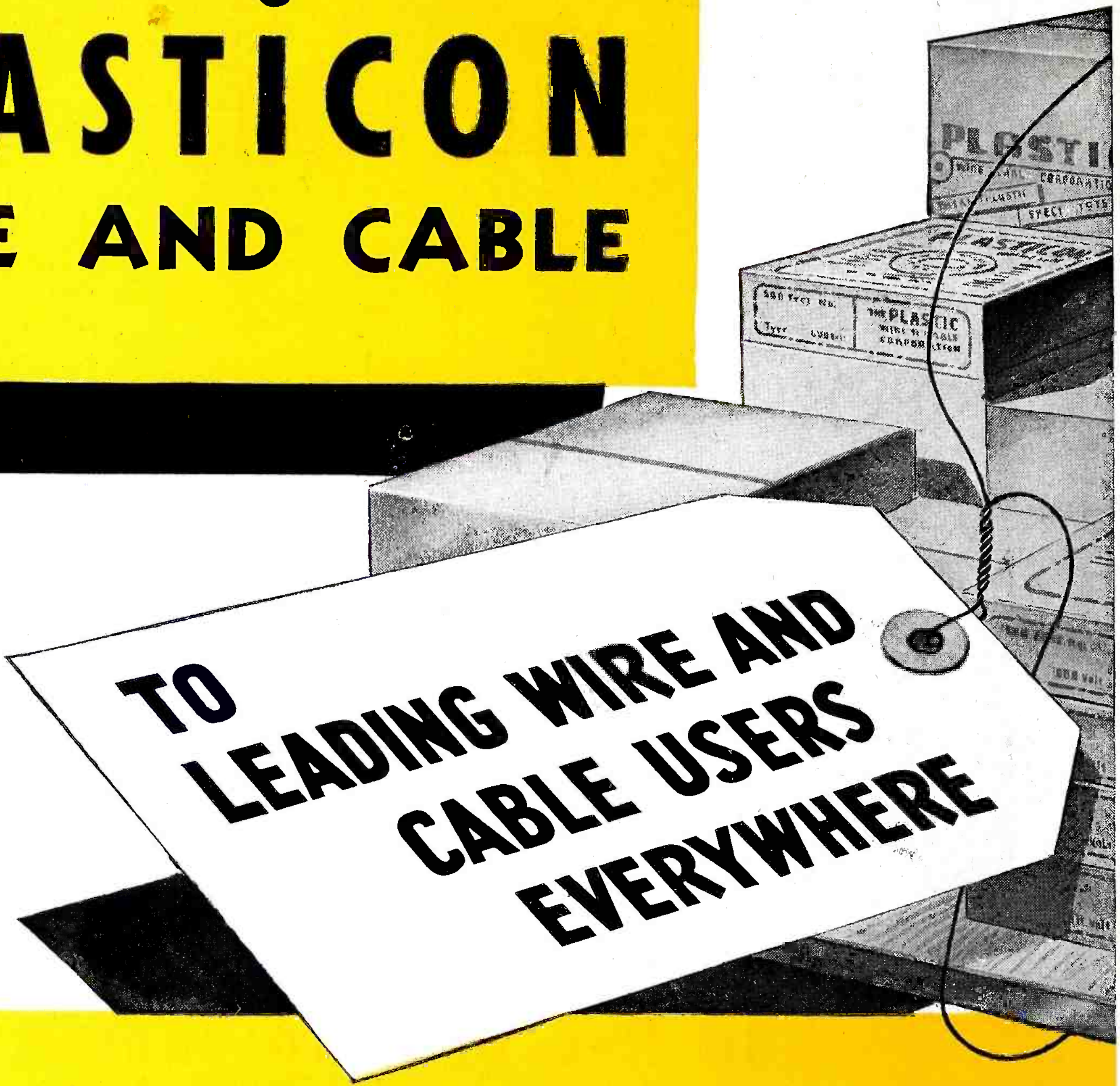
Paul and Beekman Division makes all types of precision metal stampings, and complete or sub-assemblies—including condenser cans, mounting clamps, mounting plates, chassis. From mild steel, stainless steel, aluminum, copper or brass—painted or electroplated as required.

PAUL and BEEKMAN *Division* 1805 COURTLAND ST., PHILADELPHIA 40, PA.

PORTABLE PRODUCTS CORPORATION

MANUFACTURERS OF: LAWN MOWERS • ELECTRICAL APPLIANCES • PRECISION STAMPINGS
INDUSTRIAL INSTRUMENTS • RADIOS • SAFETY EQUIPMENT

You'll be in good company using PLASTICON WIRE AND CABLE



WHAT CAN ANY INSULATION DO THAT PLASTIC CAN'T DO BETTER?

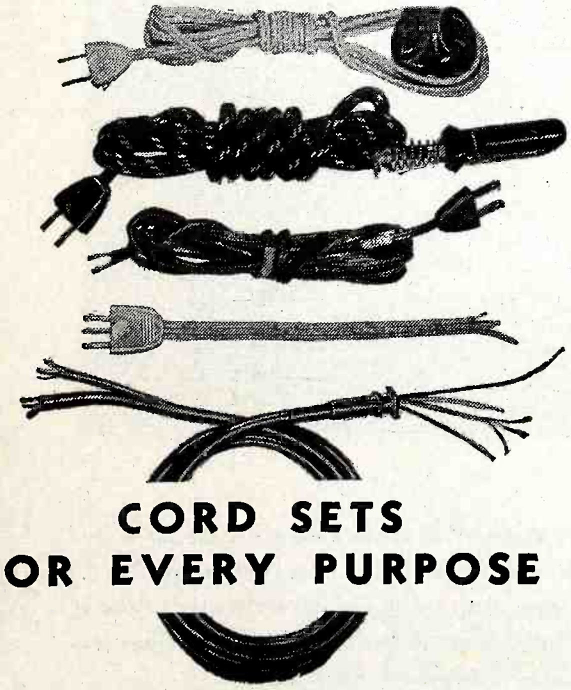
Plastic insulation is a basic permanent improvement because of its inherent qualities and its adaptability to almost any insulation requirement.

PLASTICON stands for plastic-insulated wire and cable manufactured to the highest standards by Plastic Wire & Cable Corporation — world's largest exclusive producer and pioneer of progress in plastic-insulated conductors. Plastic Wire & Cable engineers are continually expanding the development of plastic compounds to meet the specialized needs of wire and cable users.

PLASTICON

10 WAYS BETTER

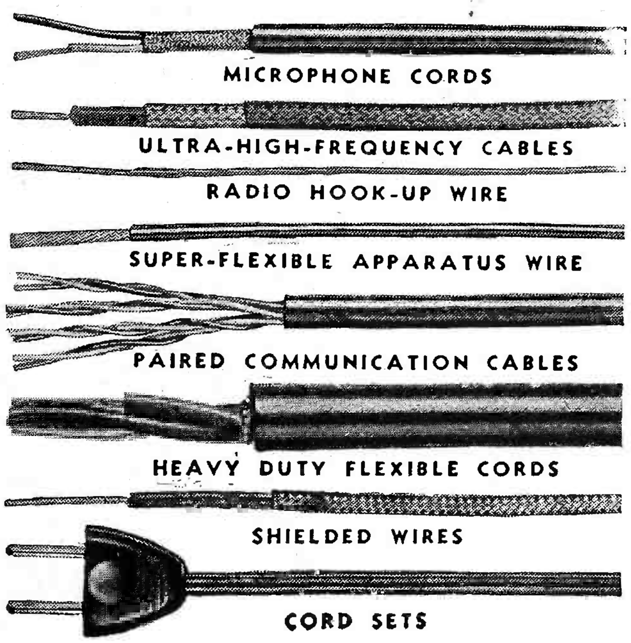
1. Greater dielectric strength.
2. Cannot fray, crack or rot.
3. Low moisture absorption.
4. Greater mechanical strength.
5. Higher abrasion resistance.
6. Flexibility at all temperatures.
7. High chemical resistance.
8. Wide range of permanent gem-like colors.
9. Non-combustible.
10. Lasting appearance.



CORD SETS
FOR EVERY PURPOSE

DECIDE FOR YOURSELF!

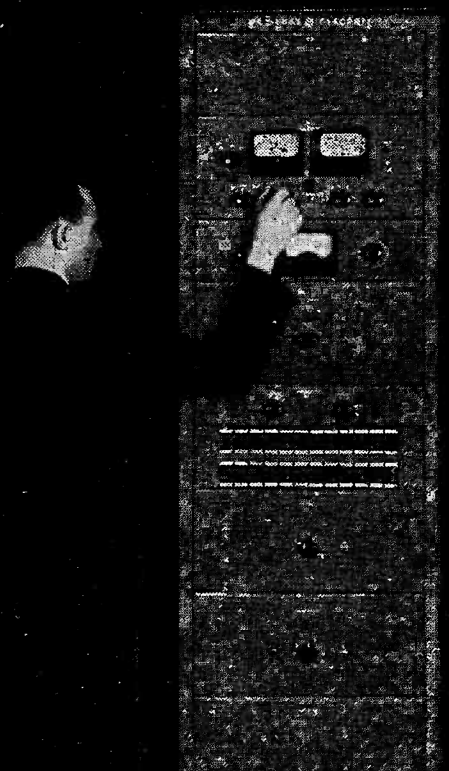
Our booklet of technical data is packed with facts about the mechanical and dielectric characteristics, resistance to chemicals, aging properties, and other important data of interest and importance to all users of wire and cable. Write for your free copy today, or explain your requirements and let us tell you how PLASTICON can meet them. Plastic Wire & Cable Corporation, 408 East Main Street, Jewett City, Connecticut.



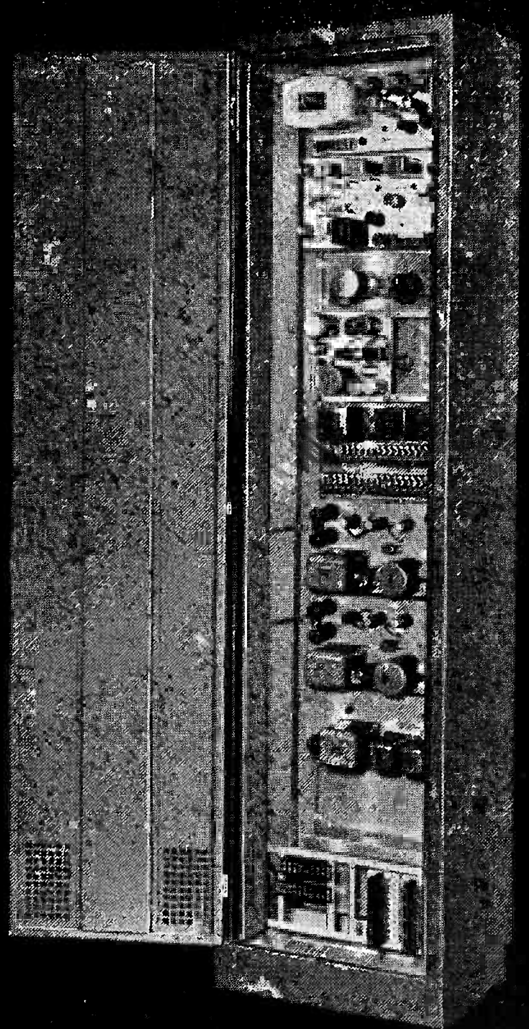
for FM, AM and TV

FEATURING INSTANT ACCESSIBILITY

General Electric's new high-fidelity audio equipment does away with complicated servicing procedures—puts *every* circuit component within instant reach! It assures you maximum on-the-air reliability, lower cost-per-hour of broadcast service—places your a-f facilities ahead of tomorrow's demands.



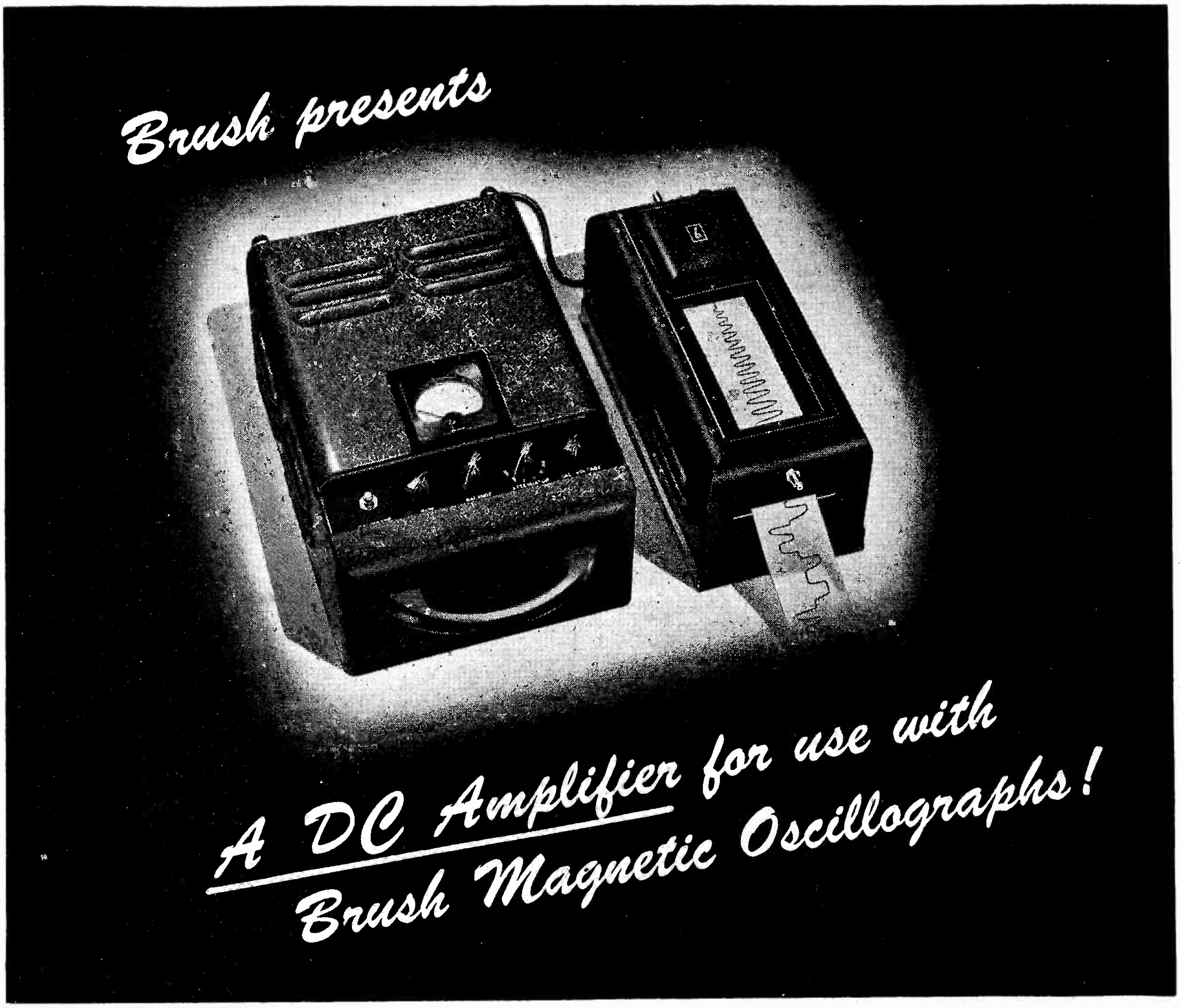
Advanced styling, plus attention to operating details, make this cabinet rack a *must* in the modern broadcast installation. General Electric cabinet racks are sturdy—made of heavy-gauge steel, adequately reinforced. The rigid, no-sag rear door is equipped with a full-size handle and smooth-acting latch.



FIRST AND GREATEST NAME IN ELECTRONICS

GENERAL ELECTRIC

160-F1-8814



This is truly a practical D.C. amplifier! It opens new uses for your Brush Direct-Inking Oscillograph. As with all Brush products this new instrument represents years of intensive research in engineering and design. Write today for the complete story . . . Brush representatives will be glad to demonstrate.

Specifications include

- **Frequency Response**—uniform from D.C. to 100 cycles per second
- **Voltage Gain**—1000 Approximately (one chart millimeter pen displacement per millivolt signal)
- **Stability**—drift—less than one chart mm. per hour
- **Calibration Circuit**—for convenient determination of input signal levels
- **Centering Control**—to position pen electrically to any point on chart
- **Power Requirements**—115 volts, 60 cycles
- **Portability**—Weight 30 pounds

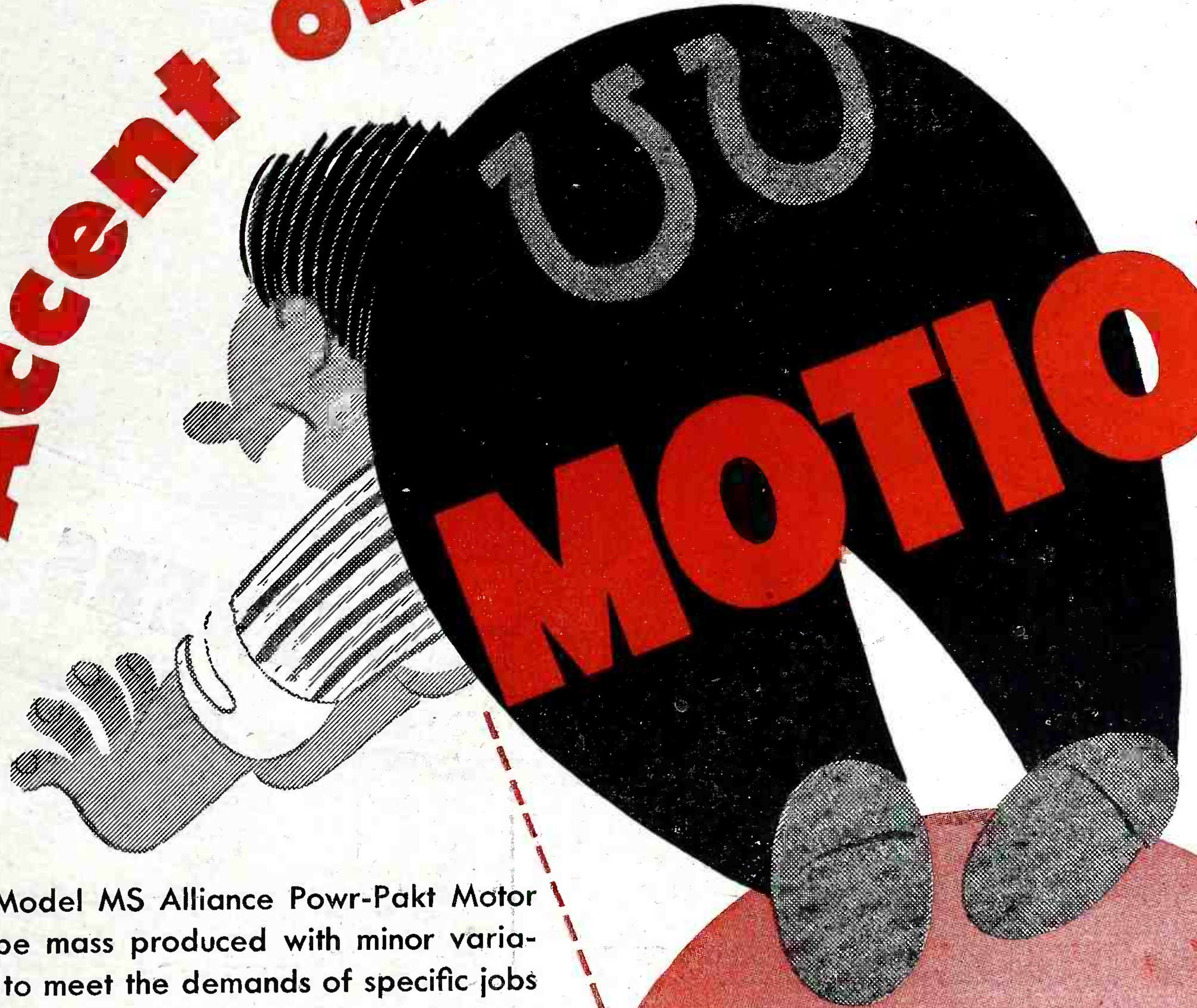
a product of

The Brush Development Co.

3415 Perkins Ave., Cleveland 14, Ohio

Canadian Representatives: A. C. Wickman, (Canada) Ltd., P. O. Box 9, Station N, Toronto 14

Accent on MOTION



The Model MS Alliance Powr-Pakt Motor can be mass produced with minor variations to meet the demands of specific jobs which require a highly efficient miniature power plant. Operating over a wide range of AC voltages from 24 to 250 and frequency of 40, 50 or 60 cycles, this compact lightweight motor can be incorporated as the vital power source in all kinds of electrical and mechanical devices.

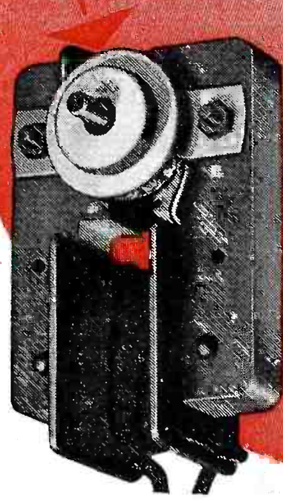
Here are just a few of the many applications which can use the Alliance Model MS or one of the other Powr-Pakt motors in the Alliance line:

Electronic, electric, radio and time controls, radio tuning and turntable drives, valve and heating controls, coin operated mechanisms, signals, switches, business machines and other specialized uses.

The trend is to make things move!

Designs will call for more action — movement! Flexible product performance needs power sources which are compact, light weight! Alliance Powr-Pakt Motors rated from less than 1-400th on up to 1-20th h.p. will fit those "point-of-action" places! Alliance Motors are *mass produced at low cost* — engineered for small load jobs!

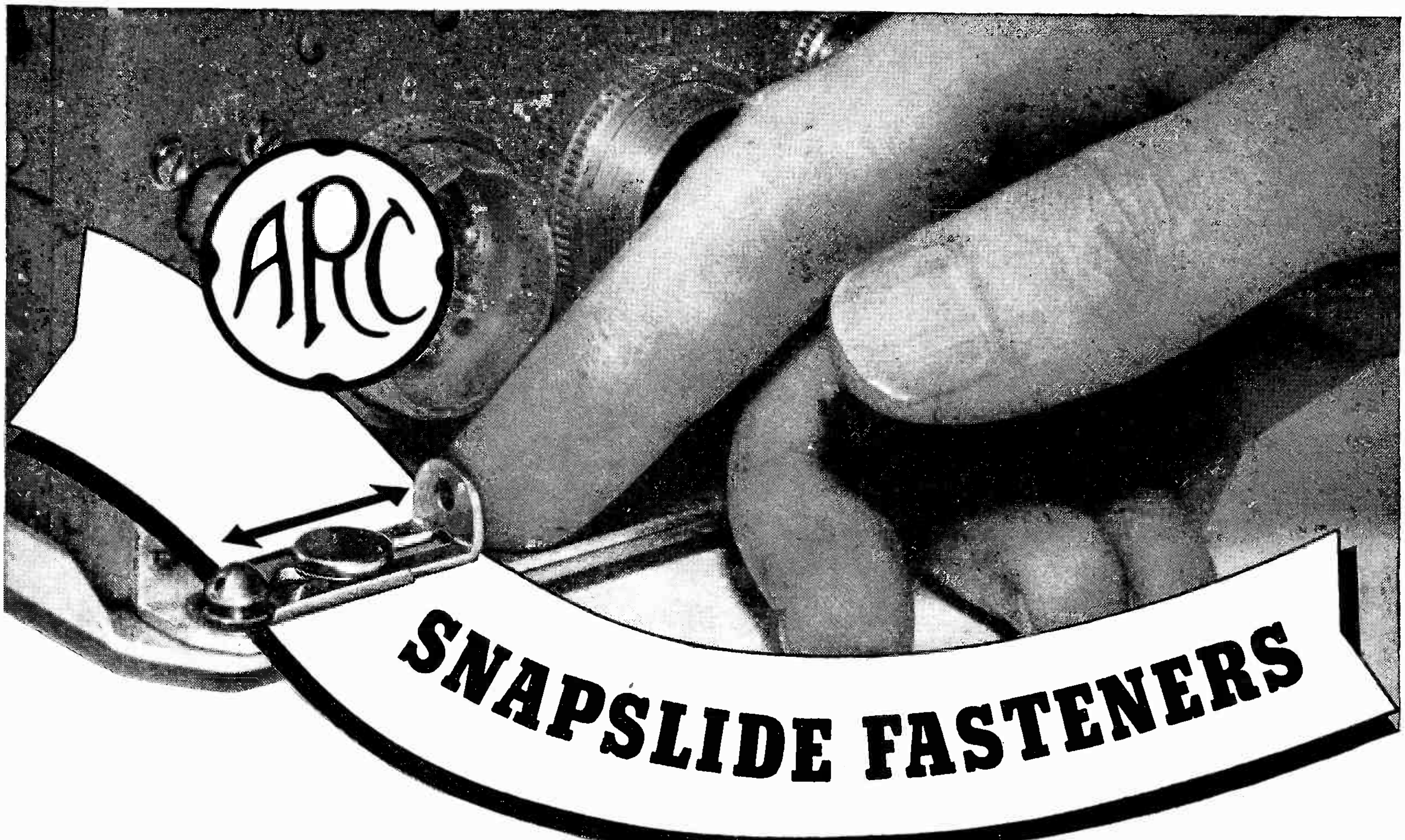
For vital component power links to actuate controls...to make things move . . . plan to use them!



Model MS Shaded Pole Induction Type Motor, size 3⅛" x 2" x 1⅜". Weight, 1 lb. 2 oz.

WHEN YOU DESIGN—KEEP alliance MOTORS IN MIND

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO



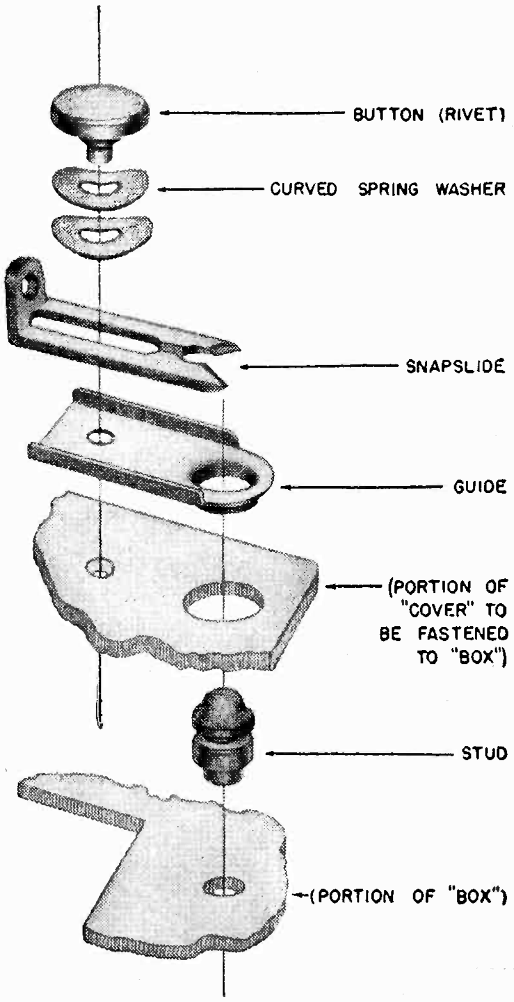
QUICK, EASY, ENTIRELY VISIBLE, NO TOOLS NEEDED

These Snapslide Fasteners were originated by A. R. C. to provide positive means of attachment and yet to allow instant disengagement. Note how the two spring jaws of the Snapslide lock around the Stud and insure complete security. Both large and small Snapslide Fasteners are available, with Buttons and Studs for various applications and different thicknesses of material.

VARIETY OF USES

Large Snapslides, approximately $\frac{7}{16}''$ wide by $1''$ long, are suitable for attaching radio sets or such units as dynamotors, converters, etc. to shock absorbers or directly to mounting plates.

Small Snapslides, approximately $\frac{1}{4}''$ wide by $\frac{19}{32}''$ long, are used to hold down tube covers, fuse covers, and similar light-weight parts.



A.R.C.

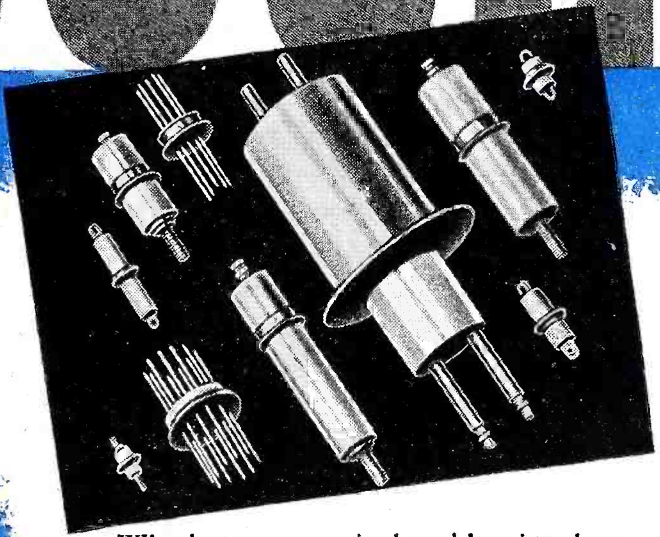
Aircraft Radio Corporation

Boonton, N. J.

Designers and Manufacturers of Radio and Electronic Equipment Since 1928

Steatite SEALEX BUSHINGS

the GUARANTEED hermetic seal!



Pressure tested, shockproof Sealed Leads and Multiple Headers

Whether your terminal problem involves vibration, temperature, hermetic sealing or ordinary lead termination, GENERAL CERAMICS Steatite Sealex Bushings and Multiple Headers offer important advantages that reduce assembly costs and improve product quality. Mounting as a single unit, they can be quickly soldered, welded or sweated to the equipment enclosure and provide perfect termination for one or as many leads as required.

GENERAL CERAMICS Sealex Bushings and Multiple Headers are available in many standard sizes and types suitable for most applications. Special types can be supplied on short notice. Hermetic sealing is absolute and each unit is individually pressure tested at 50 psi; all metal parts are hot-tinned for fast soldering. Sealex Bushings are available in sizes from 0.5 to 20 amps with flash-over ratings to 40 Kilovolts. Steatite — the insulation used in these products — has a low loss factor of only 0.7% at 1000 K.C., which recommends the use of these terminals at practically any frequency.

WRITE TODAY FOR CATALOG!

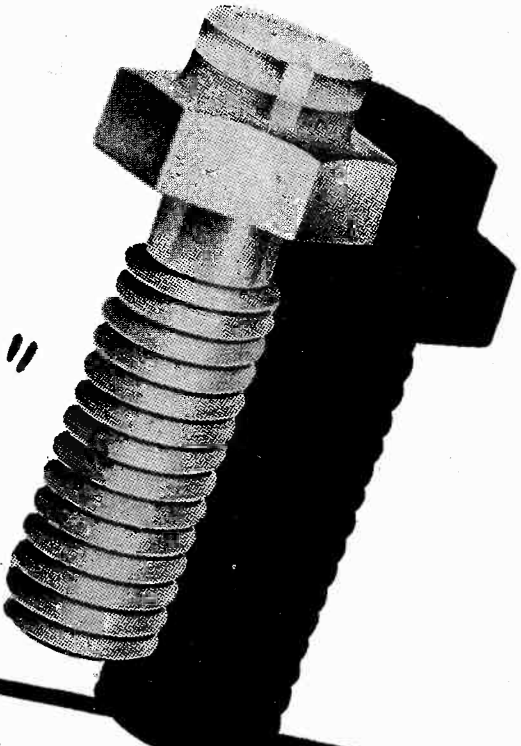
GENERAL CERAMICS engineers will gladly assist in applying Steatite Sealex terminals to your equipment, or will collaborate in developing special types for unusual conditions. An informative, fully illustrated catalog covering all General Ceramic insulators, is available free upon request on company letterhead. Write for your copy today!

GENERAL CERAMICS AND STEATITE CORPORATION
STEATITE INSULATORS

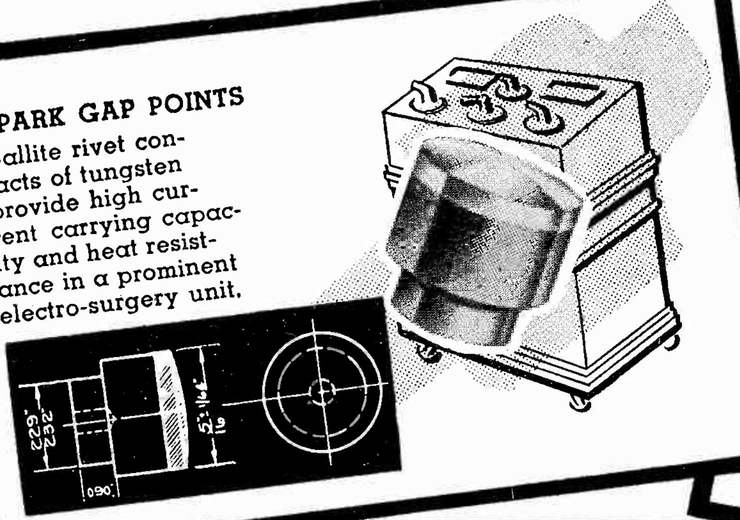
General CERAMICS and STEATITE CORP.
GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

MAKERS OF STEATITE, TITANATES, ZIRCON PORCELAIN, ALUMINA, LIGHT-DUTY REFRACTORIES, CHEMICAL STONEWARE

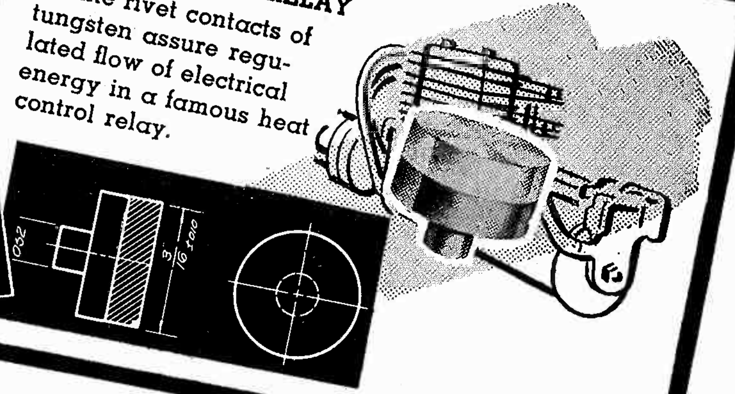
"We didn't know you could do that with Callite Contacts"



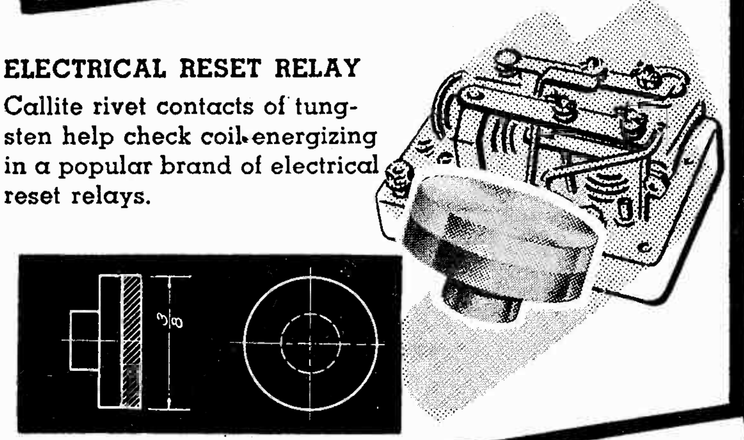
SPARK GAP POINTS
Callite rivet contacts of tungsten provide high current carrying capacity and heat resistance in a prominent electro-surgery unit.



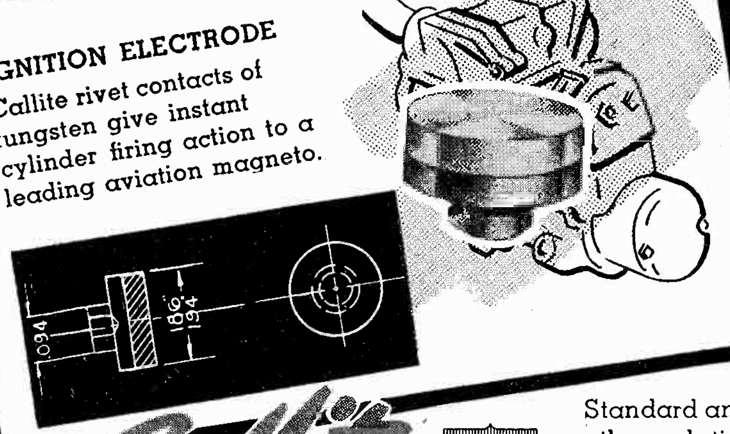
HEAT CONTROL RELAY
Callite rivet contacts of tungsten assure regulated flow of electrical energy in a famous heat control relay.



ELECTRICAL RESET RELAY
Callite rivet contacts of tungsten help check coil energizing in a popular brand of electrical reset relays.



IGNITION ELECTRODE
Callite rivet contacts of tungsten give instant cylinder firing action to a leading aviation magneto.

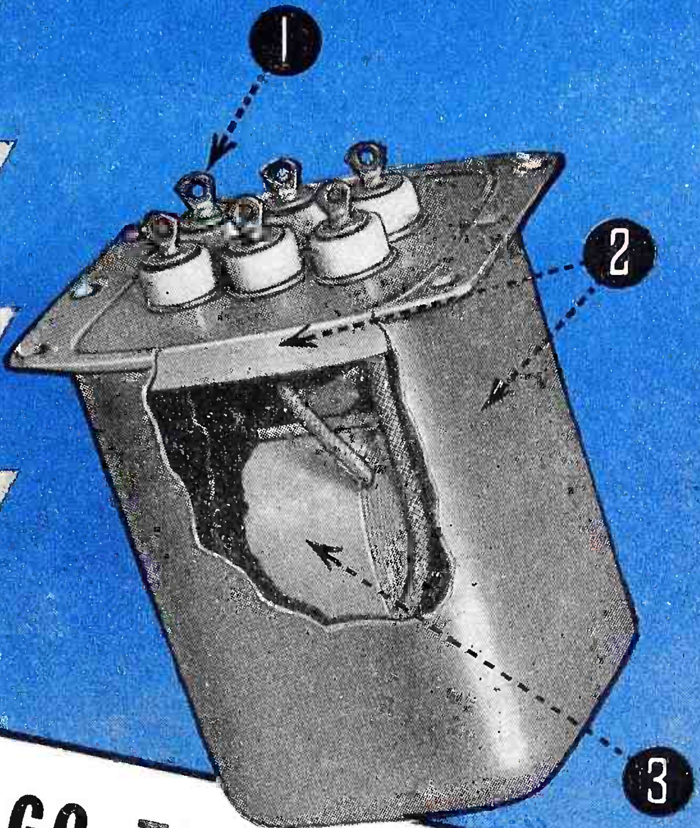


Illustrated above are four contacts that are not for sale. They were designed—after close collaboration between each manufacturer's staff and ours—for highly individual contact applications. But the same resourcefulness and engineering flexibility that produced these special designs can also be applied to furnishing the exact contact you need for your own equipment. In 26 years of specialization and pioneering with component metallurgy, we have amassed thousands of tried-and-tested stock contact types as well as the experience to produce any type not yet devised. Call your Callite engineer for an estimate. Callite Tungsten Corp., 544 Thirty-ninth St., Union City, N. J.
Branch Offices: Chicago, Cleveland.

Callite CONTACTS

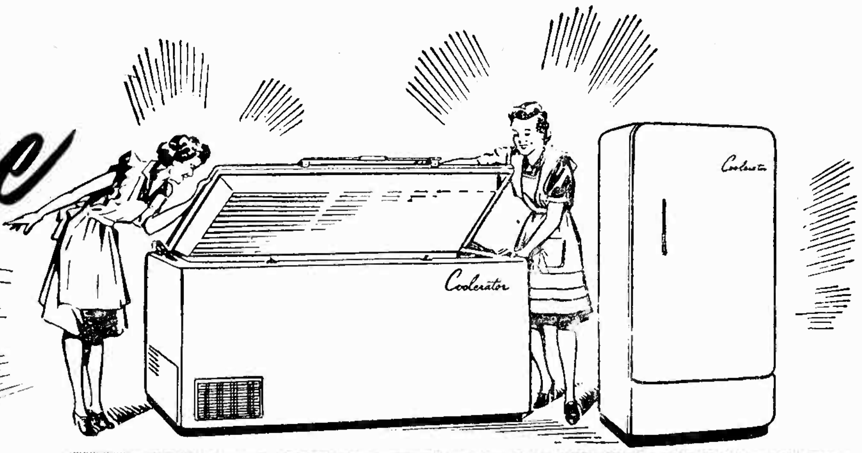
CALLITE TUNGSTEN CORPORATION CT

Standard and special shapes in tungsten, molybdenum, silver, platinum, palladium and alloys of these metals. Write for Catalog #152 which describes stock contacts and extraordinary designs used in special applications.



saves costly time

Training New Assembly Workers by using PHILLIPS SCREWS



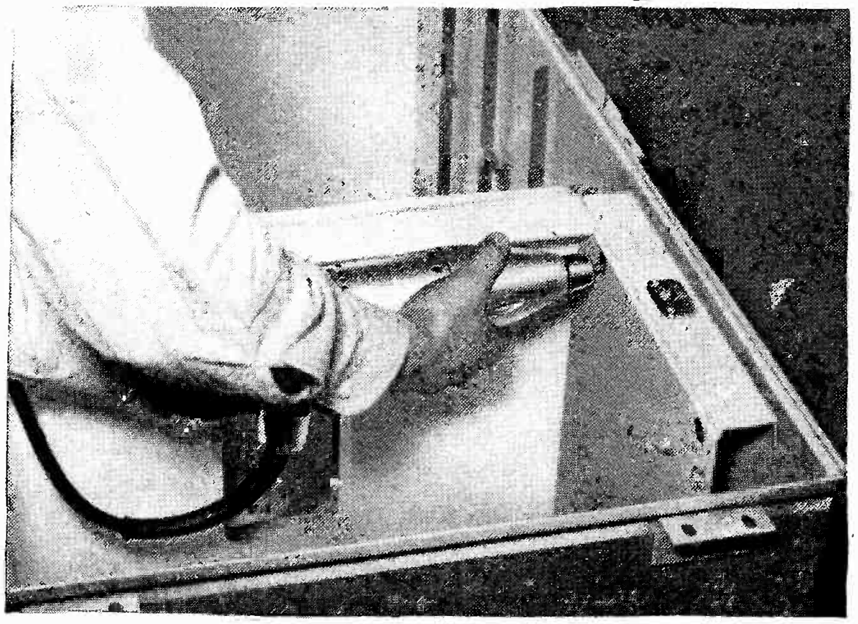
Highlights from a comprehensive report by independent investigator of James O. Peck Co.—one of their studies of assembly savings made with Phillips Screws in leading plants . . .

● "WE made an important saving we hadn't counted on when we switched to Phillips Recessed Head Screws," said the foreman of Coolerator's assembly line. "Instead of the expensively long period usually required to train operators to drive slotted screws, we found that new people could start driving Phillips Screws with a few simple instructions. Since we use about 125 Phillips Screws in every Coolerator and our daily production is 800, there isn't much time for teaching anyone how to drive a screw.

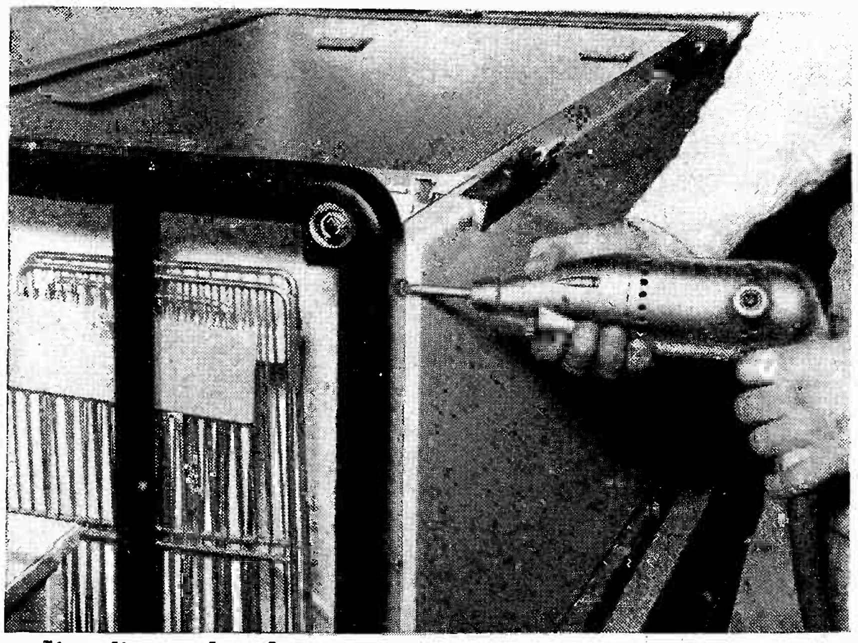
"**EASIER TO USE,** especially in awkward or blind applications . . . like fastening the black base to the bottom of the unit or attaching the ice container to the box. You have practically no control over slotted screws, while Phillips Screws are easy to line up.

"**STOPPED PANEL DAMAGE** and burring of heads. Assembly people used to almost write their names on the sides of the units when a slotted screw driver slipped. That cost real money . . . for disassembly, refinishing and reassembly, not to mention the disruption of the assembly line. Phillips Screws ended slips.

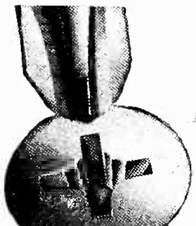
THE WHOLE STORY of this and other assembly studies in key plants . . . covering metal, wood and plastic products . . . will suggest similar savings to any production man. This coupon will bring you these reports—FREE. Mail it now.

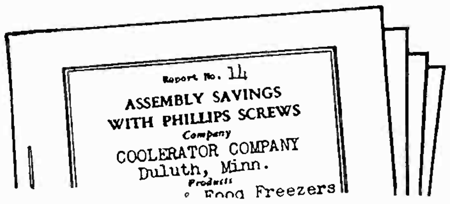


Here's a tricky bit of "blind" driving . . . through a small hole in the ice unit. With Phillips Screws, locating and driving is easier.



If ordinary slotted screws were used in fastening this black enameled base, inevitable driver slippage would do costly damage to the adjacent panels.





Phillips Screw Mfrs., c/o Horton-Noyes E-16
2300 Industrial Trust Bldg.,
Providence, R. I.

Send me reports on Assembly Savings with Phillips Screws.

Name ....

Company ....

Address ....

PHILLIPS *Recessed Head* SCREWS

Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts

23 SOURCES

American Screw Co.
Central Screw Co.
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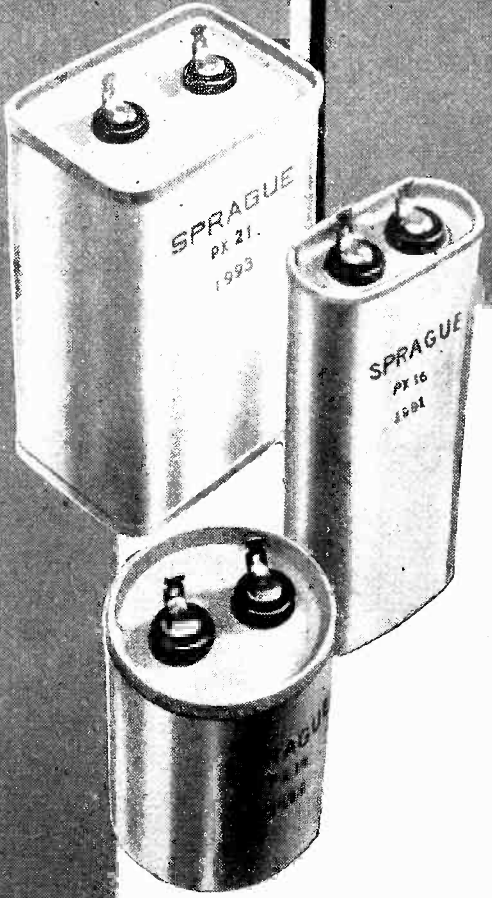
International Screw Co.
Lamson & Sessions Co.
Milford Rivet and Machine Co.
Pheoll Manufacturing Co.
National Lock Co.
National Screw & Mfg. Co.
New England Screw Co.
Parker-Kalon Corporation
Pawtucket Screw Co.
Reading Screw Co.
Russell Burdsall & Ward Bolt & Nut Co.
Scovill Manufacturing Co.
Shakeproof Inc.
The Southington Hardware Mfg. Co.
The Steel Company of Canada, Ltd.
Sterling Bolt Co.
Stronghold Screw Products, Inc.
Wolverine Bolt Company

SPRAGUE
VITAMIN Q DIELECTRIC
(TRADEMARK REG. U. S. PAT. OFF.)

HAS PERMITTED SUBSTANTIAL RE-DUCTIONS IN BOTH THE SIZE AND WEIGHT OF MANY OIL-FILLED CAPACITOR TYPES



TYPICAL! Greatly Increased Life for Fluorescent Lamp Capacitors

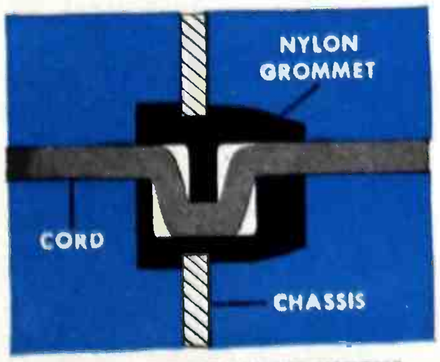
The application of Vitamin Q dielectric to Sprague Fluorescent Lamp Ballast Capacitors has established new, higher standards of performance under all conditions of use. Standard 3½ mfd. 330 volt capacitors in 2" round containers were tested competitively for 750 hours at 575v. A-C at 85°C. in still air. Not one of the Sprague Capacitors failed. All competing units by three other manufacturers failed within four hours. Write for Sprague Technical Data Bulletin No. 3200.

SPRAGUE ELECTRIC COMPANY, North Adams, Mass.

PIONEERS OF ELECTRIC AND ELECTRONIC PROGRESS

NYLON GROMMET WITH A VISE-LIKE GRIP

New safety for appliances . . . molded from a Du Pont plastic



HOW NEW GROMMET WORKS

Grommet is two-piece assembly. Wire is placed across base piece. Top section is squeezed into assembly with pliers, locking wire in a safe hairpin turn. Grommet is then snapped into hole in appliance chassis. (Nylon grommet molded by Mack Molding Co., Inc., Wayne, N. J., for Heyman Manufacturing Co., Kenilworth, New Jersey.)

WELCOME NEWS for appliance manufacturers, underwriters and consumers is a new strain-relief grommet (or bushing) molded from Du Pont nylon.

Anchored into the chassis of the appliance, this mighty little nylon grommet keeps a tight, safe grip on lead-in wire. It absorbs the stresses of tugs and twists . . . protects connections against stripping, short circuits and moisture . . . adds a safety feature and a sales boost too. Nylon outpointed all other grommet materials tested by the manufacturer. Under heat test, for example, the nylon grommet withstands temperatures up to 400°F. It is economical to install . . . and it lasts the life of the equipment.

Want to improve an old product . . . design a new one? Look to nylon . . . and other Du Pont plastics . . . for a lift to success and more sales. Write for literature. E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Room 154, Arlington, New Jersey.

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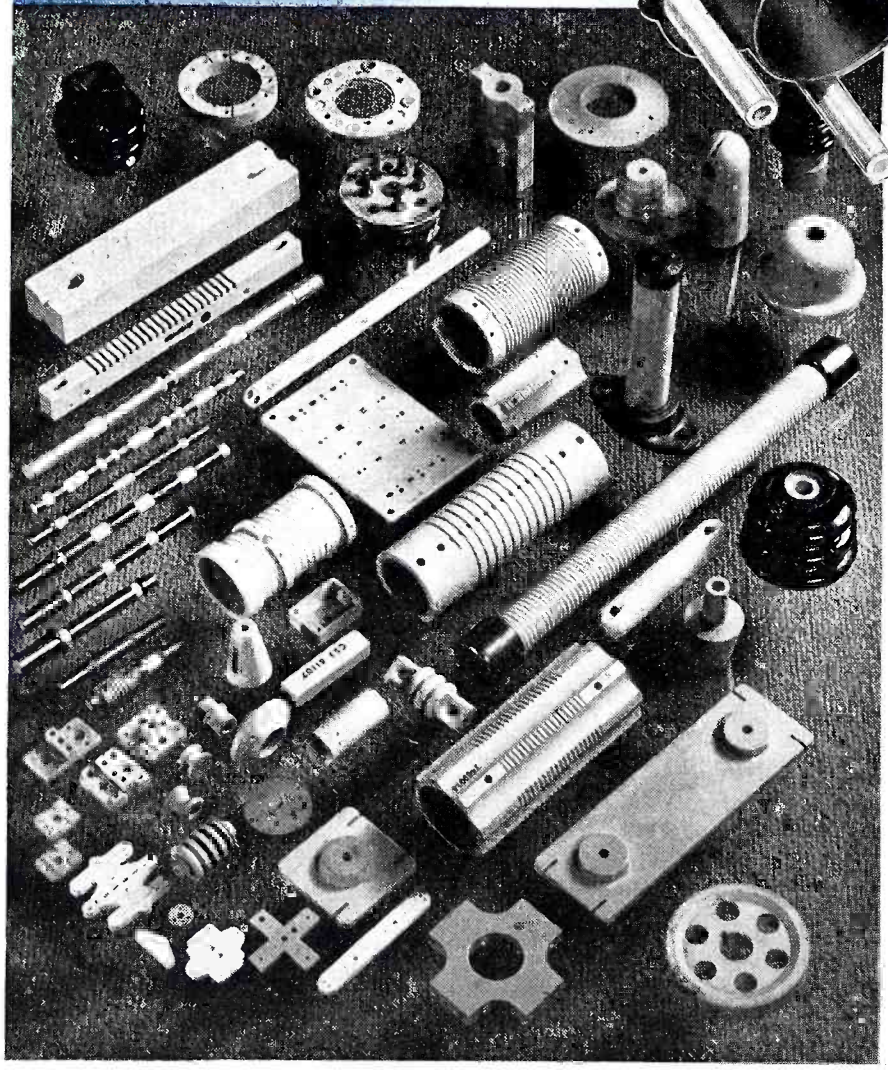
Plastics
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

for

ELECTRONIC TUBES and COMPONENTS



Precision Ceramic parts for highly sensitive Cathode Ray and other tubes—and for electronic components, require extremely close tolerances, highest quality materials and correct engineering. Such parts are constantly produced by STUPAKOFF.

The dimensional accuracy and sturdy structure of STUPAKOFF Ceramics speed fabrication processes, improve your products, make faster assembly possible and assure greater satisfaction. Standardize on STUPAKOFF for all your ceramic needs.

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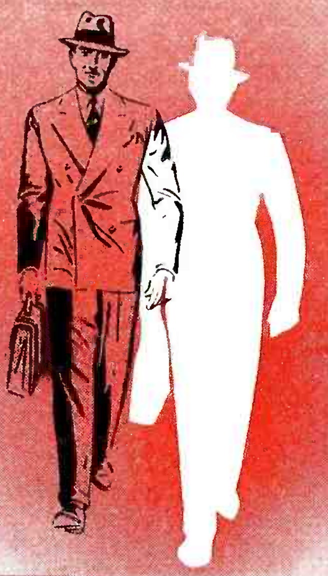
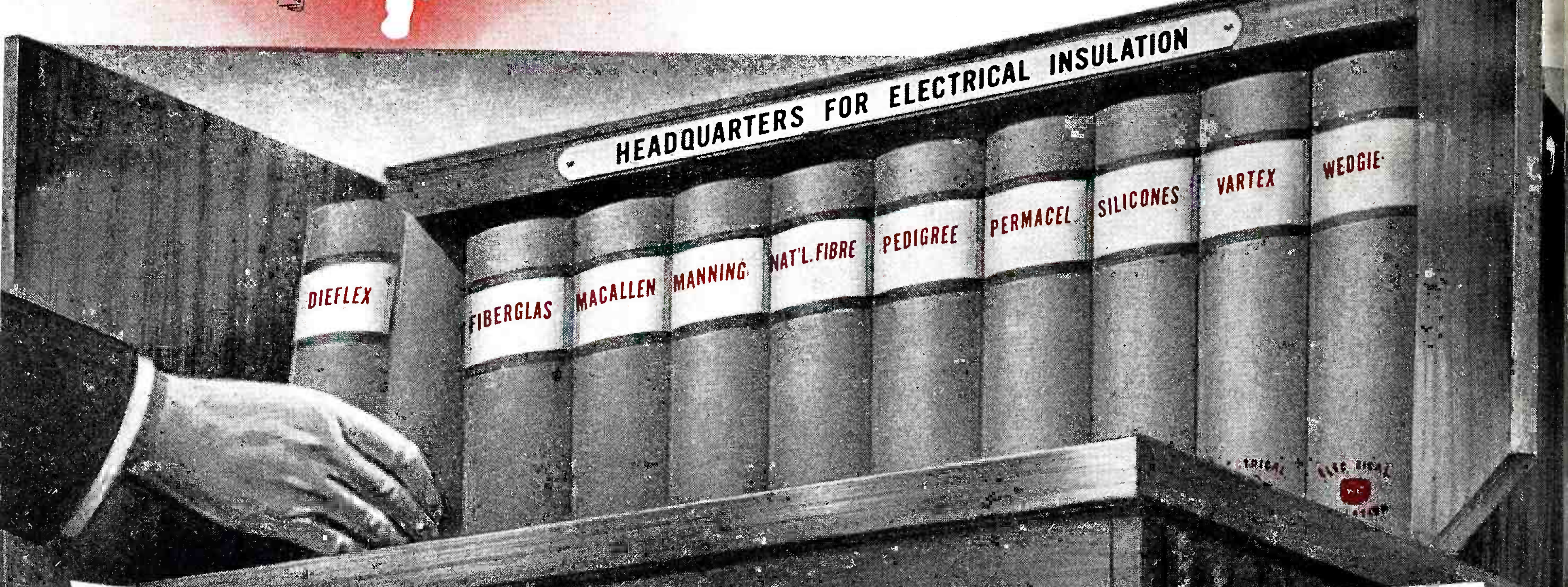


THE IMC ENGINEER IS ON YOUR STAFF.. but not on your payroll



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1. A complete line of nationally advertised insulating materials.
2. Expert advice and engineering service on the best application of these materials.

Whatever your insulation problem, call in your nearby IMC Engineer. He is trained in the application of electrical insulation, and can usually suggest an answer from his experience and the complete line of products he represents. Every one of these products is superior in quality and designed for full satisfaction in application and service.

IMC PRODUCTS: Macallen Mica Products—Vartex Varnished Cloth and Tapes—Varslot Combination Slot Insulation—Varnished Silk and Paper—Fiberglas Electrical Insulation—Manning Insulating Papers and Pressboards—Dow Corning Silicones—Dieflex Varnished Tubings and Saturated Sleevings of Cotton and Fiberglas—National Hard Fibre and Fishpaper—Phenolite Bakelite—Permacel Adhesive Tapes—Asbestos Woven Tapes and Sleevings—Cotton Tapes, Webbings and Sleevings—Pedigree Insulating Varnishes—Wedgie Brand Wood Wedges.

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TAX REVISION...

Can Make or Break American Business

IS THE American way of life—progress by private initiative—going to get a fair chance to demonstrate its superiority over all the challenging varieties of collectivism?

That's the real question before Congress as it confronts the long labor of remodeling the federal tax structure. What Congress does about taxes will come pretty close to making or breaking the U. S. A.

Today the tax colossus that sprawls across the national economy is unguided by any central nervous system. Its crushing weight comes down first here, then there, as the giant wobbles around, unguided by any central purpose except to grab as much as it can.

The central purpose of a tax system is simple. It should raise the necessary revenue without placing unnecessary fetters on enterprise.

As recently as 1929 federal taxes took only one dollar out of every twenty of national income. A loose-jointed and inconsistent tax structure was a nuisance then. But it wasn't serious.

Today the federal tax burden is the dominant element in the nation's economy.

Even if Congress succeeds in cutting $6 billions out of President Truman's $37.5 billion budget, federal taxes still will take about one dollar out of every five of the national income. And few Congressmen are hopeful enough to think that they can get the tax load below $25 billion for any year that is in sight.

Drastic Budget Cuts Required

Indeed, to get the tax load down to $25 billion, Congress will have to stop treating expenditures, like those for military purposes and veterans, as politically sacrosanct. Congress must scrutinize *every* item in the budget. Economy must go along with tax cutting or we shall end in bankruptcy.

Suppose that expenditures are slashed to the bone. Our taxes *still* will be so heavy that the *way* they are loaded on the nation's back will make a big difference in how well the nation gets along. That's something which the postwar boom has tended to obscure. It will become much clearer as this boom wears off. Then a remodeling of the federal tax system to remove its manifold obstructions to private enterprise will be of transcendent and obvious importance to everybody.

Tax Experts Agree

The remodeling will require political courage plus tax wisdom. Congress must supply its own political courage. But it can lean on tax experts for tax wisdom. Fortunately, tax experts now agree on the necessary reforms—especially on those that will remove obstructions to business. How well the tax experts agree is shown in the charts on the next page, summarizing answers to a questionnaire on possible federal tax reforms. The questions were asked by the Department of Economics of the McGraw-Hill Publishing Company. The answers came from a broad cross-section of tax experts, including the authors of a considerable crop of books on postwar federal taxes and what to do about them.

The experts agree (see the charts) that double taxation of corporate dividends should stop.

They agree that the tax rate on corporate income (now 38 percent) should be reduced as rapidly as possible to the initial rate on individual income (now 20 percent).

And they agree overwhelmingly that it is desirable to let net losses be subtracted from net profits over a 5-to-6-year period in computing business income for tax purposes.

All three changes would stimulate corporate initiative and hence make jobs. Averaging business incomes would make new ventures attractive even though these ventures *might* result in early losses. Reduction of the corporate income tax would have the same effect. So, too, would the elimination of that highly discriminatory provision whereby corporate dividends are taxed first as corporate profits, and again when received as income by individuals.

Penalties on Incentives

Beyond these changes, there must be an end to tax penalties on *individual* initiative. Consider the enterprising business man whose income fluctuates markedly from year to year. Because of his enterprise he may pay, on the same income, twice as much federal income tax as the man who plays it safe for a steady income. That's because he can't average his personal income over several years for tax purposes. He can count on heavy taxation of his good-year profits with no chance for offsetting against them his bad-year losses. It is a case of heads you lose, tails the tax collector wins. Eighty-six percent of the experts agree that an income-averaging allowance for individuals is desirable.

Three-quarters of them also agree that tax rates at the top end of the individual income scale (now running up almost to 90 percent) should come down. In my judgment, the total tax should not amount to more than 50 percent to encourage business men to venture for high stakes.

Advocating tax relief for men in the higher income brackets—and particularly for management men—has been considered political suicide for more than a decade. Some members of Congress still hold that view. A Democratic Congressman from Michigan told an Illinois colleague who advocated cutting upper bracket taxes, "If you put that idea forward at home, you won't come back."

The Congressman has an even better chance of not going back if our economy bogs down. One of the best ways to bog it down is to keep the taxes that destroy business incentives and block enterprise—for example, the confiscatory rates which drive the people in the high brackets away from risk-taking.

To give the American system of individual enterprise a fair chance was clearly the mandate of November's election. To give it that chance, enterprising business men must have a chance to make large rewards—as well as the always-present chance to lose their shirts. Under present tax rates, they don't get a break.

Prevailing federal taxation throttles bold business enterprise in other ways. It fails, for example, to encourage research and rapid industrial modernization. It tends to siphon investment away from private enterprise, driving it into tax exempt state and local securities. (The experts agree almost to a man that such tax exemption must be eliminated.) The list of obstacles could be amplified.

Hit-and-Run Revision Disastrous

Most of the reforms needed to prevent the federal tax system from smothering enterprise would lower federal revenues, at least temporarily. Elimination of the double taxation of corporate dividends might lop off $800 million. Dropping the corporate income tax from 38 percent to 20 percent might cut away as much as $4 billion.

EXPERT OPINION ABOUT TAX REVISION

TAX EXPERTS THINK WE SHOULD:

% Of Tax Experts Favoring the Proposed Changes

1 ***Eliminate double taxation of corporation dividends*** which are now taxed as corporate profit and then again as individual income.

2 ***Reduce corporation income tax rate (now 38%)*** as rapidly as budget needs permit until it equals the initial rate for individual incomes (now 20%).

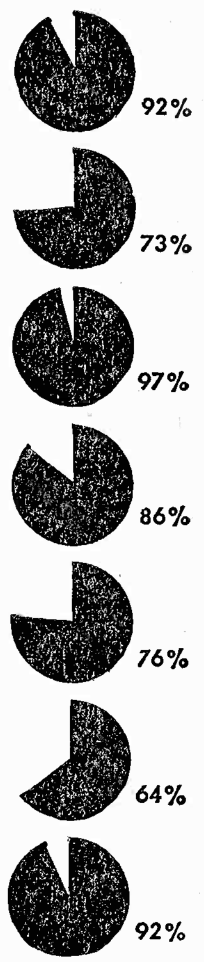
3 ***Provide for averaging business' taxable incomes*** over a period of about 6 years to allow for losses in bad years.

4 ***Provide for averaging individuals' taxable incomes*** over a period of a few years so as to treat fairly those whose incomes fluctuate.

5 ***Reduce upper bracket individual income tax rates*** to a maximum of 50% in the $100,000 bracket and 75% in the million and over bracket.

6 ***Treat capital gains, now taxed at a lower rate,*** like other income but provide full allowances for losses.

7 ***Remove the privilege of tax exemption*** from all future issues of state and local government bonds.



Because we can not avoid enormous federal expenses in the years immediately ahead, all badly needed reforms of the type to which this article is confined obviously can't be made at once. Also there are other tax reforms bearing on consumption which obviously should be weighted in an over-all program of tax revision.

But this is equally obvious: We should have a general design for tax revision which would line up all the necessary steps. Then we could get ahead with tax reductions as rapidly—and as sensibly—as revenue requirements and political courage would permit. Tax cutting may come piece-meal, but tax planning must not.

Through such a design we might discover that some decidedly beneficial improvements in the federal tax structure can be made at relatively slight cost. But today there's no way to be sure. No one in Washington with access to the information has even undertaken to make the necessary estimate.

Instead, federal tax revision continues to be a hit-and-run business—and a short-run political business. Take, for example, the proposal of a 20 percent tax reduction across the boards. There are virtues in such a proposal. But how they stack up beside many other extremely urgent needs for tax reform remains a mystery.

Congress must dispel such mysteries. Only in that way will it do the job of converting our present jerry-built tax structure into a moderately safe abode for the American system of private initiative, sparked by adequate incentives.

James H. McGraw, Jr.

President McGraw-Hill Publishing Company, Inc.

THIS IS THE 56TH OF A SERIES

BUSINESS BRIEFS

By W. W. MacDONALD

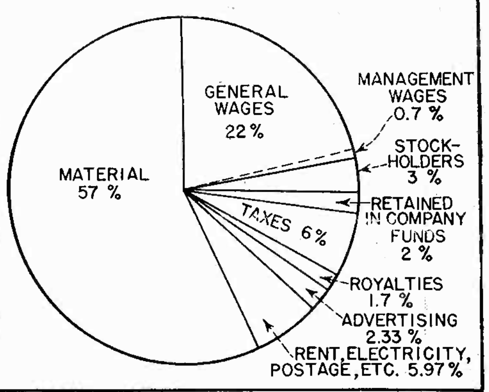
Commercial Shipping Interests have been quietly trying out radar units designed expressly for their use. At present operating under one-year experimental licenses, they are encouraged by the news that tickets for regular operation will probably be issued sometime this summer on a five-year basis, and by the generally favorable experience they have had with initial equipment.

As near as we can tell by checking with the half-dozen manufacturers most active in this field it appears that about 85 sets have been installed aboard American vessels, chiefly on the Atlantic seaboard and in the Great Lakes, a little more than half of these going out on consignment as a market and equipment test and the balance being outright sales. Additional orders on hand probably total 200 and it looks like several thousand could readily be sold in the next three or four years.

Television Antennas have been banned by 84 percent of the New York City apartment-house owners so far contacted by ELECTRONICS in a survey which is continuing as this issue goes to press (details on p 88). Even at this early stage of the game it is evident that the concerted move by realtors to avoid rooftop ratnests will have considerable effect upon the video receiver market since the figure given above covers 344 buildings housing 14,810 tenants.

C-R Tubes cost more than any other component in a television receiver. Anything which tends to reduce their price can have a marked effect on overall receiver cost. And it seems that several things which will ultimately do this are on the way, although they are unlikely to make themselves felt immediately due to other cost factors which set manufacturers originally underestimated.

For one thing, an order for envelopes large enough to initiate steps in the direction of true mass production has been placed with one glass-blower. For another, we



HALLICRAFTERS EXPENSE BREAKDOWN ($8,054,682 SALES IN 1946 IS 100 PERCENT)

hear that certain extremely rigid specifications to which glass is blown could probably be relaxed without visibly affecting the picture and that this would materially reduce the number of envelope rejects.

Television's Attractiveness is exemplified by a story sent in by one of our Hollywood friends. It seems that a certain studio asked a certain receiver manufacturer to supply several dummy sets for use in a new picture. No piker, the manufacturer shipped working models. A couple of weeks later, when the sets were wanted, they had all disappeared from the prop room.

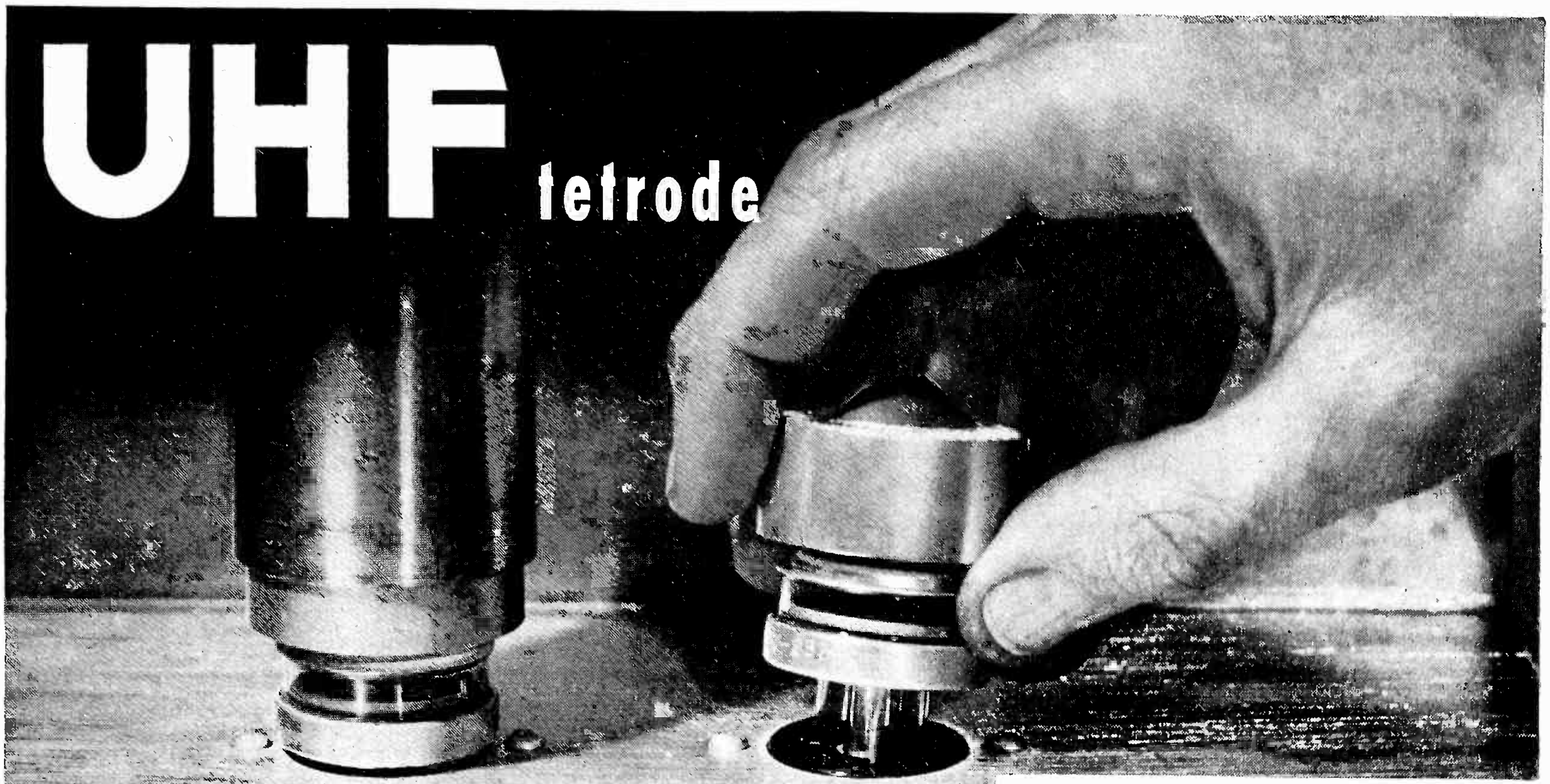
Crosslicense Agreements have been entered into between Philco and RCA, Westinghouse and General Electric, on an equal basis.

Among the major developments enabling Philco to get under a common patent coverlet with such big bedfellows is its single-stage f-m detector, wideband amplifiers for television, electromechanical record-changer and pickup designs, and some cute technical tricks in connection with radar. The contributions of the other three companies to the agreement are well and widely known.

Dynamotor Deliveries are slowly improving but production still lags 8 to 10 months behind orders.

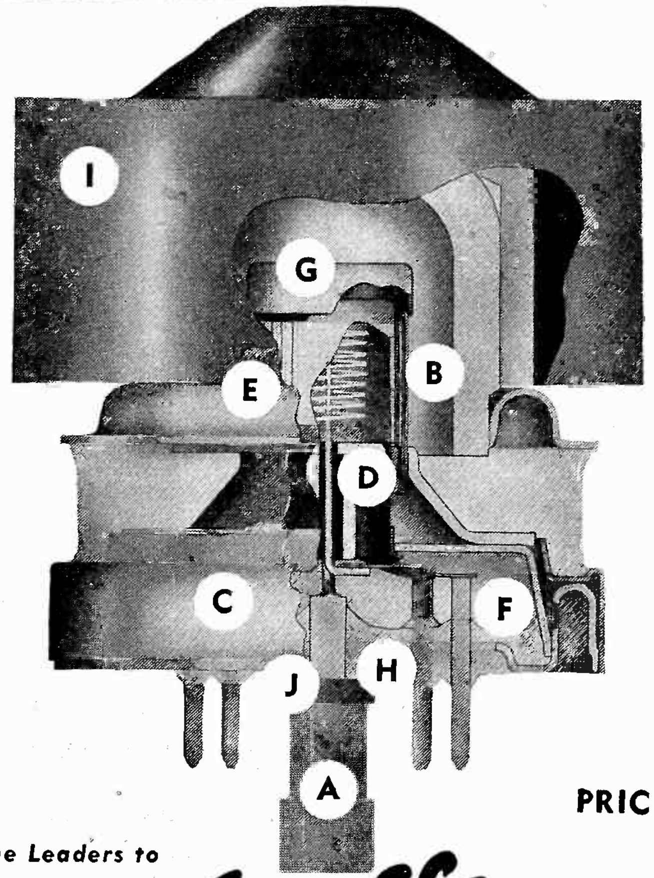
Primary reason is the unexpected windfall of business from new services such as taxicab radio, superimposed upon a 4-year back-

UHF tetrode



Eimac 4X150A Power Tetrode

Electrical Characteristics		
Heater voltage	6.0	volts
Heater Current	2.7	amps.
Grid-screen amplification factor (approximate)	4.	
Direct interelectrode capacitance (typical)		
Grid-Plate	0.02	μμf
Input	12.0	μμf
Output	4.6	μμf
Maximum Ratings		
DC Plate voltage	1000	volts
DC Plate current	200	ma.
Plate dissipation	150	watts
DC Screen voltage	300	volts



The 4X150A, a new Eimac tetrode, extremely versatile—diminutive in size, will fill the bill in all types of application and at all frequencies up to 500 mc. Performance characteristics include — high transconductance, low plate voltage operation, low grid drive, high plate dissipation, and traditional Eimac-tetrode-stability. Physical features include:

- **A** Low inductance grid lead.
- **B** Close element spacing for UHF and high transconductance.
- **C** Screen grid, mounting, and ring connector design effectively isolates input and output circuits.
- **D** Heater isolated from cathode.
- **E** Indirectly heated cathode.
- **F** Low inductance cathode terminals, (four separate paralleled pins).
- **G** Controlled primary and secondary grid emission, by specially processed grids.
- **H** New molded glass header, precision pin alignment.
- **I** Forced air cooled (vertical finned).
- **J** Simple installation, adaptable to standard loctal socket.

You will find the 4X150A suited to your requirements, whether for wide-band low-efficiency service such as television video and audio or conventional application. For further information on this new, versatile, Eimac tetrode, type 4X150A, write to:

PRICE, $31.00

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log built up among more conventional customers. Secondary reason is limitation of production below full plant capacity by shortages of magnet wire, silicon steel, yoke material, ball bearings, and bolts.

Most of the companies that jumped into the business during the wartime emergency have already retired from it, believing that the productive capacity of old-time manufacturers will be ample as soon as the material situation clears up. And some of the specialists have diverted a little of their energy from dynamotors to new products in heavy demand. But these two factors are to only a limited extent responsible for the shortage.

Electronic Consultants are to be listed in the editorial section of our buyer's guide and directory, an extra number that comes out around mid-June between two regular issues of the magazine. In the process of collecting their names, addresses and other data, which continues at this writing, some interesting statistics are being developed:

Of the 250 consultants replying to our questionnaire so far, 24 percent specialize in communications, 38 percent concentrate on industrial applications, and the remaining 38 percent handle both types of work. Patent matters are interesting to 37 percent.

Hotel Radio Business is one of the markets to watch this year. Several manufacturers are injecting new life into it by offering coin-operated sets. And a firm selling centralized systems suggests that the availability of wiring over which fire alarms may be sounded in each room may help stave off pending legislation that would necessitate the maintenance of special safety crews, at considerable expense to the hotels.

More Men, more money, and more room are three pressing Patent Office needs. Patents are being applied for in greatly increased number and are being issued at about half the pre-war rate. Facilities for handling them are about as adequate as the kit of tools that comes with a modern car.

At the close of business in 1946 there were 3,699 patents identifiable as radio on the hook awaiting action, and another 1,244 on telegraphy and telephony. It is difficult to identify electronic apparatus listed in other categories but there are obviously many additional thousands of applications on hand covering navigational gear, industrial equipment and medical devices using tubes, not to mention instruments of all kinds, electrical apparatus and many other things we think of as allied products.

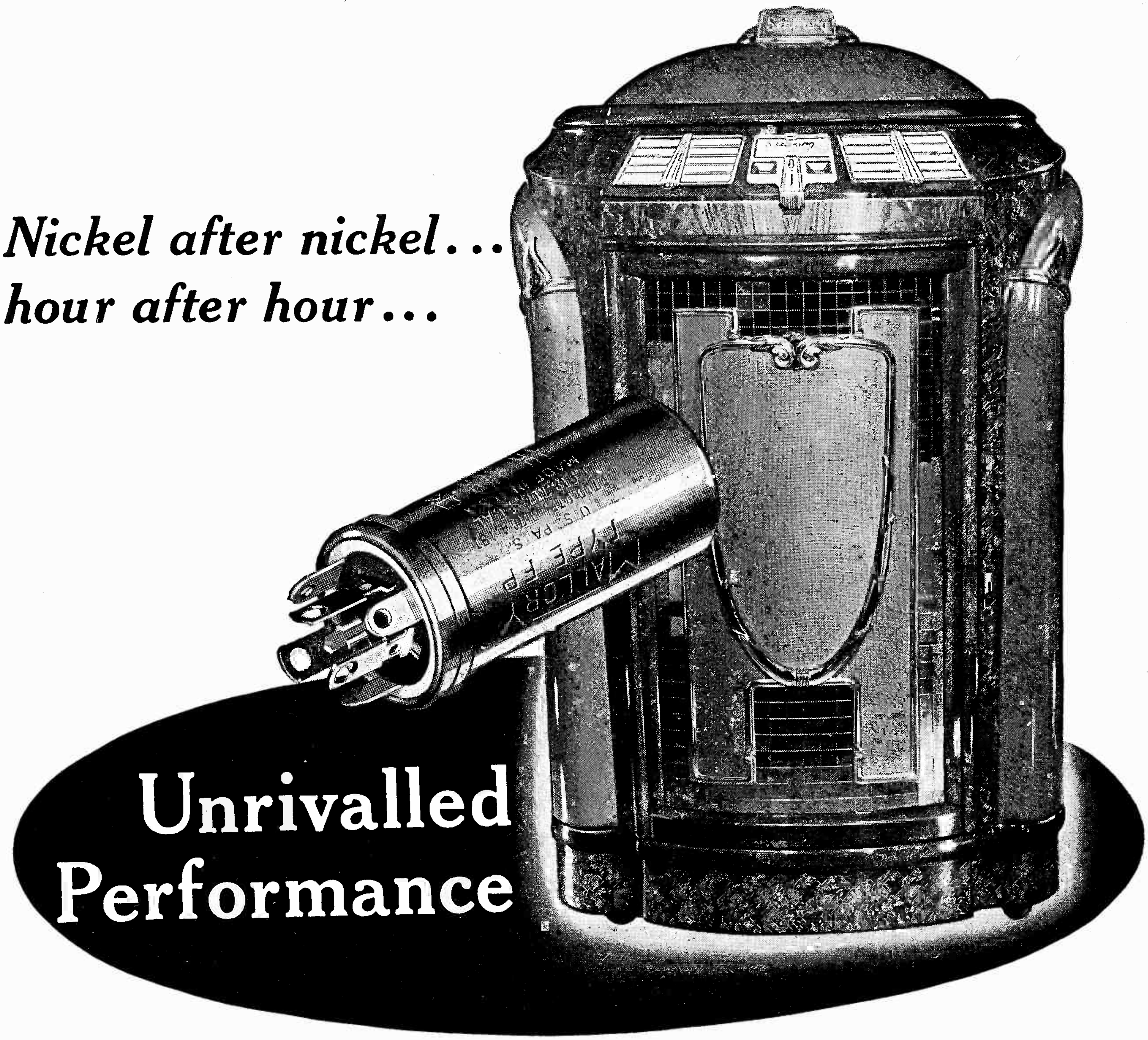
Surplus Equipment is sometimes a bad buy at any price and no substitute for commercial gear designed expressly for a job. A case in point is recent interference with instrument-landing systems by f-m broadcast stations, which turned out to be the fault of surplus receivers in the aircraft.

Miniature Panel Instruments were built in quantity for the military during the war and this market will continue although not, of course, at the same level. Such instruments are useful in certain Army, Navy and Air Force gear which must be ultra-compact.

Commercially, instruments 1½-inches or less in diameter appear to have a good but somewhat specialized market. Current research indicates that they are in demand for use in portable units which really must get down to minimum size, photographic exposure meters and test equipment for hearing aids being typical examples. Volume comparable with that achieved by more conventional larger varieties seems unlikely, chiefly because of the cost factor. As in the manufacture of watches, small size does not necessarily mean small cost.

Talking With A Group of engineers working on a temperature control problem the other day we picked up a remark worth repeating. We won't vouch for its authenticity, but it does seem of more than academic interest. The remark: "Physically and mentally men and women are satisfied at temperatures 1½ degrees apart."

Nickel after nickel . . .
hour after hour . . .



Perhaps the world's toughest job for an electrolytic capacitor is found in the familiar "juke box." Necessarily rugged in itself, the "juke box" requires sturdy components. High temperatures, heavy ripple currents, high voltages and continuous operation impose a tough set of conditions.

Mallory FP capacitors are famous the world over for their ability to stand up under severe punishment. That's why, in so many thousands of "juke boxes," like the popular J. P. Seeburg Co. instrument pictured, Mallory FPs are standard equipment. No other capacitors perform so dependably—*nickel after nickel*, hour after hour, *year after year!*

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Everything you want to know about Mallory electrolytic capacitors—types, sizes, electrical characteristics—even data on test measurements and mounting hardware. Write today for a free copy.

CROSS TALK

▶ **SUBAQUEOUS** . . . A young lady formerly with the MIT Radiation Laboratory tells us the girls had a word for Ted Hunt's Underwater Sound Laboratory at Harvard. Passing this highly secret establishment on their way to work, it was their custom to murmur "blub, blub, blub."

▶ **CIRCUS** . . . It's time, we feel, to register heavy protest over the six-ring circuses conducted currently by our friends in the IRE and the National Electronics Conference. The straw which broke our back was the 1947 IRE National Convention just concluded in New York. This melee presented 124 papers in 25 sessions, running four abreast in five meeting places in two buildings, morning and afternoon for three and one-half days. This is a load well beyond the capacity of Bunyan and the Blue Ox, let alone any reasonably good insurance risk in the profession of electronics.

To the familiar hazard of multiple sessions, which for years has prevented hearing all the papers one might reasonably want to hear, was added this year a fast sprint from the Commodore to the Grand Central Palace. No one, including the committee chairman, was happy about it.

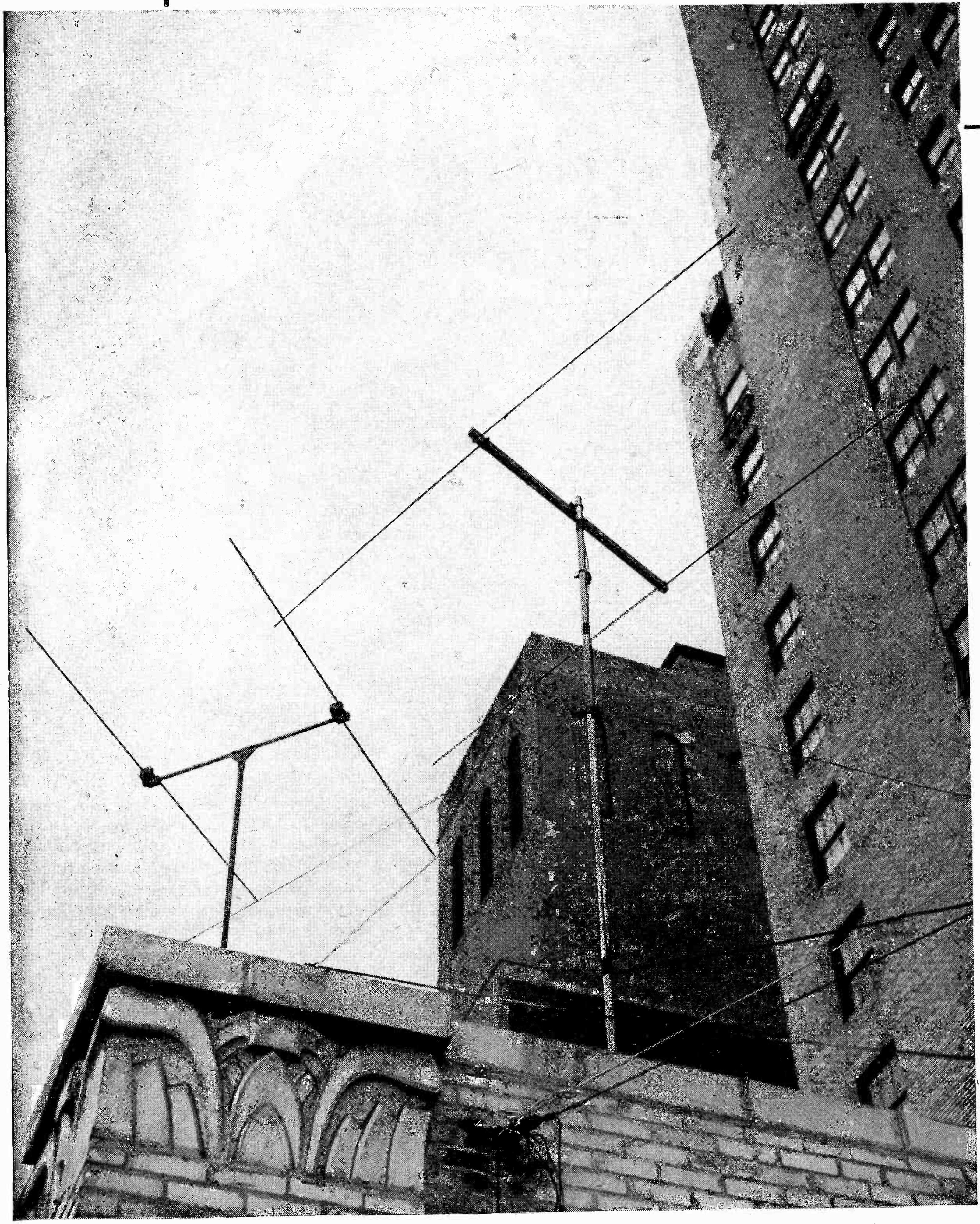
Within the framework set up, the program committee did a good job in separating papers into sessions on particular and, hopefully, non-conflicting subjects. But the segregation just didn't work. The members of our fraternity are still young enough to be interested, vitally and definitely, in matters not directly connected with their particular field of work. The broadcast engineer has a bread-and-butter interest in antennas, propagation, television, f-m, recording, and power tubes. He has a vital interest in nucleonics, aids to navigation, radar, microwaves, pulse-time systems, and his own professional status, all of which formed sessions in hopeless conflict with each other and with his primary interests. And similarly for all the other types of engineers in our business.

The only answer, it would seem, is a firm resolve on the part of program committees to hold the number of papers down at all costs. Papers of lesser importance must make room for essential and vital ones; papers on subjects previously presented in print or at other meetings must be weeded out. Only thus can the technician of varied interest (and who is not?) overcome his present frustration.

▶ **THANKS** . . . Recently we were shown an r-f signal generator made during the war by a Swiss firm for German use. Electrically very similar to one of the outstanding American designs, this device shows evidence of a fiendish ingenuity in behalf of the Allied cause. Where a straight shaft might have sufficed, a tube socket was placed in line with the shaft and the socket bypassed mechanically by bevel gears. On the tuning dial are engraved thousands of microscopic divisions, visible only under a strong glass, and having no discernible use. In dozens of similar instances, unnecessary man-hours were poured into the design, thus assuring against high-speed production, and hindering the ultimate user. The bad mechanical engineering was so cleverly contrived that it must have been an intentional effort to obstruct the German war machine. To the unknown Swiss designer, and to countless others like him both in and out of Germany, we owe thanks.

▶ **PPI** . . . The wheels within the wheels of electronic endeavor never fail to amaze. Now comes word from MIT that work is underway on a plan position indicator, originally developed to map radar targets, to map electric potentials on the human skull. These tiny impulses (1 to 50 microvolts) are useful in determining the presence and position of brain tumors. Those working on it say the job is a tough one because the voltage is so small. As in radar, the problem is to lick the noise. Our guess is that the noise will be licked.

The TELEVISION



ANTENNA PROBLEM

Organized move by New York landlords, forbidding individual outdoor antennas in apartment houses, threatens to choke off large slice of video market. Thorough analysis of master antenna systems and installation costs needed to clear atmosphere

THE RECENT PROHIBITION against erecting individual television antennas, imposed on the tenants of more than 100 apartment buildings in New York City, has brought into sharp focus a problem long recognized but not squarely faced. Television engineers have been aware for many years that the erection of a number of antennas, within an area of a few tens of square wavelengths, would permit interaction between receivers generally injurious to reception. Work on master television antenna systems which would provide multiple signal sources from a single antenna had begun, but had been neglected in view of the more urgent problems.

The industry was shocked when, early in February, the Wood Dolson Company of New York served notice on several thousand tenants that the apartment owners would not permit the installation of television sets "until such time as some scientific method has been developed for a master television aerial." The reasons given for the action are compelling: even assuming that it was a physical possibility to erect individual antennas for even half the families in a 50-family apartment, such an installation would be unsightly and dangerous. Since it would be unfair (and possibly illegal) to restrict some tenants while allowing the first comers to have service, the only prudent action was to prohibit all installations from the start, until a system was installed capable of serving all tenants on equal footing.

The first reaction by the television industry was to form a committee in the Television Broadcasters Association, under the chairmanship of Ernest A. Marx, to organize all TBA members and affiliates to study the problem and advise on procedure. The committee's first action was a request to the apartment owners to rescind or modify the order, at least temporarily, while the problems of the master antenna system were being worked out, and to allow the service to proceed while few tenants were involved. At the time of writing, however, this request had not been granted.

There was general agreement that, even if installations were permitted at present, the problem would have to be faced. Most apartment sites are subject to multipath interference, which can be minimized by locating the antenna at a critical position where reflected components cancel one another. The subsequent erection of another antenna within a wavelength distance would set up additional reflections and destroy the critical adjustment of the first. The mutual impedance between such close-spaced antennas might also destroy the impedance match to the transmission lines of each, and it would supply a closely coupled path through which even minute reradiation from the local oscillator of one receiver could cause interference to the other.

The master antenna has many obvious advantages. Installed by experts, with a reasonably free choice of location on the roof, it could be positioned to secure the best possible reception. The absence of other antennas would make it feasible to install several units, perhaps a separate antenna for each station within range, and to optimize reception from each. The disadvantages are, first and foremost, cost, particularly cost of installation in existing buildings, and second, technical problems related to original equipment costs. The outlet installed in each apartment should provide for all existing stations and permit ready additional service as new stations appear. It must provide for a wide variety of impedance levels, and balanced as well as single-ended terminations. It must be reasonably unilateral, to avoid reaction on other units, and the level of signal provided should be high enough to mask interference arising from other connected units.

A survey of the half dozen firms now engaged in the design of master systems revealed some doubt as to the ability of existing systems to cope with all these requirements, but agreement that answers can be found quickly and at reasonable cost.

NEEDED—AN EXCHANGE OF INFORMATION

The television industry and the realty interests have no fundamental quarrel. Television needs the apartment house audience. Landlords know that sooner or later an apartment without a television antenna connection will be as hard to rent as one without a refrigerator.

The first step in solving this mutual problem is an exchange of pertinent facts. Engineers can tell landlords the facts about indoor antennas, about master antenna systems, about costs of running conduit and cable. Landlords can tell engineers how much the traffic will bear, and who can be persuaded to pay how much for service.

The editors of ELECTRONICS are currently surveying both groups. First findings will be published in the next issue.

EXPERIMENTS

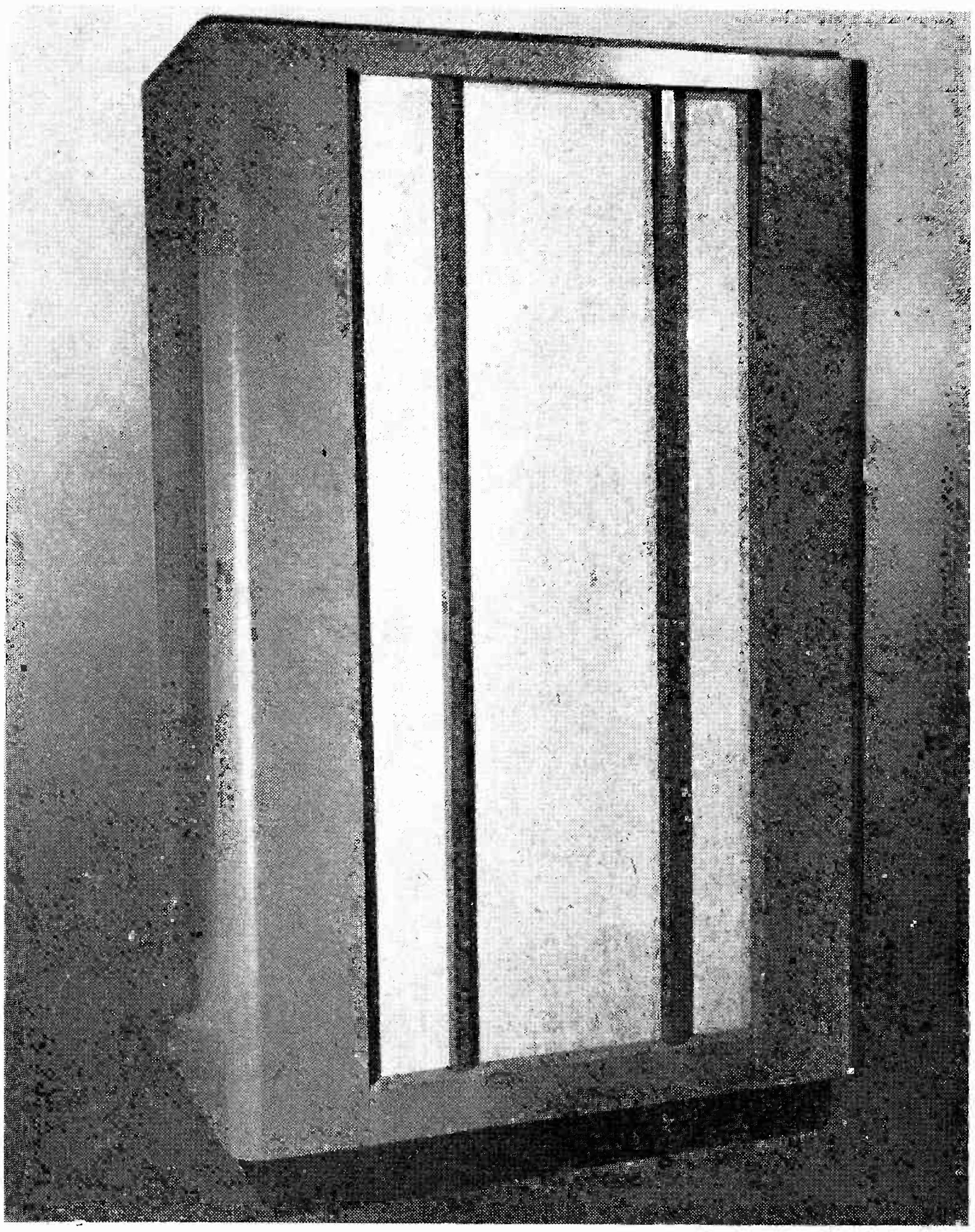
Audience reaction to reproduced music, from both live and transcribed sources, is tested with a high-quality audio system. Results of tests and technical data on the design of the stereophonic equipment used are given

QUALITY in sound reproduction has long occupied the attention of broadcasters, engineers, musicians, and radio manufacturers; in fact, just about everyone in the radio industry has had his say on the subject.

Until recently the expressions of opinion were subjective and to that extent added little to the real solution of the problem. Only limited attempts have been made to apply scientific methods and for the most part the question has remained an academic one.

In practice, the telephone people and the set manufacturers settled the problem by either rationalizing or subscribing to convenient doctrines based upon doubtful evidence. The result, insofar as the present state of a-m radio is concerned, is a general lack of high-quality reproduction for listening enjoyment. To discuss the responsibility for this state of the medium is not the purpose of this article. However, it is apropos to point out that the advent of f-m has brought a renewed interest in the problem of quality sound reproduction.

The engineering department of McClatchy Broadcasting Company has been trying to secure objective data that might throw some truth on the subject. We feel that our findings, although by no means complete, are of such nature as to represent an original contribution.



Front of speaker console used to obtain audience reaction to reproduction of live and transcribed music

MORE TESTS NEEDED

Much of the mail to the editors of ELECTRONICS concerns sound reproduction and the various technical factors involved. Objective analysis of listener reaction to present equipments, the tests discussed in this article being a good example, is sorely needed for further progress of the art.

Practical Approach

The common attitude seems to be that the average listener is a queer animal who doesn't appreciate quality in reproduction—in fact, his sense of discrimination is so poor that he can't even recognize the good from the bad. It is maintained that Mr. and Mrs. Listener, when left to their own devices, turn up the bass content to booming proportions and consider the result the ultimate in high-quality listening.

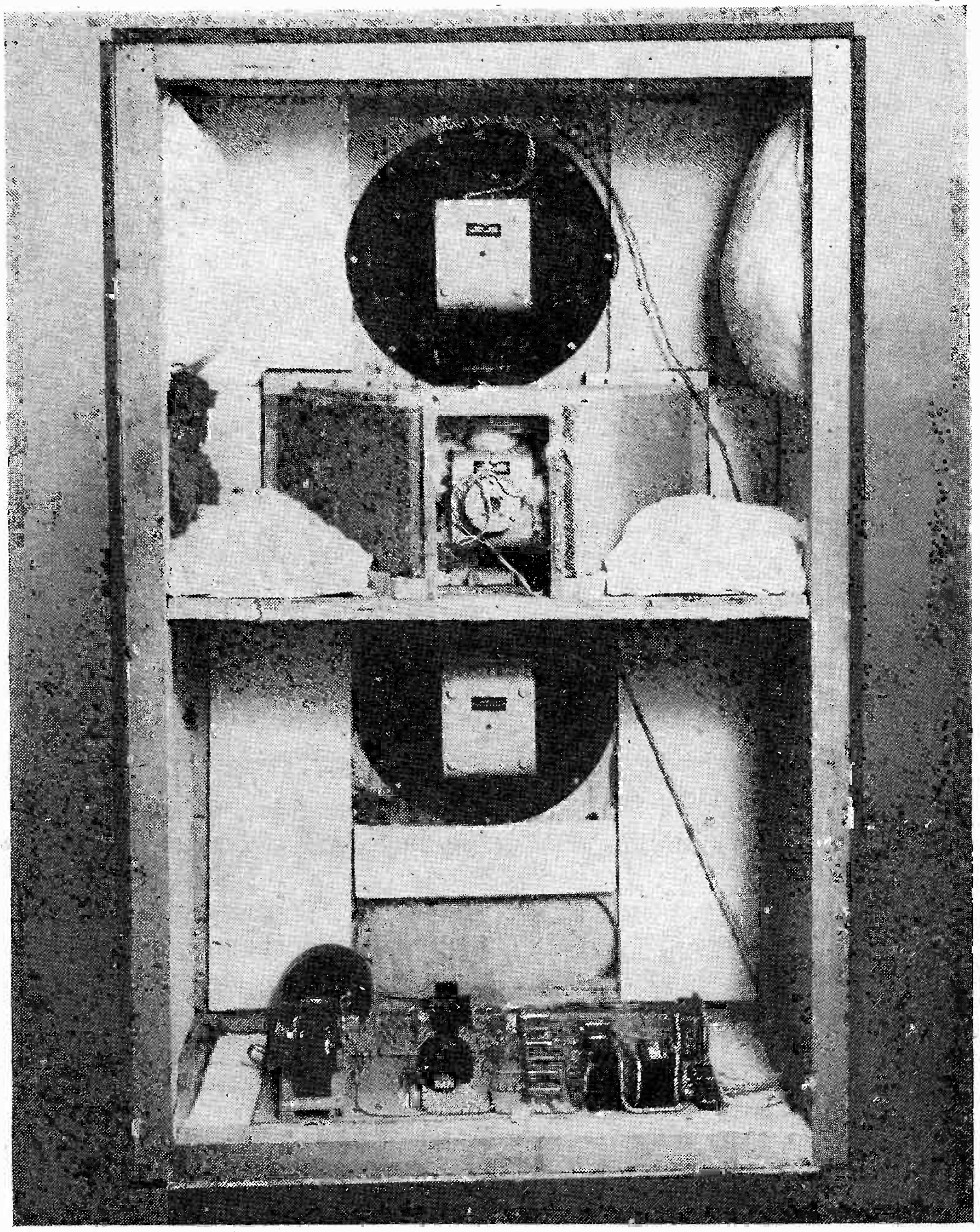
We refused to subscribe matter-of-factly to this doctrine for it ap-

IN LISTENING

By NORMAN D. WEBSTER and FRANKLIN C. McPEAK

Technical Director — *Special Project Engineer*

McClatchy Broadcasting Company
Sacramento, California



Back of console housing three loudspeakers. The cover has been removed to show the interior

peared quite possible that the listening public might appreciate and prefer quality reproduction if it were made available. Actually, the position of the bass control has little influence in the discussion since in any position quality reception is generally well-nigh impossible.

There are very few radio receivers constructed with an eye to quality reproduction and those that are cannot realize their potential since the telephone lines of the networks exclude quality before the receiver is even reached. The simple fact of the matter is that there just isn't much quality listening available; the best is generally a poor compromise. This situation may explain in part why good musical programs never have been particularly popular on the air whereas a love of music in its original form is almost universal in man.

Amplifiers and Speakers

Our approach to the problem was the construction of a sound system that would result in as near perfect reproduction as possible. Once possessed of such equipment we would demonstrate it to the public and record their reaction. Our test groups, unlike many others, would not consist of just engineers or just musicians, but would be composed of a general cross-section.

The reproducing system finally developed for use in our testing project is worthy of description. The amplifier is particularly outstanding as it has the following operational characteristics:

Frequency response:	20—17,000 cycles ± 1 db
Power output:	40 watts into a load between 850 and 1200 ohms
Distortion:	RMS distortion less than 1 percent at 40 watts
Noise level:	—70 db below full output unweighted
Internal impedance:	Effective output impedance less than 15 ohms with 850-ohm load
Load impedance:	500—2,000 ohms optional. Measurements made with 850-ohm load

Many individual loudspeakers and combinations of loudspeakers were tested before we arrived at our final arrangement. This consisted of three units with crossovers at 225 and 800 cps. The low-frequency speaker operates from 40 to 225 cps, a medium-frequency speaker covers the range from 225 to 800 cps, and a high-frequency speaker covers 800 to 12,000 cps.

The two low-frequency ranges were covered by 15-inch cones of good efficiency, while the range above 800 cps was covered by a small multicellular tweeter.

These loudspeakers have handled their assigned frequencies without the generation of sub-harmonics, production of noticeable cross-modulation components, or rattles. The console to house this combination was an engineered structure, solidly built, well insulated and properly dimensioned to prevent appreciable cabinet resonance effects.

The complete system was tested using live talent at the microphone. The quality of reproduction was better than even we had anticipated, for there was no distortion that the trained ear could detect. Satisfied that our equipment was capable of doing the intended job, we added one major improvement, the use of two complete systems. This gave us an audio perspective combination capable of reproducing those subtle characteristics of dimension, the final touch of realism.

In our preliminary privately conducted tests we used a string ensemble and an organ. The results were not only comparable in every way to the original, but at times seemed superior. It may seem paradoxical to claim that the reproduction could surpass the original, but it is really quite feasible. It was not a matter of adding anything not in the original, but rather a matter of making it possible to hear everything in the original. For example, the concert-goer, although seated in the room where the music is being played, may miss much of the output of certain instruments simply because of the relation of his seat to those instruments. With the two-channel microphone system we

Reproduction Tests

TABLE I

QUESTION: In your opinion, how does the quality of audio perspective reproduction compare with live music?

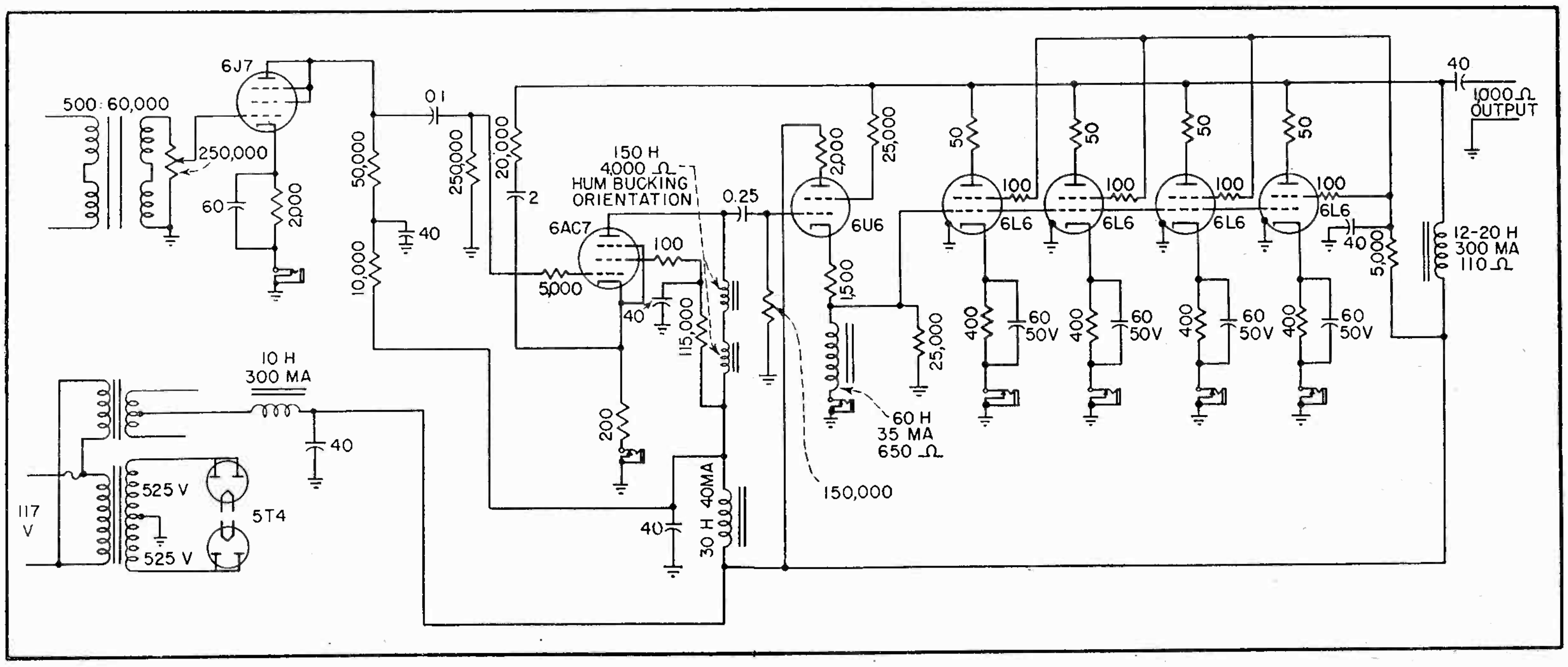
Answers	Sacramento Tests 1	2	3	Fresno Tests 4	5	Total
Superior	52%	43%	30%	67%	45%	46%
Equivalent	39%	57%	70%	33%	45%	50%
Inferior	9%	....	....	....	10%	4%

Total Cases: 74 persons

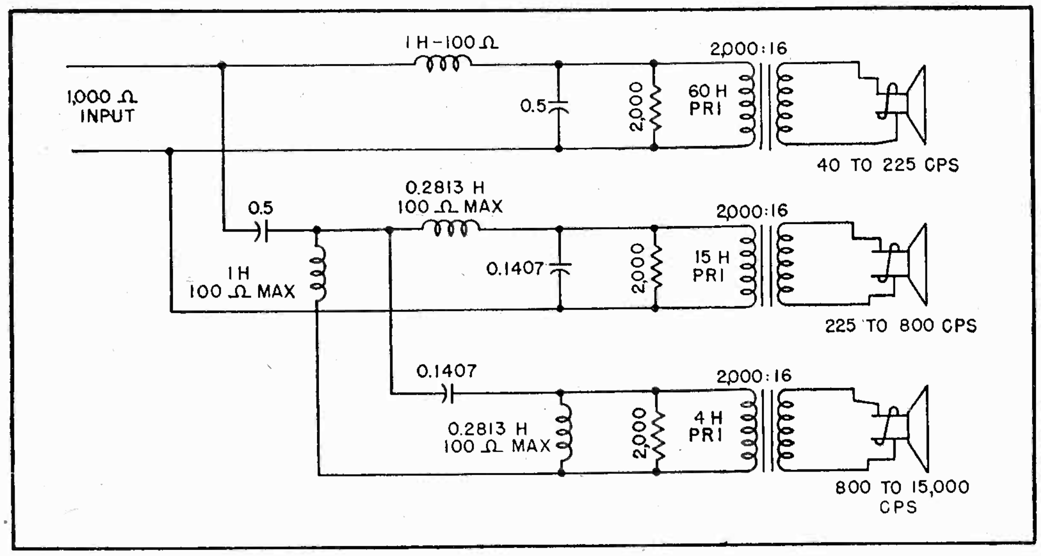
TABLE II

QUESTION: In your opinion, how does the quality of audio perspective reproduction compare with the juke box?

Answers	Sacramento Tests 1	2	3	Fresno Tests 4	5	Tota
Superior	100%	100%	100%	100%	100%	100%
Equivalent	....	....	....	....	....	....
Inferior	....	....	....	....	....	....



Complete circuit of amplifier designed for the listening tests



Speaker circuit arrangement and values of components in crossover networks

are able to spot our microphones so as to make all the instruments audible and to achieve pleasant balance. Our initial impression of this effect was later borne out by many unbiased observers.

Details of Tests

The next step was to call in the public and determine their reaction to quality reproduction. Would they recognize the superiority of our system or would they be unaware of this new listening experience? If they were aware of a difference would they like what they heard?

Three demonstrations were held in Sacramento and two in Fresno. The group consisted of merchants, hotel owners, club managers and other business people invited to attend the demonstrations. Admittedly the selection was not by random techniques and hence we cannot project general conclusions from these groups. Nonetheless, the results are interesting and thought provoking, especially when it is realized that many of these people are constantly listening to live music.

In each instance the program was furnished by live talent and with one exception consisted of an organ solo, a piano solo and popular music by a six-piece local band. The exception was the second Fresno meeting where the program was made up of a piano solo, music by a string ensemble, and by a ten-piece dance orchestra.

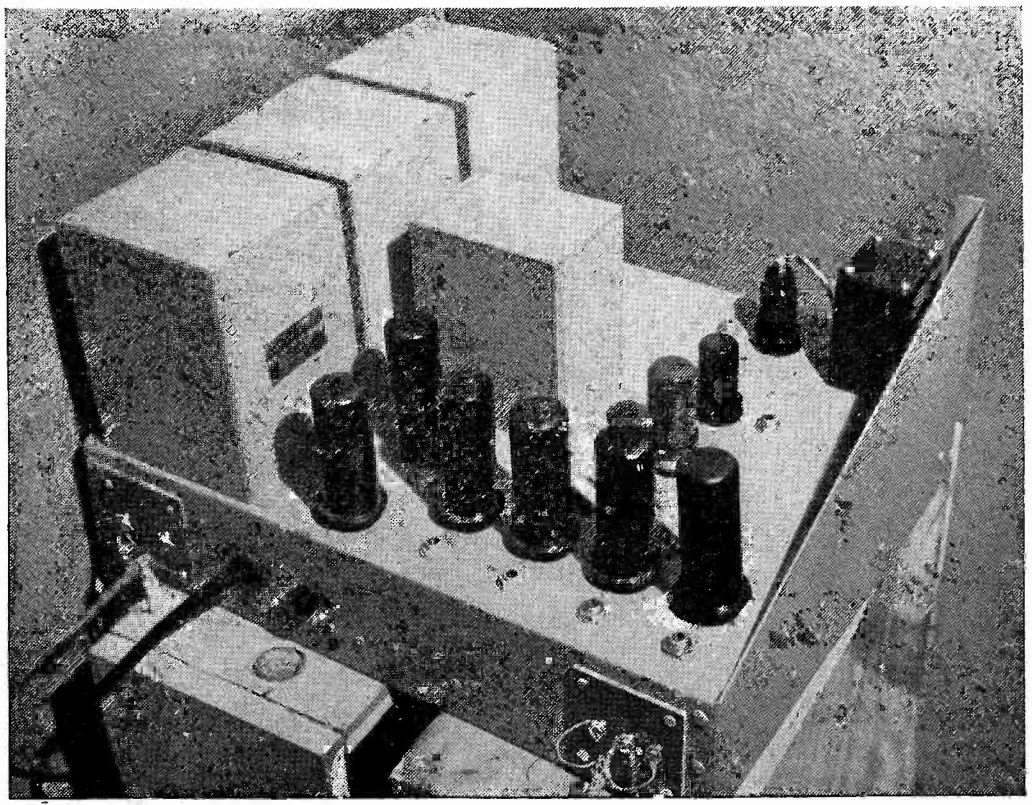
In Sacramento, the program originated in one studio and was carried by wire to the demonstration room. For the first Fresno experiment the program again originated in Sacramento and was carried by high-quality telephone lines to Fresno, 175 miles away. In the final Fresno demonstration, the music originated five miles from the demonstration studio. Despite the changes in program material and the use and non-use of telephone lines, the reactions of the various groups, as recorded by individual questionnaires, was quite similar. Table I shows the results obtained.

It is a real tribute to the reproducing system that 46 percent of the auditors considered the reproduced output superior to live music and the fact that 96 percent believed the result to be at least the equivalent of live music is testimony that these people did recognize quality. They seemed to recognize that what they heard was endowed with the beauty of live music despite the fact that the booming bass was not present.

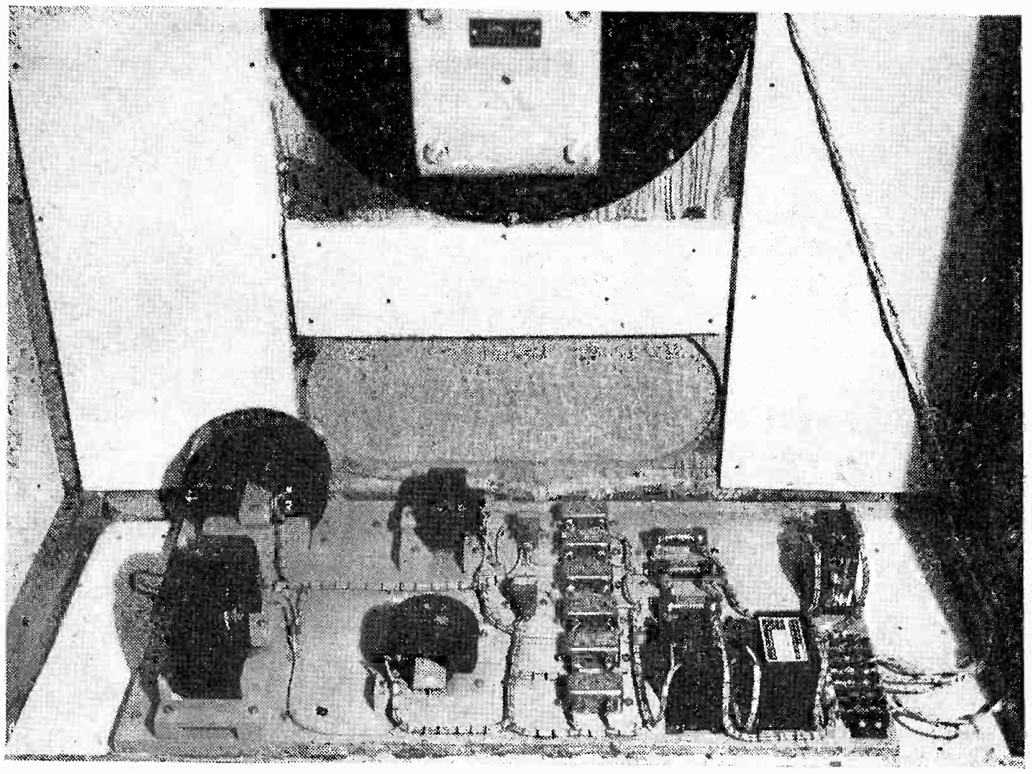
Table II is presented as further evidence of the fact that our groups not only recognized quality, but appreciated it as well. It shows in what esteem these people held juke box quality, and that the group could distinguish between good and bad quality.

As a further check on the desire for quality listening each group was asked to express itself on the willingness to purchase this high-fidelity equipment. It was explained that the equipment would be expensive since the component parts embodied in its design necessitated expense. Despite this word of caution, 70 percent of those attending expressed a desire to purchase such a system for use in their own homes.

There are, of course, many variables that cannot be controlled in such demonstrations as we conducted. However, it does appear that there is much in these results to suggest that the test group and the public is capable of judging and does appreciate quality reproduction to the extent that in many cases it would spend the money necessary to secure quality listen-



Chassis of 40-watt amplifier



Crossover networks mounted in the bottom of the loudspeaker console

ing. These experiments have also led us to believe that a two-channel system of broadcasting might be well received by the public. It not only has the appeal of the novel, but it does a job that nothing else at present achieves.

Opportunity for F-M

Like most broadcasters, the McClatchy organization is interested in f-m and its implications for the future of broadcasting. It provides an opportunity for the broadcasting art either to benefit by old errors and start anew, or, to adopt an attitude of smug complacency and adhere to the old despite its shortcomings. The answer will in large measure depend upon the set manufacturer, but the broadcaster will also be in a position to exert much influence.

Should either or both adopt the theory that the public can't recognize good quality, then f-m will soon slip into the patterns of performance that characterize a-m today. If f-m broadcasting is to consist of the standard a-m network offering simply rerouted through the local f-m transmitter, then it will be a disappointment to the many who look upon it as the open sesame to quality listening. Under these circumstances the quality will be lost in miles of telephone cable and dozens of telephone repeater amplifiers long before the program reaches the local f-m transmitter. In fact, f-m will only serve to emphasize some of the distortions that now exist, especially needle scratch, transients, and cross-modulation components. Should the local station depend upon transcriptions, f-m will only serve to make more conspicuous the faults inherent in most modern transcriptions. A possible solution lies in the use of local live talent and highly developed magnetic tape recording. When we first made this suggestion many informed persons threw up their hands at the idea of local talent competing with name attractions.

"Quality or not," they say, "the average listener will not select local talent in preference to known stars."

Frankly, we didn't know what the public would prefer so we decided to get a reaction directly from the public on the matter by letting a representative group listen to local live artists and to transcribed national talent and then express their reactions. There might be many reasons for preferring the name attraction, but only better, more natural quality would determine a preference for the unknown live talent. To this end we secured six new transcriptions featuring world renowned soloists and orchestras. The arrangements were superbly designed to show the artist or band at its best.

The local talent employed was no better and no worse than that existing in any community of 100,000. The local performers were told nothing other than the selection they were to play and were instructed to secure any arrangement compatible with their abilities. The selections to be played were the same as those to be given by transcriptions.

The audio perspective system was set up so that it might be used as a single or double-channel device. Modern broadcast turntables were used and all outputs were monitored to insure the best possible presentation of the transcriptions and the living talent.

The test group was invited by personal and blanket invitation. Although a truly random method of selection was not employed, every effort was made to so distribute the invitations that a fairly representative group would result. The following data show to what extent we succeeded:

Number Present, 175

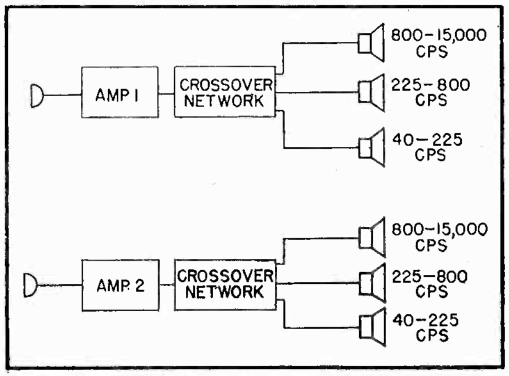
(a) 57% female
(b) 43% male

Age Levels

7–15 yrs— 7%	of total group
16–20 yrs— 8.5%	of total group
21–30 yrs—15.5%	of total group
31–40 yrs—25.5%	of total group
41–50 yrs—36%	of total group
51–60 yrs— 4%	of total group
61–70 yrs— 2%	of total group
71–80 yrs— 1.5%	of total group

Education Level

Grade School only—
8% of total group
Some High School—
33% of total group



Block diagram of the audio perspective system

Some College—
59% of total group

Vocational Classification

Professional & Scientific—
28% of total group

Housewives—
22% of total group

Clerical & Sales—
18.5% of total group

Students—
13% of total group

Management—
10.5% of total group

Manual Arts & Crafts—
8% of total group

Since random selection was not employed it must be realized that we cannot designate these results as being statistically representative of the general population.

The test group when assembled was told that they were going to listen to six pieces of music and that each piece would be played three times and that each playing would undoubtedly sound different to the listener. The audience was to participate in the test by ranking each of the three playings purely on the basis of pleasure appeal—which gave the most pleasure, which the next and which the least. The group was not told that it was making a choice between live and transcribed music, nor was any reference made to the source of the output.

The loudspeakers were hidden behind a screen so that the complete senses of the individual listener could be focused on the musical output. Each composition was played three times: transcriptions over single channel, local live talent over single channel, and local live talent over two channels. The three alternatives were so played that any pattern of repetition was avoided. The live music was carried by wire from the originating studio as was the transcribed music. Every precaution possible was taken to insure selection based only on the music itself.

TABLE III—Reproduced Live Music versus Transcribed

Group	Instrument or Orchestral Group Used / Composition Played	First Choice: % Selecting Transcription	First Choice: % Selecting Live Single Channel	First Choice: % Selecting Live Double Channel	Second Choice: % Selecting Transcription	Second Choice: % Selecting Live Single Channel	Second Choice: % Selecting Live Double Channel	Third Choice: % Selecting Transcription	Third Choice: % Selecting Live Single Channel	Third Choice: % Selecting Live Double Channel
1	Organ Solo *Intermezzo* Local organist vs nationally known recording artist	32%	24%	44%	23%	34%	43%	45%	42%	13%
2	Dance Orchestra *I Don't Stand a Ghost of a Chance* Local 6-piece orchestra vs a 20-piece nationally known orchestra	15%	36%	49%	21%	43%	36%	64%	21%	15%
3	String Group *When You're Away* Local 5-piece string group vs 20-piece nationally known recording orchestra	18%	40%	42%	18%	46%	36%	64%	14%	22%
4	Dance Orchestra *A Kiss in the Dark* Group same as 2 above	21%	39%	40%	26%	39%	35%	53%	22%	25%
5	Piano Solo *Polonaise* Local pianist vs a world famous piano artist	24%	30%	46%	29%	30%	41%	47%	40%	13%
6	String Group *Artist's Life* Group same as 3 above	44%	22%	34%	16%	61%	23%	40%	17%	43%

Results

Table III shows the results obtained. The local artists, as was expected, offered nothing that was even remotely equivalent except for the more natural quality of reproduction. It was a situation where a recognition of quality and an appreciation of quality was necessary before the live talent could exert any appeal. The results show, however, that in every case the group found the live music more pleasant than the transcribed music. Table IV, showing the first choice on the basis of live versus transcribed music, brings out this fact even more clearly than Table III.

TABLE IV—First Choices

Group	Live Music	Transcribed Music
1	68%	32%
2	85%	15%
3	82%	18%
4	79%	21%
5	76%	24%
6	56%	44%

It is admitted that all persons were not always able to detect and appreciate the subtle superiority of the two-channel offering, yet reference to the third choices, the least-liked choices, in Table III shows that with one exception there was almost unanimous agreement as to the listening superiority of the two-channel reproduction. This is further evidence of the public's ability to enjoy quality when quality is available.

It is not our contention that these tests prove any conclusive point, but we do believe there is enough evidence to justify further study and to dispel any certainty concerning the question. Every technical means necessary for high-fidelity broadcasting and reception now exists. It remains only for the manufacturer and broadcaster to become impressed with the worth of the effort. It is our intention to continue this study further in the hope that our findings will perhaps contribute to the betterment of the broadcasting art as a source of complete listening entertainment.

Photoelectric

By GEORGE L. BUSH
Engineer
The Teleregister Corporation
New York, N. Y.

Standard typewriter adapted for feeding teleprinter circuits. Light source unit is at right, while phototubes, thyratrons, and associated relays are in housing at left, with pilot lamps and control switches conveniently near the typewriter shift key

The photoelectric transmitting typewriter to be described was developed as part of a comprehensive system of automatic aids for air traffic control to facilitate the work of radio operators and controllers in sending flight data into their system for display on electric flight progress boards. A standard teleprinter may also be used for this purpose, but many radio operators, because they are expert typists, find it difficult to adjust themselves to the fixed keyboard speed necessary to operate a teleprinter efficiently. The desirability of preserving the touch of the typewriter keyboard led to the choice of photoelectric means for translating the motion of the keys into electric impulses.

CHARACTER ON KEY	CODE ELEMENT							
	1	2	3	6		4	5	7
ST	1	2	3	6	6	4	5	7
A^{-2}_{K}	1	2	3	6		4		7
Q	1	2	3				5	7
1	1	2	3	6	6		5	7
U	1	2	3					7
7	1	2	3	6	6			7
/	1	2		6	6	4	5	7
A^{-1}_{J}	1	2		6		4		7
W	1	2					5	7
2	1	2		6	6		5	7
A	1	2		6				7
X	1		3			4	5	7
REP	1		3	6	6	4	5	7
F	1		3	6		4		7
Y	1		3				5	7
6	1		3	6	6		5	7
BELL S	1		3	6				7
C_{B}^{M}	1			6		4	5	7
D	1			6		4		7
Z	1						5	7
F P	1			6	6		5	7
E	1							7
3	1			6	6			7
WEA V		2	3	6		4	5	7
SUS C		2	3	6		4		7
P		2	3				5	7
O		2	3	6	6		5	7
I		2	3					7
8		2	3	6	6			7
G		2		6		4	5	7
R		2				4		7
4		2		6	6	4		7
A^{-3}_{L}		2		6			5	7
●		2		6	6			7
M			3	6		4	5	7
N			3	6		4		7
H			3	6			5	7
SP			3	6	6			7
EM				6	6	4		7
O						4	5	7
9				6	6	4	5	7
T							5	7
5				6	6		5	7
SH					6			

FIG. 1—Special six-unit code developed for use with photoelectric transmitting typewriter

Since the device must transmit into teleprinter circuits, the standard teleprinter five-unit code for character identification is used. The total number of code combinations available with this code is $2^5 = 32$. This allows for the 26 letters of the alphabet but not for numbers.

In telegraph practice a shift code is sent over the line which causes the type bracket on the receiving printer to move to upper case, and an upper case character is assigned for every letter of the alphabet. The letters Q, W, E, R, T, Y, U, I, O, P are assigned to the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 0. Normal typewriter operation does not permit inserting a shift character when it is desired to change from letters to figures, and vice versa. To overcome this a sixth element was added to the code, the presence of which causes an upper case character or figure to be transmitted, and the absence of which causes a lower case character or letter to be transmitted. These codes are shown in Fig. 1.

Light Channels

The space directly below the keyboard of the typewriter is divided into seven light channels passing at right angles to the key levers, as shown in Fig. 2A. Six of these channels represent the six elements of the six-unit code. (The function of the seventh light channel will be described later.) To each key lever is attached a shutter, the bottom edge of which is so shaped as to interrupt the light channels according to the code of the character being typed, as shown in Fig. 2B.

The light channels are made as wide as possible ($\frac{3}{8}$ inch each), so that enough light will pass under

Transmitting Typewriter

Teleprinter code messages are sent with a standard typewriter by translating key motions into electrical impulses. Shaped shutters interrupt different combinations of seven light beams for each key, to actuate phototube-thyratron channels feeding a perforator

the shutter to hold the photoelectric circuit until the last 1/16 inch of key lever motion. This assures that the character which is striking the paper is the only one registered, and is necessary because a fast typist may have as many as five key levers in motion at the same time.

The center light channel, for the sixth element of the code, is made wider so that it may be interrupted in sections. Letter-key levers whose upper case characters are not permanently assigned to a number key may have their upper case characters transmitted by use of the shift key. These key levers have shutters which interrupt half of the center light channel. The shift lever has a shutter which interrupts the other half of the center light channel. When only the letter key is operated enough light passes through half the center channel to prevent the photoelectric circuit from operating. When the shift key lever is also operated, the center light channel is completely shut off and the sixth element is introduced into the code, causing the upper case character to be transmitted.

On the teleprinter keyboard the figures 1 to 0 are the upper case characters of the letters Q, W, E, etc. However, on the typewriter these characters have separate keys. In the case of the figure keys the shutter completely interrupts light channel 6, and the lower case letter keys do not interrupt any of light channel 6.

Optical System

The optical system consists of an exciter lamp, a reflector, a condensing lens, and deflecting mirrors. The exciter lamp is a standard double-filament automobile headlight bulb. The bulb is of the prefocus type so that it may be replaced without changing the adjustment of the optical system. The mounting of the lamp socket is so arranged that should one filament burn out the other filament may be switched into the circuit and moved into the focal position by operating a lever.

The reflector is spherical and is used to concentrate the source. The single spherical parabolic lens used to condense the light for all seven channels gives a minimum of cross light in the condensed beam. Cross light is further limited by channel separators located at five positions along the path of the beam.

The light channels are so close together that it was not possible to locate the phototubes so that all seven could receive light directly from the light channel. All but the center channel have a mirror to deflect the light from the channel onto the phototube. These mirrors are of the first-surface type so that as little light as possible will be lost in the deflecting operation. All surfaces in the light channel outside the aperture leading to the phototube are finished in dull black to prevent reflections from interfering with the operation. Inside the aperture leading to the phototubes the surfaces are finished white so that as much of the light as possible that enters the aperture will reach the

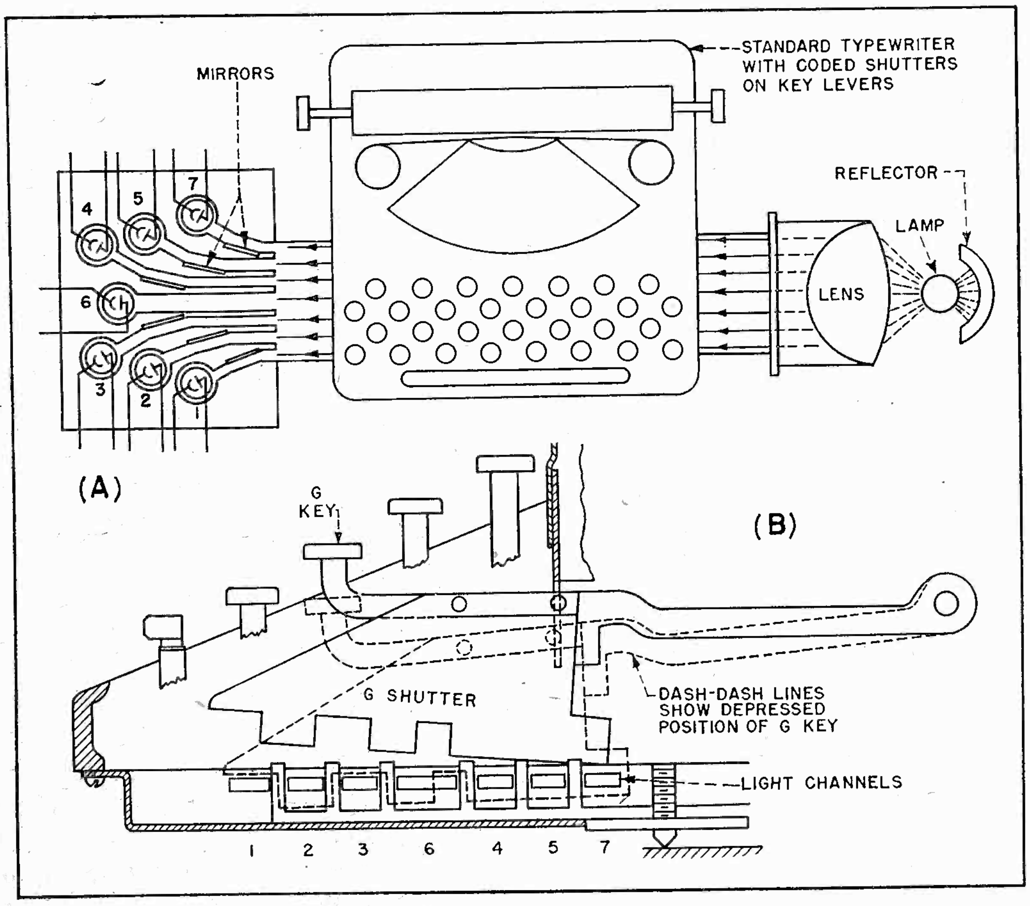


FIG. 2—Details of optical system that directs seven light beams under typewriter keys to phototubes, and side view of shutter for letter G

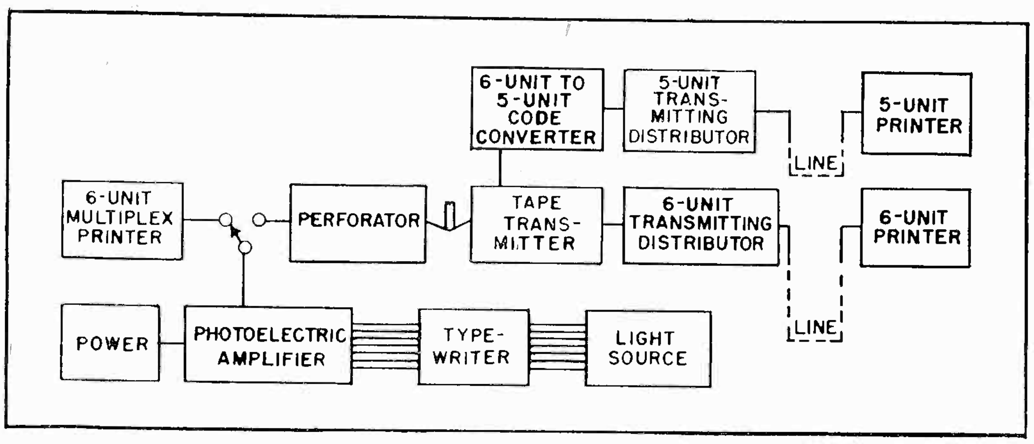


FIG. 3—Block diagram of complete system, illustrating how standard typewriter can be made to actuate three different types of printers

phototube. A new optical system is now under development using the 1P42 miniature phototube and a tubular light source.

Thyratron Circuit

The photoelectric typewriter may work into receiving storage relays of a six-unit code multiplex printer or into a tape perforator and associated equipment, as indicated by the block diagram in Fig. 3.

The photoelectric amplifier circuit for each of the six channels consists of a phototube (929 or 1P42) and a thyratron (2051 or 2D21), all connected as shown for channel 1 in Fig. 4. The bias on the grid of the thyratron is the algebraic sum of the fixed bias determined by the setting of the 3,000-ohm potentiometer and the voltage drop across the 5-megohm grid resistor due to the current through the phototube. The thyratron will fire when this sum is more positive than minus two volts. The fixed bias is adjusted so that the grid potential will remain more negative than minus two volts until all but the last 1/16 inch of light channel is cut off by the shutter, and will become more positive than minus two volts when the light is completely cut off by the shutter. This assures complete registration without interference with other keys.

Plate voltage for the six channel thyratrons is applied through individual trip-latch magnetic coils, a common relay *C*, and a make contact on relay *PR*. The plate current is limited to 200 ma by a 500-ohm resistor in the plate lead to each of the six code-registering tubes. When a key lever is operated, the tubes for the code combination of the character on the key will fire, and the corresponding trip latches on the perforator will operate, along with common relay *C*. This relay closes the circuit to the perforator punch magnet *PM* through its make contact, punching the code in the tape and, at the end of its stroke, opening a break contact in the circuit to the *PR* relay. The *PR* relay releases and opens the plate circuit to the code-registering thyratrons. The common relay *C* then releases and opens the circuit to perforator punch magnet *PM*. In releasing, punch magnet *PM* resets any trip latches which were operated by the previous code, advances the tape to the next character, and reestablishes the circuit to the *PR* relay.

Universal Seventh Channel

Holding down a typewriter key too long would make the *PR* relay operate and repeat the cycle just described, if an additional photoelectric circuit controlled by the seventh or universal light channel were not provided. The phototube in this circuit is connected to a positive power supply so the effect of light on it is to make the bias on the grid of the thyratron more positive than minus two volts and allow it to fire. The fixed bias as determined by the 3,000-ohm potentiometer is adjusted so the resultant bias on the grid of the thyratron is more negative than minus two volts when the seventh light channel is cut off, thus preventing it from refiring when the circuit to the *PR* relay is reestablished on the release of the punch magnet in the perforator.

Plate voltage for the thyratron in the universal photoelectric circuit is applied through the *PR* relay and the break contact on perforator punch magnet *PM*. The plate current in this circuit is limited to 70 ma by a 1,500-ohm resistor in the plate lead. Every key on the typewriter except the shift key has a shutter which interrupts the seventh light channel. When any key lever is operated, light is cut off from light-channel 7 and the thyratron in the universal photoelectric circuit is prevented from refiring when its plate battery is reconnected by the release of the perforator punch magnet *PM*.

The seventh light channel is located nearest the pivot point of the key levers so that it will be the last to be uncovered when the key is released. All code light channels must have enough light to prevent their photoelectric circuits from operating before there is enough light through the seventh light channel to cause its photoelectric circuit to operate, thus preventing another registration when the key lever is released.

Line Transmission

Provision is made for operating the typewriter normally, without producing teleprinter signals. This was found desirable for some applications, as where preliminary information was typed on the page before the part to be transmitted. The line transmission switch (which may be a foot switch if frequent changeover is required) operates relay *CI* in Fig. 4. In the released position this relay places a fixed bias more negative than minus two volts directly on the grids of the code-registering thyratrons, thus preventing any control by the phototubes. A make contact on the relay cuts a resistance into the primary circuit of the exciter lamp transformer in its released position, to reduce lamp voltage during ordinary typing and thereby prolong the life of the lamp.

Line Feed

The operations of line feed and carriage return are automatically registered on the tape perforator by use of contacts on the carriage and on the back of the typewriter. For line feed a sensitive snap-action switch is mounted on the left end of the carriage and operated by the jockey roller on the line-feed ratchet wheel. The circuit to the line-feed contact is carried through sliding contacts on the carriage to a receptacle on the back of the typewriter.

The carriage return contacts on the back of the typewriter are actuated by the friction in the sliding contacts in the line-feed circuit. When the carriage is returned the contacts close to complete the carriage return circuit. When the carriage reverses at the end of the carriage-return motion the contacts complete the blank relay circuit, causing a blank character to be punched in the tape.

When a transmitting system operates into a page printer the mechanical motion of returning the carriage requires more time than the transmission time of one character, so the character following carriage return must be a nonprinting function. In normal teleprinter operation this function is line feed. In the normal operation of a typewriter the line-feed motion precedes the motion of returning the carriage, so a blank is introduced after carriage return to allow the carriage on the receiving printer to be completely returned before sending the first character of the next line.

The registration of line feed is through relay *LF*, which is in series with a 20-μf capacitor between + 120 volts and ground. The *LF* relay locks through its other winding and trip-latch 2 on the perforator to the same registering circuit as the thyratron. Once the relay is up, the locking circuit assures complete registration. If the pulse from the line-feed contact is long, repeat registration is prevented by the capacitor circuit. Once the relay is operated by the charging current of the capacitor the current is reduced to a low value which will not hold the registering circuit. A 50,000-ohm resistor across the capacitor discharges it when the line feed contact opens, restoring the circuit to normal.

Carriage Return

The registration of carriage return is somewhat different from that of line feed due to two factors. The first is the possibility of receiving the carriage return pulse before line feed is completely registered, and the second is the necessity of producing a blank registration after carriage return. When the carriage-return contacts on the back of the typewriter close, carriage-return relay *CR* operates on the charging current of the 20-μf capacitor in the typewriter. If relay *CR* is operated before relay *LF* is released it locks up to a local resistance circuit through a make-before-break combination on relay *LF*. When the registration of line feed is complete and relay *LF* releases, its make-before-break contact combination transfers the locking circuit of relay *CR* from the local resistance circuit to trip-latch 4 on the perforator, which registers carriage return on the tape.

During the time the carriage is returning, the capacitor in the typewriter is being held charged through the operate winding of relay *CR*. When the carriage reverses at the end of the carriage-return motion the charged capacitor is connected to the operate circuit for blank relay *BK*. This relay operates on the discharge current of the capacitor and locks through trip-latch 6 of the perforator, which registers a blank code in the tape.

Run Out

When a tape transmitter is associated with the tape perforator in a transmission system there is a tight-tape switch between the perforator and the transmitter, actuated by the tape, which causes the transmitter to stop when the tape is tight. If the perforator stopped at the end of the message there would be several characters in the tape between the perforator and the transmitter. In order to get these characters into the tape transmitter a run-out key is provided on the typewriter which operates a run-out magnet in the perforator. An adjustable mechanism in the perforator causes enough blanks to be perforated to allow the last character of the message to pass through the tape transmitter.

The system just described may also be adapted to other communication fields, such as interoffice communication in large plants, radio teletype transcribing, and fields where experienced teleprinter operators are not available.

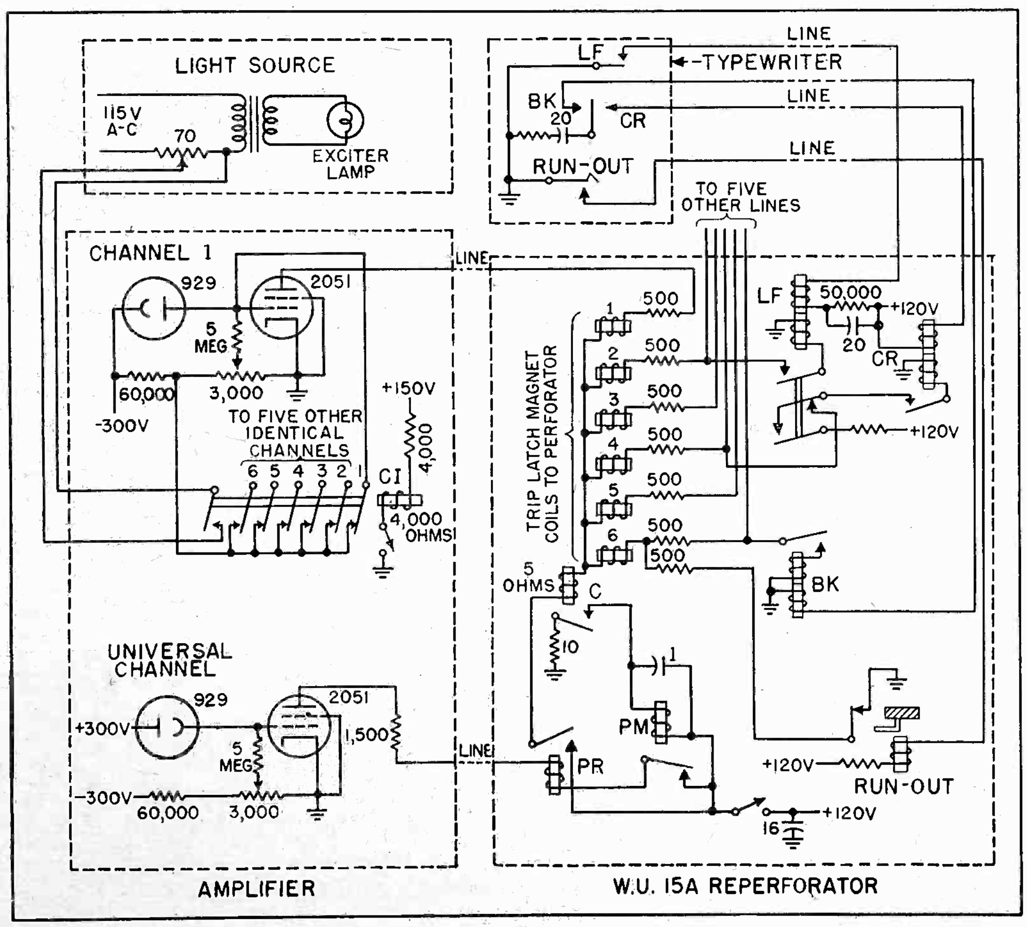


FIG. 4—Circuit of complete photoelectric system and interconnections with Western Union reperforator used to convert to standard teleprinter five-unit code

when the frequency of electrical circuits is increased to a point where inductors and capacitors become too small to handle. A similar transition exists in the field of mechanical vibrations; only, because sound travels so much more slowly than do electromagnetic fields, the transition must be made at much lower frequencies. Velocity of sound in steel and many other solids is of the order of three miles per second, making the length of a longitudinal wave at 455 kc about one-half inch, and a half-wave resonant line is therefore one-quarter inch long, which is not an inconvenient size.

To learn how to arrange mechanical lines to obtain a filter, let us look first at electrical lines which are more familiar. In the left portion of Fig. 1B, a half-wave line is shown which connects a generator to a load; to the right there appears its lumped-circuit equivalent, an inductance and capacitance in series. The following conditions must be met: Resonant frequency left and right should be the same, and characteristic impedance Z_1 of the line should be equal to $2/\pi$ times (about 64 percent) the reactance of L_1 or C_1 at resonance. Then the two networks become equivalent at all frequencies not too far from the resonant frequency F.

Using the equivalence just stated, series inductors and capacitors of the original filter can be replaced by half-wave lines of the proper impedance. There remain the shunt capacitors. These can best be taken care of by means of open-circuited line stubs less than a quarter wave long. For instance, if the stubs are an eighth wavelength long, their reactance becomes numerically equal to their characteristic impedance, which we may call Z_2.

With these two kinds of line elements, we can now draw the line equivalent of the original filter. Figure 1C shows several half-wave sections of impedance Z_1, shunted at their junctions by open eighth-wave lines of a much lower impedance Z_2. Bandwidth ratio W/F, which was previously equal to 2 C_1/C_2, becomes now $(4/\pi)$ (Z_2/Z_1). With these relations we design a line.

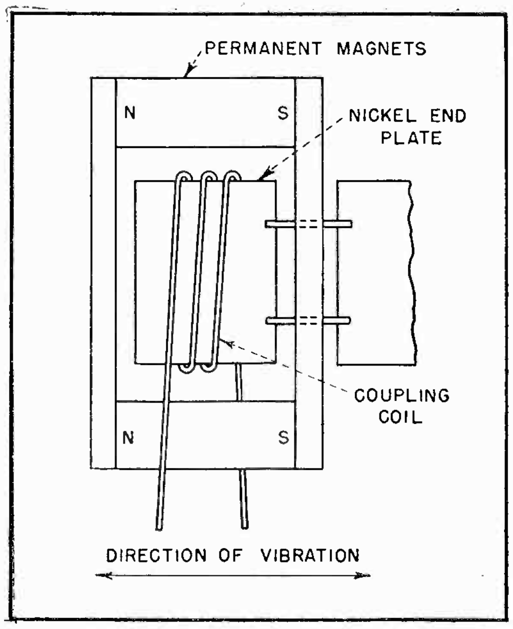


FIG. 2—Magnetostrictive end plates are magnetized and coupled by coils to the electrical circuit

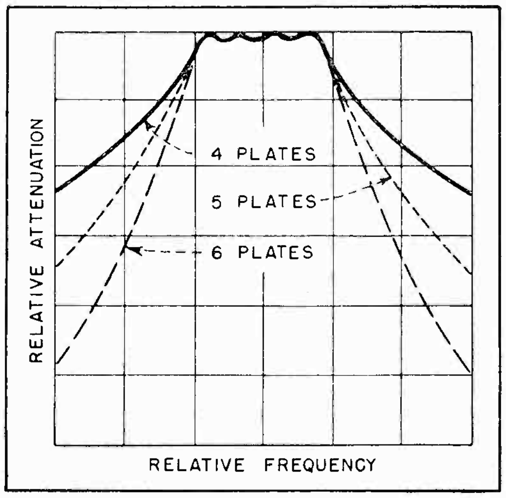


FIG. 3—Cutoff at edges of pass band is sharper for mechanical filters having more plates

To obtain $W = 9$ kc at $F = 455$ kc, Z_2 must be made 1.57 percent of Z_1. It is apparent that the shunting stubs must be cut from lines of very low impedance; also, the impedances of the terminating half-wave lines should be only $0.5Z_1$.

Equivalent Mechanical Filter

We are now almost ready to apply the knowledge gained with the aid of our electrical model to an equivalent device in which mechanical lines are used. Half-wave and eighth-wave mechanical lines can easily be constructed for a given frequency; all we need to know is the velocity of sound propagation in the medium we select. There remains, however, the need for defining the ratio between the impedances of two mechanical lines, for upon such a ratio depends the bandwidth ratio W/F of the filter.

Let us consider a section of mechanical line made of a given solid material in which vibration is propagated longitudinally. For a fibre of line having one unit of cross-sectional area, isolated from the surrounding body, it takes a certain force to produce a desired motion; then, if total cross-section of the line is A units, the total force required to impart the same motion to the entire area will be A times this certain force. In other words: Force for a given motion is proportional to the cross-sectional area. If we think of mechanical force as equivalent to electrical voltage, it follows that mechanical impedance of the line is proportional to its cross-sectional area.

The rules just derived enable us to design mechanical line elements which, when combined, will produce the desired pass band, but we still need to know how these elements should be interconnected. Let us again refer to the electrical analogy, shown in detail in Fig. 1D. A coupling spring between two mechanical objects exerts equal forces upon both, while taking up the difference between their velocities. Similarly, an electrical shunt connected between a generator and a load maintains equal voltages across both, but takes up the difference between generator current and load current. To act in a manner equivalent to electrical shunts, our mechanical eighth-wave stubs should therefore be connected like coupling springs between the half-wave resonating lines.

Figure 1E shows a highly schematized view of the structure which is obtained by joining mechanical lines together in the manner just derived. Any mechanical structure built in accordance with this schematic design will act as a bandpass filter.

Electromechanical Terminations

The figure calls for a mechanical generator on the left and for a mechanical load on the right, both having the proper resistance but no reactance. Because this filter is to be used between electrical circuits, generator and load should both be electromechanical converters, somewhat like a speaker and a microphone. For the frequency range near 455 kc, the only suitable converters are piezoelectric or magnetostrictive bars. Such bars always have mass and elasticity, however, and so it seems impossible to construct the desired converters.

To find a way out of this difficulty, let us look once more at the lumped electrical circuit (Fig. 1A) from which our filter was first derived. It is the resistive elements R which cannot be built without introducing reactances. But instead of attempting the impossible, consider the terminating elements R, 0.5 L_1, and 2 C_1 as a unit; together they form a tuned circuit with $Q =$ of $0.5[(L_1/C_1)/R]^{1/2}$. This Q, incidentally, is equal to the reciprocal of the bandwidth ratio W/F, becoming 50 for the 9-kc filter.

If it is permissible to consider the resistive elements as damping tuned circuits which terminate this electrical filter at both sides, then, in analogous fashion, the required resistance can be incorporated into the terminating half-wave lines of the mechanical filter by giving them the proper damping.

Finally, the resistances in the mechanical filter should simultaneously serve as electromechanical converters, which is possible only if the terminating half-wave lines themselves are piezoelectric or magnetostrictive.

Electromechanical Damping

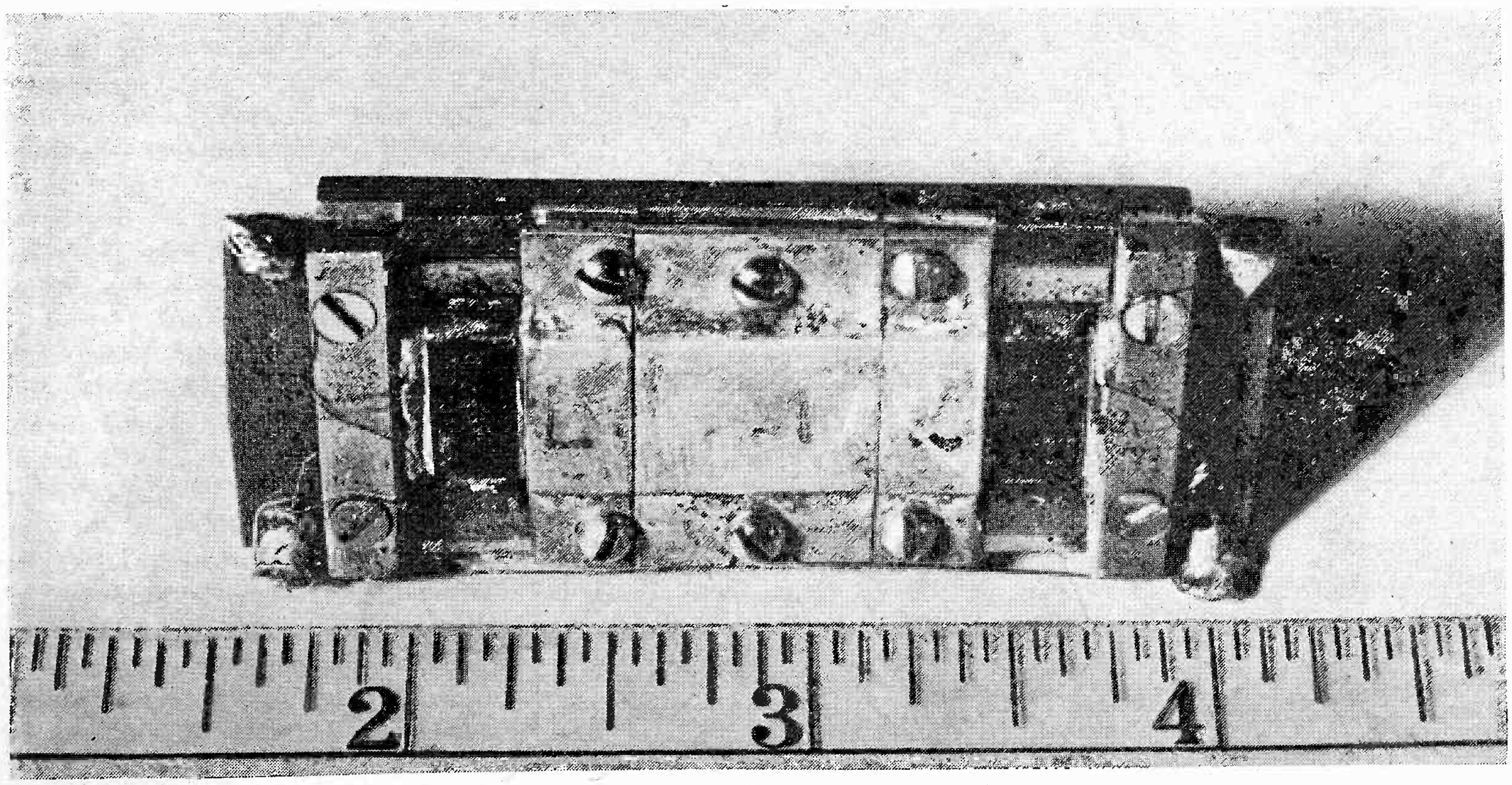
The electromechanical filter must therefore consist of several half-wave resonators with the least possible mechanical damping, coupled to each other and to the terminating elements by eighth-wave lines of much smaller cross section. Electrical properties of all these elements are of no consequence. But the terminating half-wave resonators must be made of piezoelectric or magnetostrictive material. They should have half the impedance of the other resonators, and their damping must be carefully controlled.

A few words about the nature of this damping: If any electromechanical converter—we may, for instance, think of the oldest kind, the rotating d-c generator—is loaded on its electrical side, a reflected mechanical resistance is established which causes expenditure of mechanical energy whenever electrical energy is absorbed from the generator. Mechanical energy consumed by this reflected resistance is not lost but reappears in electrical form.

Evidently, then, reflected mechanical resistance produced by loading the electrical side of converters provides damping. From an efficiency viewpoint it would be best to produce exactly the required amount of damping in this manner and use no frictional damping at all. In piezoelectric converters this is indeed possible, and with them a filter of the type described could be built having nearly ideal transmission. Magnetostrictive converters, at frequencies near one-half megacycle, are not quite as efficient. Only part of the required mechanical resistance can be produced by electrical loading; the remaining portion is inherent in the mechanical damping—internal and external friction—acting upon the two end pieces. Accordingly, a fraction of the incoming electrical energy is lost in the filter input, and an equivalent fraction of the mechanical energy arriving at the filter output is lost there.

The question may therefore be asked why, in spite of these losses, the magnetostrictive type should have been chosen for a practical design. The answer lies in its simplicity, economy and stability.

A typical filter consists of flat



For use in intermediate-frequency amplifier of broadcast receivers, the electromechanical filter is housed in a protective case. Coupling coils are wound around end plates, which are located in the field of permanent magnets

nickel end plates 0.005 inch thick, stainless steel plates twice as thick (to maintain the required impedance ratio) and pairs of parallel steel wires 0.006 inch in diameter, which connect adjacent plates. It is put together by spotwelding the steel wires to the rectangular plates. To put it into operation, each of the nickel end plates is premagnetized in the direction of vibration, by means of small permanent magnets as shown in Fig. 2, and coils are arranged around each nickel end plate to make it vibrate as a magnetostrictive half-wave bar.

The filter structure is held loosely in place between linings of soft cloth or neoprene inside a flat metal cover. As long as no undue pressure is exerted upon the stainless steel plates, their mechanical Q is quite high, between 2,000 and 4,000, and they come fairly close to pure reactances. Consequently, the losses inside the filter, aside from the conversion loss at the terminations which was discussed before, are very small, and additional stainless steel sections cause no noticeable increase in the attenuation inside the pass band. Every additional section, however, causes sharper cutoff at the band limits. The curves of Fig. 3 show how frequency response varies with the number of sections.

For the six-piece filter shown in the pictures, the combined cross-section of both coupling wires is equal to about 1.5 percent of the cross-section of the stainless steel plates, measured in the direction of vibration. Because they are made of very similar materials, their impedance ratio is also about 1.5 to 100, leading to a theoretical bandwidth of 8.5 kc at 455-kc center frequency. Measured response of this filter is shown in Fig. 4. For purposes of comparison, the i-f response of a conventional receiver of good quality is plotted under the same zero line. It is interesting to note that the mechanical filter transmits the higher audio frequencies, up to about 4 kc, somewhat better than do conventional i-f transformers; but the adjacent carrier (10 kc away) is attenuated 1,000 times by the mechanical filter. The conventional filter needs 20-kc spacing to do the same.

By using coupling wires with other diameters, pass bands up to 14 kc and down to 4 kc have been obtained in experimental filters. For the wider bands, the low Q required in the nickel end plates becomes more difficult to realize.

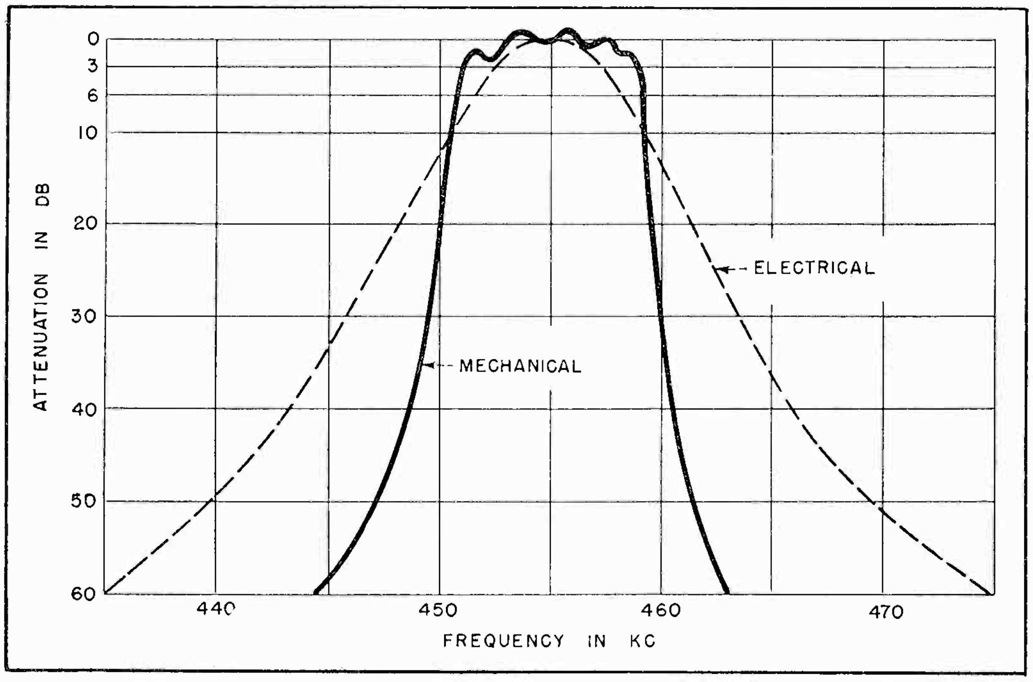


FIG. 4—Comparison of electrical and electromechanical filter bandpass characteristics

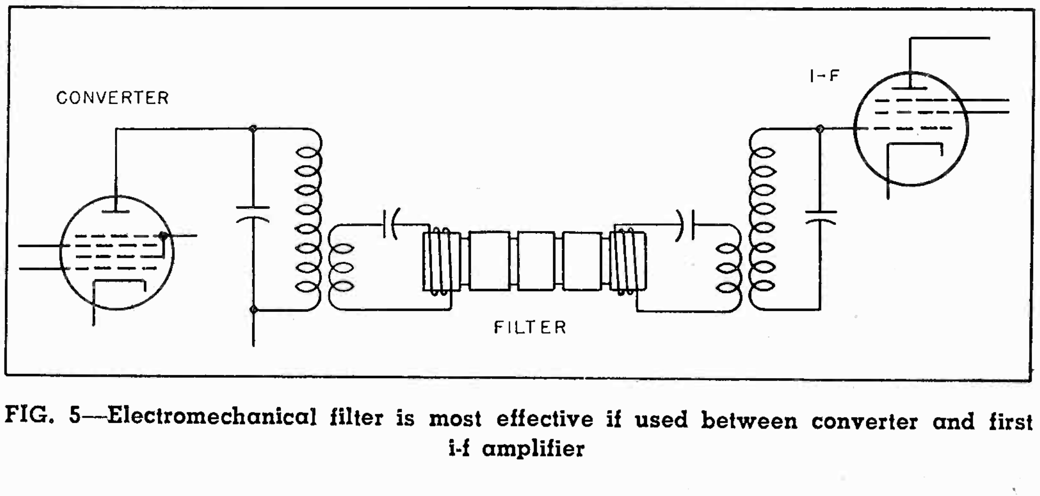


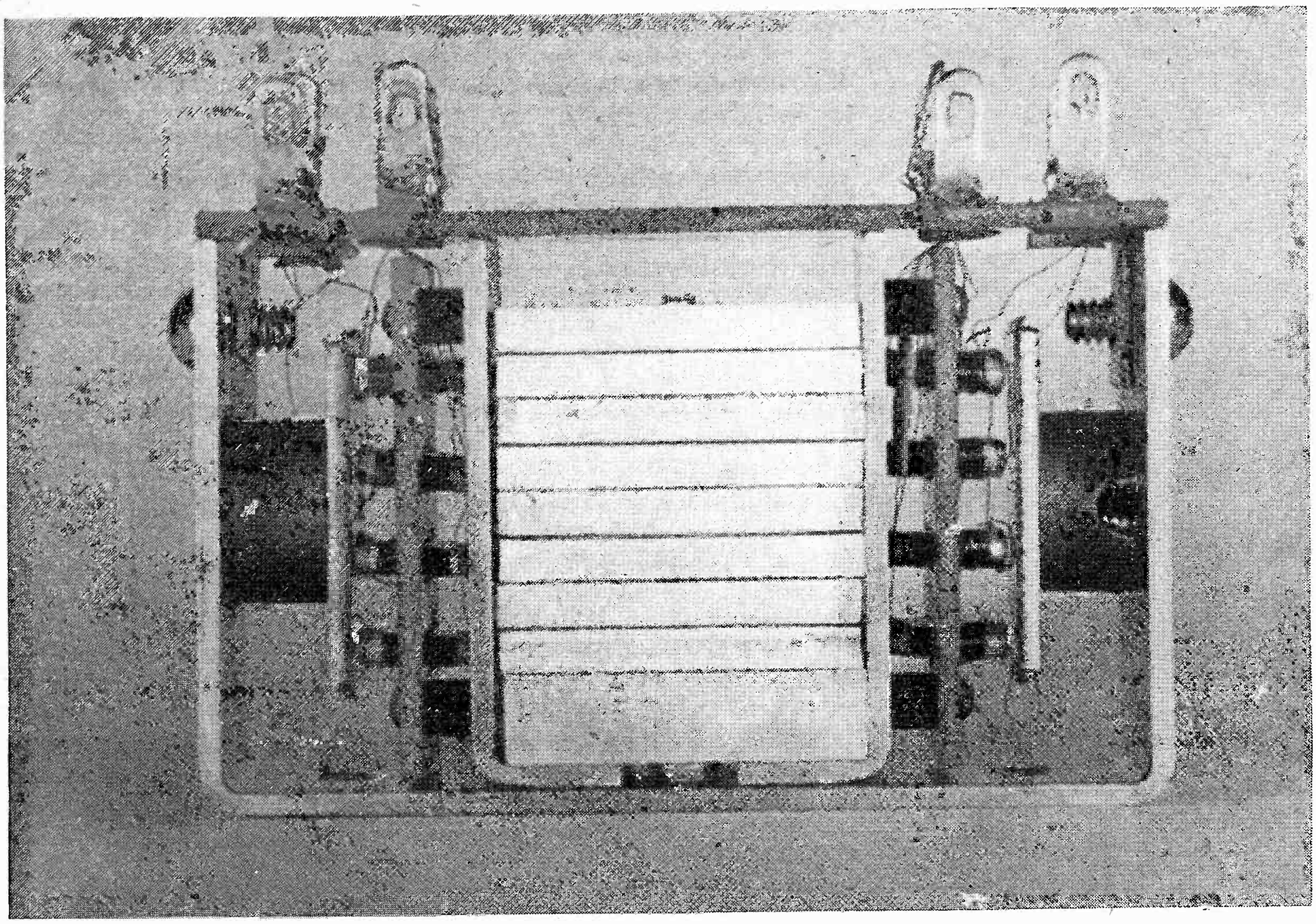
FIG. 5—Electromechanical filter is most effective if used between converter and first i-f amplifier

Use in Receivers

In a radio receiver, the best place for the electromechanical filter is right after the converter, as shown in Fig. 5. The coupling coils which surround the nickel end plates of the filter structure can most easily be wound for impedances of the order of 100 ohms; transformers are used to match this low impedance to the plate circuit of the converter and to the grid circuit of the following i-f tube.

The insertion loss of the filter in its present form is about 14 db. In designing a practical receiver, however, it has been found that some of this loss can be recovered. The matching transformers around the filter can be built with higher impedances than are normally used in i-f transformers, because the mechanical filter greatly relieves the stability requirements for the electrical circuits, permitting the use of a higher L/C ratio. Furthermore, the insertion loss in the filter reduces the overall i-f regeneration. It seems fair to say that, in a balanced i-f design, the net loss caused by introducing the filter in its present form is between 6 and 10 db, corresponding to a reduction in gain by a factor of two or three for a given tube combination.

Temperature variations affect the mechanical resonant frequency of the half-wave plates, causing the pass band as a whole to shift by a small amount. If the plates were made of plain steel, a temperature rise of 50 degrees F would shift the band by somewhat more than one kilocycle. Stainless steels are available which show much smaller frequency shift; plates are prefer-



In experimental receiver, four filters with different bandwidths are assembled in a single structure. Any filter can be selected by four-position switch (switching is simple at the 100-ohm impedance of the filter terminations). Merits of different bandwidths can thus be determined

ably made from such materials.

Receiver Performance

The performance of a broadcast receiver equipped with the six-piece filter described (two times down 4.5 kc off center, 1,000 times down 10 kc off center) is interesting in many respects. It was first suspected that such a set would be hard to tune, but tests with a number of lay listeners did not bear this out. Change in tone quality caused by incorrect tuning sets in at two clearly defined points much more abruptly than in conventional receivers; listeners seem to find it quite easy to tune between these two points.

With correct tuning, tone quality appears to be quite similar to that of conventional sets. One might expect to hear unfamiliar transients around 4,000 cps caused by the unusually sharp cutoff of the pass band, but nothing unusual could be detected. It appears that at 4,000 cps, where the sensitivity and discrimination of the human ear are not as good as in the medium range, an even greater rate of cutoff would be required to produce noticeable transients.

Adjacent-channel selectivity, of course, is the distinctive feature of a receiver using the electromechanical filter. Any desired channel can be tuned in even if there is a strong local signal on an adjacent channel. In Chicago, for instance, it is possible to tune in the New York transmitters WNBC, WOR, WJZ, and WCBS, although there are Chicago stations (three of 50,000 watts and one of 10,000 watts) separated only 10 kc from each of these four New York channels. It would take rather expensive electrical filters to equal this performance.

While economical adjacent-channel selectivity may be a highly desirable feature in broadcast receivers, especially for certain regions, it is of paramount importance for communication receivers. The new filter, together with its coils and magnets, weighs less than an ounce and takes less than one cubic inch of space. Its essential parts are stainless steel, easily manufactured by punching and spotwelding. There are no adjustments which could drift or vary; the frequency response is fixed.

Much further development remains to be done; improvements in the electromechanical conversion efficiency of the nickel end plates would be very useful; and careful study of alloys, dimensions and coupling coil design may well bring such improvements about. Economical production methods must be developed. The present structure seems simple enough, but it has not yet been manufactured in quantity.

It should not be forgotten that this structure represents only one among many possible forms. Other varieties, perhaps based on other modes of vibration, might be found which are simpler, and perhaps can be punched out in a single operation.

mately 90 degrees, the conditions for rotation of a two-phase motor are satisfied.

Dynamometer Action

The motor is mechanically coupled to the iron armature of the receiver coil in such a manner that rotation of the motor caused by unbalance of the bridge drives the armature in the direction necessary to rebalance the bridge. A suitable device for indicating or recording displacement of the receiving armature may also be driven by the motor and armature linkage.

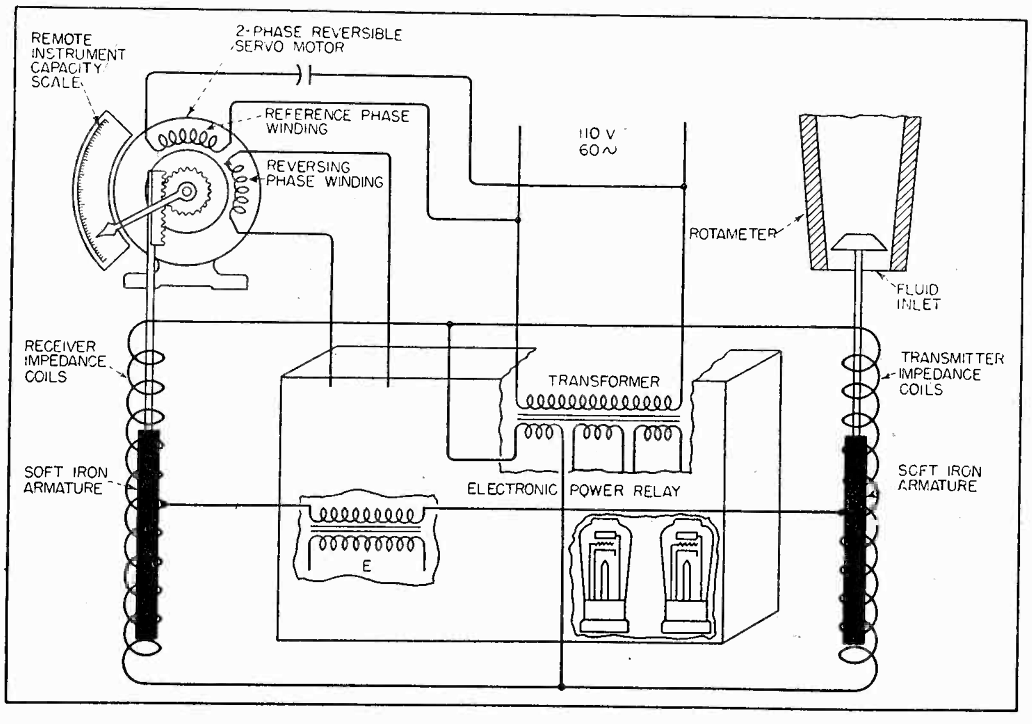
Reactive currents in the bridge circuit, comprising components 90 degrees out of phase with the line voltage, will be either in phase with or 180 degrees displaced from the reference line phase and will therefore produce no rotation of the two-phase motor. Thus the servo unit acts as a true power detection device or dynamometer.

There is a widespread misconception regarding impedance bridges. Many engineers believe that a current detector is the only necessary detecting element across the center leg of the bridge. A true impedance balance can only be found, however, by using a detector which is responsive only to the real component of unbalance current. Therefore a detector of the dynamometer (wattmeter) type, which measures only in-phase current, is necessary to indicate true balance.

The motor generally supplied with the variable-area type of remote flow rate indicator is of the two-phase, low-inertia, high-torque type. Various types of motor drive circuits may be used, the choice depends largely on the power output required. Among the types developed are the direct drive, the transformer coupled, the thyratron drive and the saturable reactor type of motor drive circuit. However, with the saturable reactor type of drive circuit it was difficult to achieve the high instantaneous braking forces obtained with other systems. These braking forces are an important consideration, since damping is the greatest problem in all servomechanism applications.

One of the prime considerations in the damping problem lies in the choice of the rebalance motor. It should obviously have the lowest inertia rotor assembly with the highest torque possible. In some applications it is advantageous to supply the motor drive tubes with unfiltered direct current from a full-wave rectifier supply. The resulting 120-cycle pulsations, transmitted to the motor by a transformer, provide excellent dynamic braking.

These pulsations literally have the motor running at full speed when the system is in balance. In a 60-cycle system the motor will develop full torque in one direction for 1/120th second while during the next 1/120th second it develops full torque in the opposite direction. This motion is very slight and is not perceptible at all when reduced through a gear train. The chattering rotor, however, helps to overcome the effect of friction in the system. Since the unit already is in motion, very small signals will be responded to and will initiate rebalance of the bridge.



Complete setup of the elements in the electronic null balance

Armature Design

The reduced size of the transmitter armature has an important effect on flow measurement. Normally the larger floats may be displaced from their rest positions by the electromagnetic force or solenoid action of the transmitter and receiver coils. This has required special precautions during calibration.

The float must be in an instrument that is energized during calibration to correct for the effect of any electromagnetic forces. The weight of the armature has been reduced to a fraction of a gram.

In conjunction with the very low magnetic forces of the small coils, electromechanical displacement of the float becomes too small to be measured. With the float in a flow stream of five cubic centimeters of water per minute, no deviation of float position with the coils either energized or disconnected is noted.

Reduced eddy current losses in the armature prevent vaporizing volatile fluids by excessive heating effects.

Another advantage of this small primary element is that noble metals can be used for the purpose of corrosion resistance.

The trend toward float and armature assemblies of miniature size was initiated by the need for accurate measurement of the small flow rates encountered in laboratory scale operations, as well as for the small industrial flow rates associated with the manufacture of perfume essences, vitamin additives, synthetic rubber modifiers and numerous other processes requiring a high degree of control over small liquid and gas flows.

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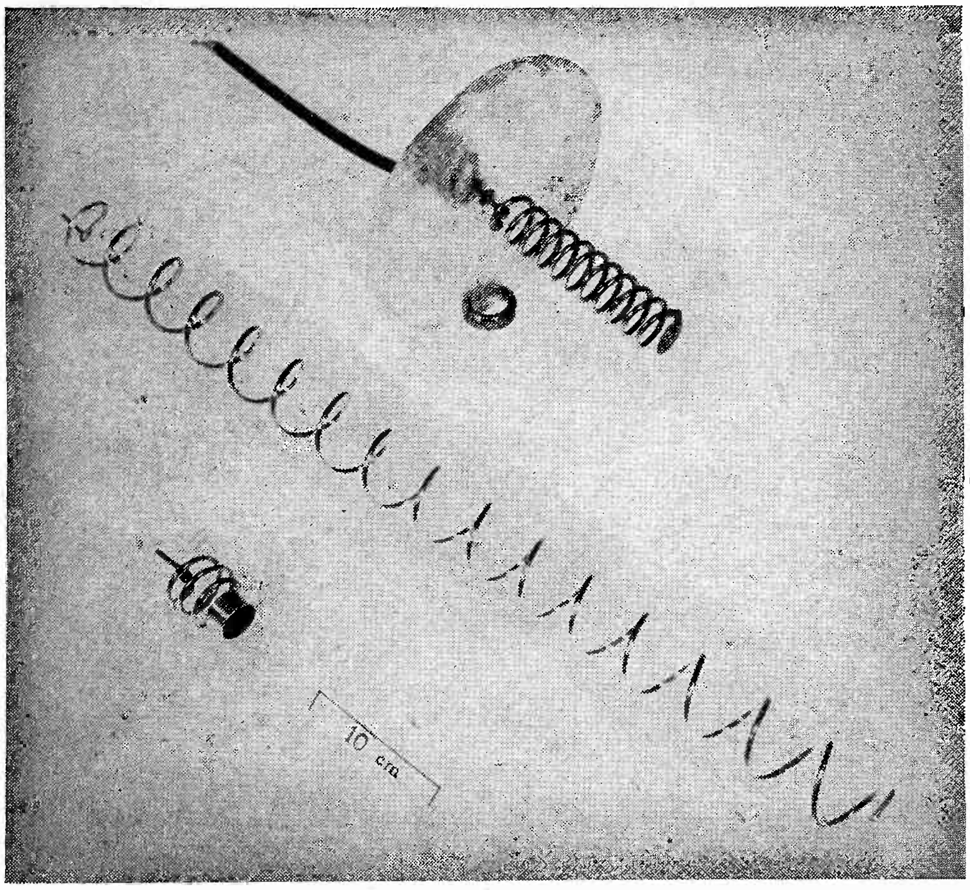
Helical Beam Antenna



Three uniform helical beam antennas for 10-cm operation. The one at the top is shown with its ground-plane plate in place

Axial mode radiation provides circular polarization, with readily controlled directivity and gain. Dimensions for 10-cm operation are given

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A HELIX with a circumference of one wavelength can be excited as a beam antenna. Radiation is maximum in the direction of the helix axis, and is circularly polarized.

This new mode of operation of a helix is known as the axial or beam mode. The polarization is right or left-handed, depending on the direction in which the helix is wound. The helix may be uniform or tapered. The former type is called a uniform helical, and the latter a tapered helical beam antenna.

The photograph on this page illustrates three examples of uniform helical beam antennas. All are designed for 10-cm operation. The medium-length helix (1.2 wavelengths long) has a beam width between half-power points of 43 degrees. The longest helix (6 wavelengths) has a beam width of 20 degrees. The shortest ($\frac{1}{2}$ wavelength) has a beam-width of 58 degrees. Ground planes are used with all three antennas.

Referring to Fig. 1 (left), a helix is shown mounted on a ground plane and excited by a coaxial transmission line. The axial or beam mode produces the maximum radiation in the direction of the axis of the helix, a typical radiation pattern being as indicated.

At this point it may be well to distinguish clearly between this axial mode and another mode of operation of a helical antenna.[1] The other mode produces circularly polarized radiation having an omnidirectional pattern, with maximum radiation perpendicular to the axis and a null in the direction of the axis as shown in Fig. 1 (right). The helix dimensions required to produce the omnidirectional mode are different from those required to obtain beam mode discussed herein.

The beam mode should also be distinguished from the mode of helix operation used in the traveling wave tube[2]. In the traveling wave tube the helix circumference is only a small fraction of a wave-

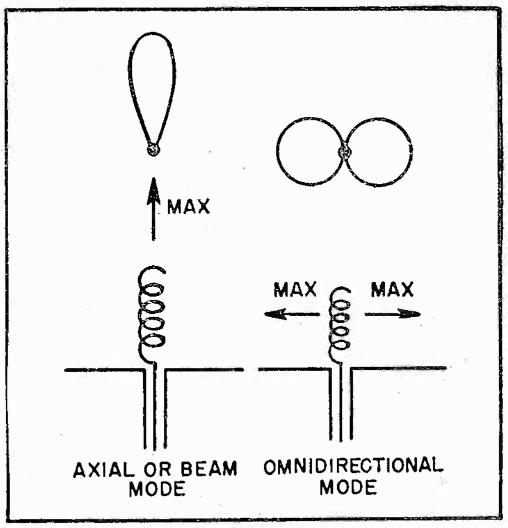


FIG. 1—Axial or beam mode of helical antenna discussed (at left), and omnidirectional or perpendicular mode requiring other dimensions, with which the new mode should not be confused (at right)

length and no antenna beam mode is present.

Nature of Beam Mode

To understand the nature of the beam mode, consider a traveling wave on a helix one turn of which equals a wavelength. At a given instant regions of positive and negative electric charge appear at opposite ends of a diameter, as indicated in Fig. 2A, which shows the helix viewed from a point on the axis. The instantaneous direction of the electric field lines is then as shown. With passage of time the regions of charge travel along the helix and the field rotates, making one revolution per cycle. Thus an observer located on the axis on the helix (perpendicular to the page) receives circular polarization.

Referring next to Fig. 2B, the dimensions of a conductor wound in the form of a helix will be designated as follows: S, the spacing between turns; D, the diameter of the helix; and L, the length of one turn. Dimensions S and D are center-to-center distances. Assuming a traveling wave on the helix, it may be shown that a condition for circularity of polarization in the direction of the axis is fulfilled when

$$L - S = n\lambda \qquad (1)$$

where λ is the wavelength and n is any odd integer.

A condition for maximum directivity along the axis is also expressed by Eq. 1. When $n = 1$ both conditions are fulfilled. This case is the one considered here.

The relation between the diameter, turn length, and turn spacing of a helix is given by

$$D = \sqrt{L^2 - S^2}/\pi \qquad (2)$$

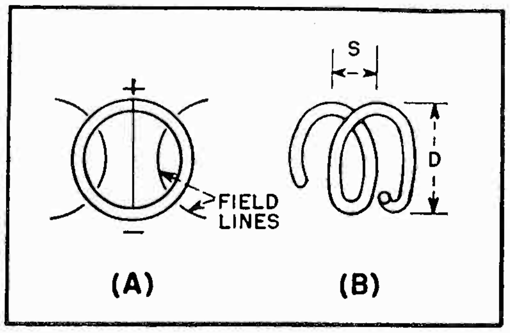


FIG. 2—Electric field (A) around a single turn of a helix which is one wavelength in circumference, and (B) dimensional rotation referred to in the text

Substituting for L from Eq. 1 in Eq. 2 we can express the relation of Eq. 1 in terms of D and S. Figure 3 is a graph of this relation for $n = 1$.

Numerous uniform helical antennas with spacing S between 0.1 and 0.4 wavelength have been constructed and found to generate the beam mode. The diameter D for a given spacing to produce the most nearly circular polarization was usually between the curve value in Fig. 3 and a value about 25 percent less.

Axial Ratio of Polarization

The ratio of the major to the minor axis of the polarization ellipse of the electric field intensity is called the axial ratio. The axial

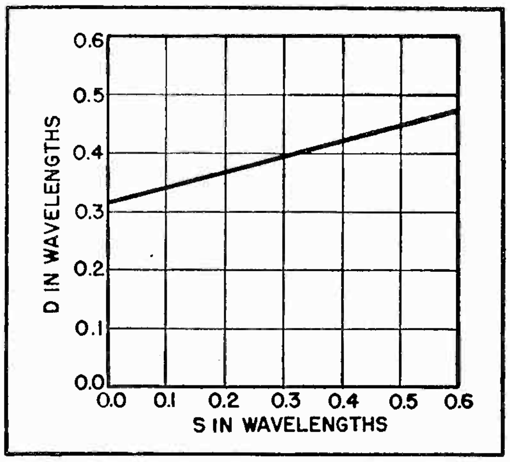


FIG. 3—Relation between diameter *D* and spacing *S* for the beam mode of operation

ratio is unity for circular polarization and infinite for a plane polarized wave.

Axial ratios of 1.2 or less are readily obtainable with helical beam antennas. Experimentally it is found that the axial ratio can often be reduced by bending the last turn of the helix (open end) to change the spacing of the last turn. An alternative method is to attach a disc or ring to the end of the helix. The position of the disc or ring along the axis is adjusted for minimum axial ratio.

Beam Width and Gain

With a helix of given diameter and turn spacing, the beam width is a function of the overall length of the helix, the beam becoming narrower with increased length. The measured beam widths of the three antennas pictured have already been indicated. Based on the directivity patterns, the short, medium, and long helices have directed power gains over an isotropic circularly polarized source of 11, 13, and 20 db respectively.

The measured electric field intensity patterns in the plane of the axis are presented in Fig. 4. for the medium length helix. One curve shows the vertically and the other the horizontally polarized component of the radiation. The antenna is a uniform helix with $S = 0.12$ wavelength and $D = 0.28$ wavelength. The conductor diameter is 0.035 wavelength. The measured axial ratio is 1.1 in the direction of the axis.

The dimensions of the short helix are 0.5 wavelength long, $S = 0.11$ and $D = 0.33$ wavelength; and for the long helix $S = 0.38$ and $D =$ 0.38 wavelength.

The pattern measurements given above were made with the antennas mounted on a square ground plane 5 wavelengths on a side.

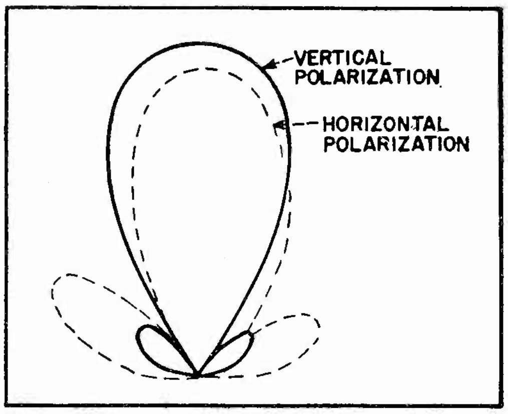


FIG. 4—Field intensity patterns of uniform helical beam antenna 1.2 wavelengths long

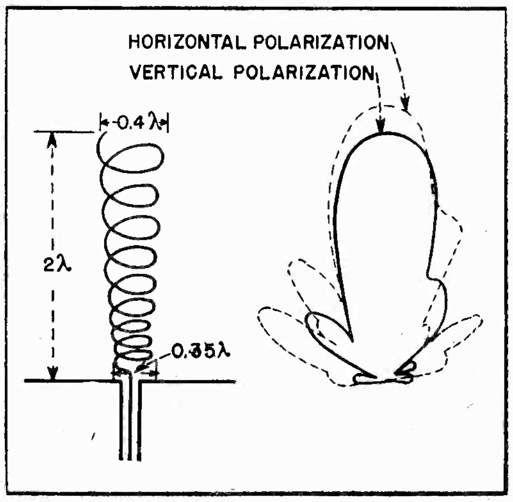
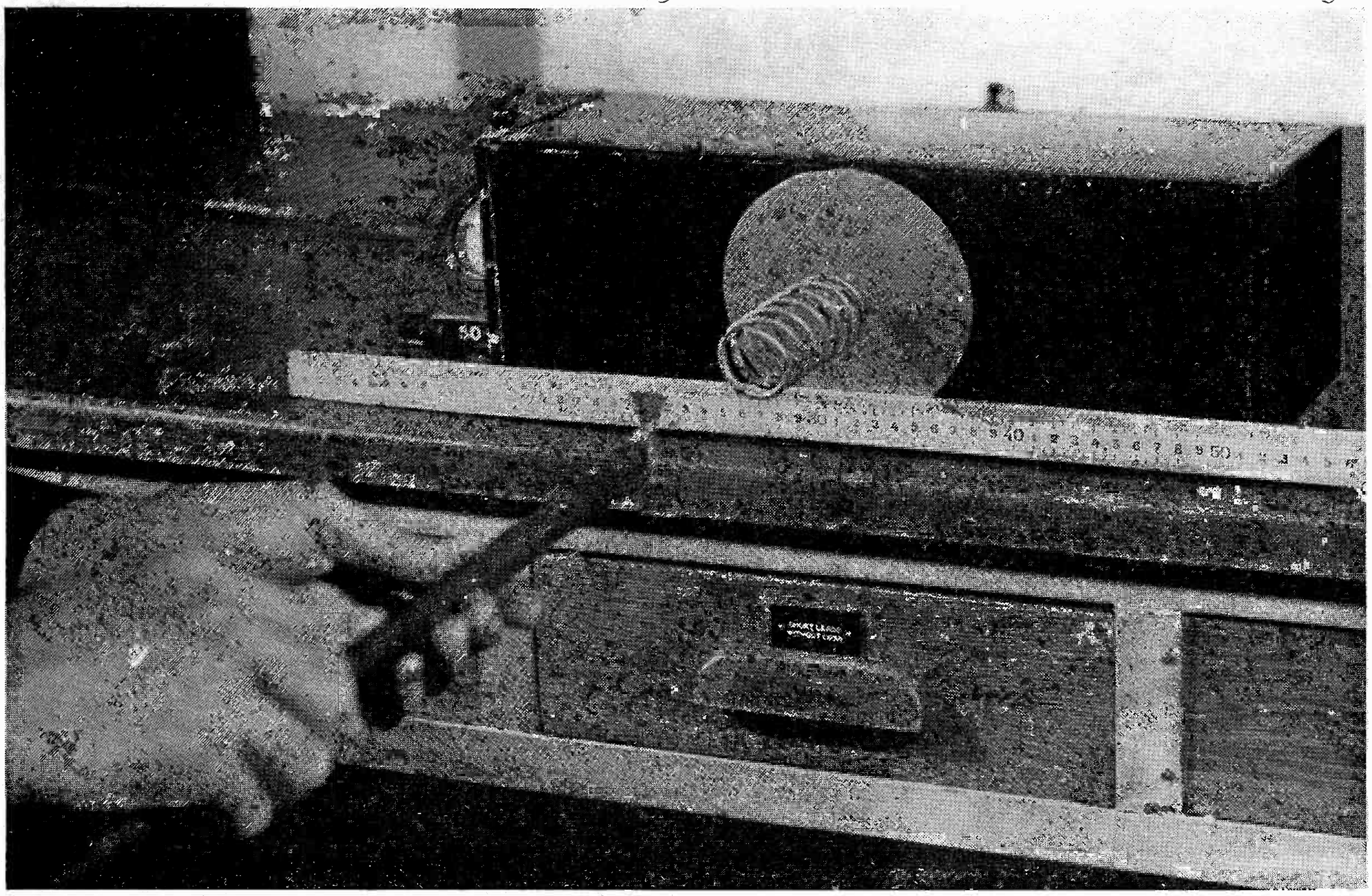


FIG. 5—Tapered helical beam antenna, with field intensity patterns



Circularity of helical beam transmitting antenna polarization may be observed by rotating a linearly polarized receiving antenna at the end of a probe, response being constant with rotation

The helical antennas so far described are of the uniform type. By increasing the spacing, S, as a function of the distance along the axis of the helix and simultaneously increasing the diameter, D, in accordance with the curve of Fig. 3, a tapered helix can be constructed having circular polarization and maximum directivity along the axis.

A 9-turn tapered helical beam antenna 2 wavelengths long with a diameter of 0.35 wavelength at the feed end and 0.4 wavelength at the open end is illustrated in Fig. 5, with the measured field intensity pattern. The beam is 33 degrees between half-power points (16-db directed gain) and the axial ratio is 1.17.

Terminal Impedance Characteristics

The terminal impedance of a helical beam antenna is a function of frequency, and also depends upon the dimensions of the helix including the conductor diameter, and the spacing of the helix from the ground plane. Spacings of 0.1 to 0.2 wavelength have been employed.

The impedance values of a typical helical beam antenna at frequencies near the one giving optimum circularity and directivity are in the range of 100 to 500 ohms resistive, and $\pm j300$ ohms reactive (when off resonance). Hence for maximum power transfer from a 100-ohm line, for example, a transformer section between the 100-ohm line and the antenna may be required.

Helical beam antennas can be scaled to operate at any wavelength. The dimensions have been given in wavelengths to facilitate scaling. They can be employed for both transmitting and receiving. Reception of waves radiated by a helical beam antenna may be accomplished by either a linearly polarized antenna placed vertically, horizontally, or any angle between, or by a circularly polarized antenna having the same direction of rotation of the electric vector. Thus if a helical beam antenna is employed for reception it should be wound in the same direction as the transmitting helix, that is, both should be wound right-handed or left-handed.

When used on a ground plane, beams of wide or narrow width may be obtained, depending on the helix dimensions. To obtain sharper beams a helical antenna can be used as the primary source to illuminate a parabolic reflector. Another application is the generation of a circularly polarized TE_{11} mode in a circular waveguide.

Acknowledgment

The author is indebted to Dr. George Sinclair and Robert B. Jacques of the Antenna Laboratory of the Ohio State University Research Foundation for their kind cooperation, and to R. A. Fouty and W. P. Summers for assistance in measuring some of the characteristics of the antennas described.

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METALLIZED

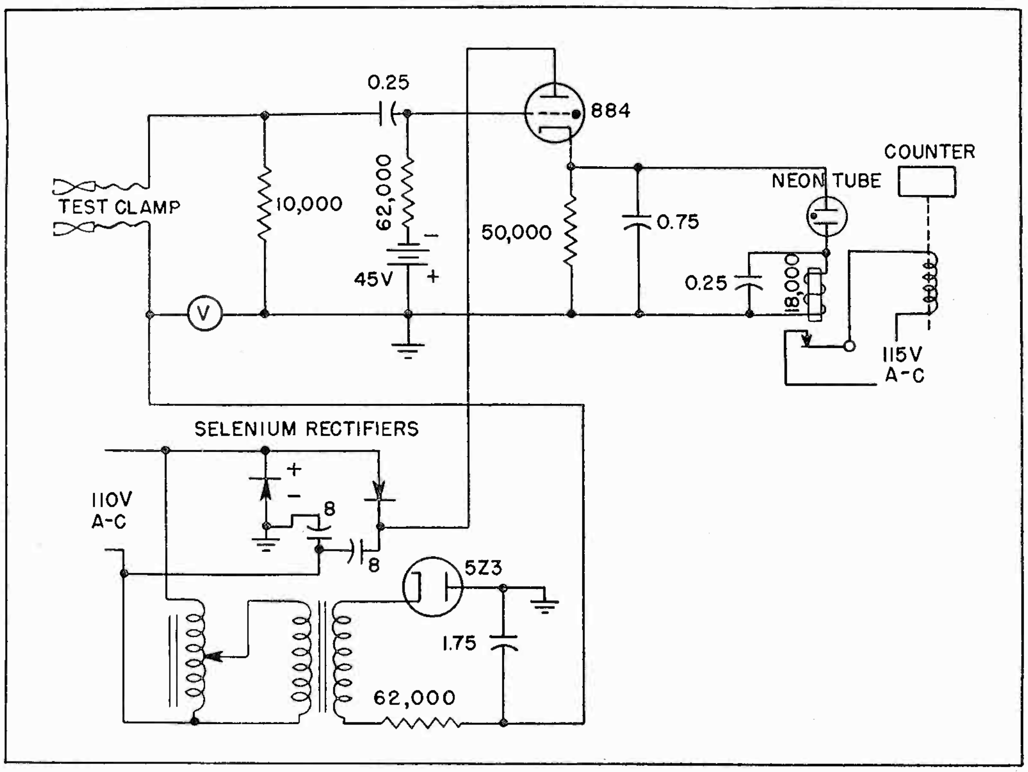

FIG. 1—Counting circuit for determining the number of times the dielectric of a metallized capacitor arcs through

DEVELOPMENT of the high-speed diffusion pump for industrial as well as laboratory use has created many new commercial processes involving the use of high vacuum. Among them is the process of thermal evaporation of metals and their salts, which can be accomplished satisfactorily only in absolute pressures in the micron range.

Since all metals have a definite vapor pressure at any given temperature, all that is required to evaporate a metal is to reduce the pressure of the surrounding atmosphere below the vapor pressure of the metal being heated. Normally, pressures of from 10^{-4} to 10^{-1} mm Hg are maintained in vessels used for evaporation. Table I gives the approximate evaporation temperature of various metals at 10^{-2} mm Hg.

Table I

Metal	Evaporation Temperature at 10^{-2} mm Hg
Aluminum	1000C
Copper	1270C
Silver	1050C
Tin	1350C
Zinc	340C

The evaporation vessel is evacuated to the desired pressure by a combination of mechanical vacuum pumps and diffusion pumps. The metal to be evaporated is then heated in any convenient manner to its evaporation temperature, and the material to be coated is maintained relatively cool so that the metal vapor condenses upon contact with it. Naturally, practical evaporation processes are not nearly so simple as set forth in the foregoing, but this serves to describe the basic principle.

As early as 1932 the Robert Bosch Co. started experimental work in Germany on a process to evaporate thin zinc films onto capacitor paper. From 1936 until the end of the war they are reported to have made as many as 40 million metallized paper capacitors[1] and apparently made many improvements in their evaporation process during this period.

In 1943 the British started producing capacitors made from aluminum-coated paper. Apparently, this activity was stimulated by the discovery of metallized paper capacitors in German aircraft shot down over Britain early in the war. Capacitors of this type are being produced in this country.

The subject of self-healing of thin metallic-coated capacitor papers, and of capacitors made from them, is difficult to define in exact terms[2]. However, it is claimed that metal coatings whose thickness is of the order of one micron will evaporate or oxidize around an area where there is a conducting particle or a hole in the dielectric when a current passes through the particle or hole. The evaporation or oxidation of the metal film around this area breaks the conducting path, and the paper or capacitor is healed, since no further current can pass through the dielectric to the film unless the voltage gradient is increased.

Test Circuit

To prove and demonstrate the self-healing property of metallized dielectrics and to determine the factors which enter into this phenomenon, a series of tests have been made. A counting circuit[3] was used which, through a relay, would operate a magnetic counter as illustrated in Fig. 1. By means of this set-up, the number of discharges through the metallized capacitor paper were recorded up to a maximum of ten per second, which was the limit of the counter used.

A voltage was established across the metallized paper by means of the clamp illustrated in Fig. 2. This was increased in 10 to 25-volt steps at one-minute intervals, and the number of discharges during each interval was noted until a

CAPACITOR TESTS

Discharges through paper of metallized capacitors are counted automatically as voltage is raised in small steps. Results of tests, dielectric constant measurements, and percent increase of power factor due to resistance of the metal coating are given

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maximum of 350-400 volts was achieved. The voltage was then dropped to zero, and the foregoing procedure was repeated two or more times.

Since it was felt that the two principal contributing factors to the phenomenon of self-healing were the thickness of the metal film and the energy available in the circuit feeding the test sample, coatings of various thicknesses were tested using various resistances in series with the test sample. Obviously, self-healing would not occur if the metal coating were thick enough to conduct the heat caused by the discharge away from the point of discharge rapidly enough to prevent evaporation or oxidation of the coating. Likewise, if the energy supplied to the discharge were too great, there would be danger of carbonizing the paper, thereby causing a complete breakdown. Also it was felt that there should be some relationship between these two factors.

Results

Some typical results of the tests made are given by the curves illustrated in Fig. 3 and 4. The paper used in all tests was 0.0004 Kraft capacitor tissue, and no attempt was made to dry it out. Probably a large percentage of the discharges noted was due to moisture present in the paper, and the results obtained should not be construed as indications of the quality of the paper. The metal used for coating the paper was zinc, and the thicknesses of the coatings were selected to give d-c resistances of approximately 10, 20, and 30 ohms per foot on a strip one-inch wide. Two pieces of the metallized paper, approximately two inches square, were inserted between the plates or jaws of the clamp, and the metal film on the lower sheet connected to the lower jaw of the clamp by inserting a U-shaped strip of aluminum foil. Resistances of 2,500; 10,000; 50,000; 150,000; 1,000,000; and 3,200,000 ohms were placed in series with the test capacitor.

The results of the tests prove that thin metal films coated on capacitor paper will self-heal. In only one case, using the test procedure described, were there any discharges below 250 volts after the procedure had been repeated three times, and only once was there a short circuit through the paper which did not heal. If the voltage were rapidly increased to a high value of about 250 volts, a series of discharges would occur in such rapid succession as to be almost continuous, and there would be danger of a complete short circuit. However, once the metallized paper had self-healed up to 250 volts, there would be no further discharges no matter how rapidly the voltage was increased up to this value.

Coatings whose resistance measured about 30 ohms per foot on a one-inch strip seemed to heal more readily than heavier coatings. But even the thickest coating (10 ohms) appeared to be perfectly satisfactory in this respect. For most satisfactory results in self-healing, a

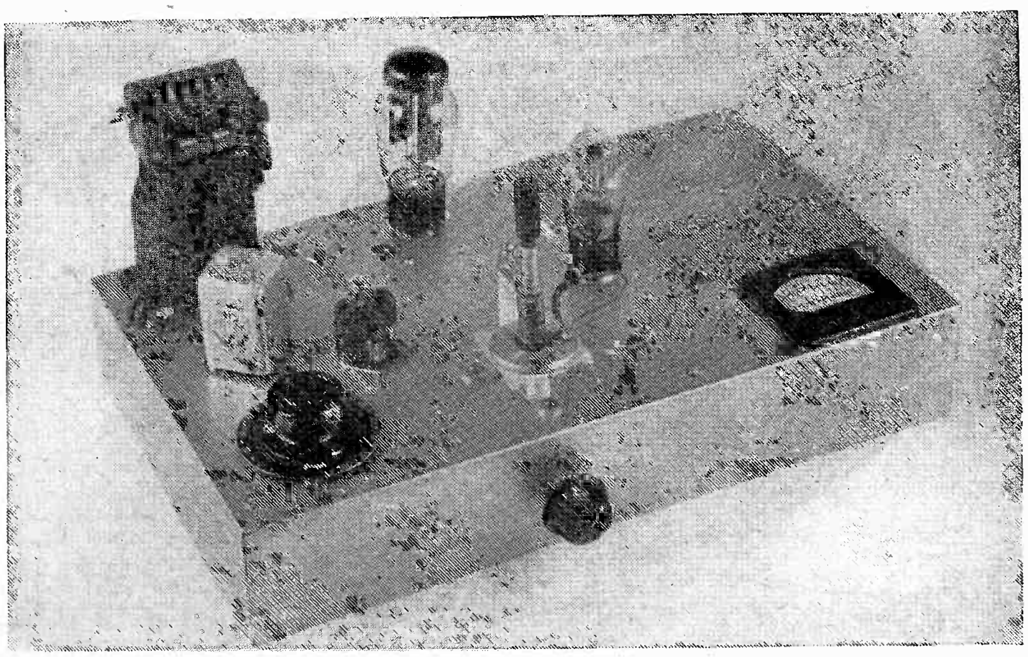

FIG. 2—Electronic test unit used in the self-healing experiments. Square sections of metallized paper were inserted between the plates of the clamp

series resistance of the order of one megohm would seem advisable. This value should be adjusted to conform to the circuit feeding the test sample.

Dielectric Constants

Numerous tests have been made to determine the dielectric constants of metal-coated paper as compared to the same paper uncoated.

The relative dielectric constants of the untreated paper as compared to the metallized paper are given in Table II. It will be noted that values are given for different numbers of paper sheets measured as a group. These dielectric constants have been measured at a frequency of one kilocycle with a two-inch diameter ground surface electrode under a pressure of approximately 10 pounds per square inch.

Accurate dielectric constant measurements on thin samples of a dielectric are normally very difficult to make. This is especially true of paper in view of its construction. For thin, continuous dielectric films, such measurements are made by use of sprayed metallic surfaces or by the use of Aquadag surfaces or silvered surfaces. These are not applicable to paper in view of its fibrous construction.

The difficulty in making such measurements may best be appreciated by an example: Assuming a one-mil dielectric film with an actual dielectric constant of five, the measurement of such a film with a 0.1-mil air space between the film and the metal electrode will give a measured dielectric constant of 2.5 instead of the actual value of five.

The dielectric constant values given in Table II show that the dielectric constant values for the metallized paper are very much greater than for the plain paper. These increases are probably in most part due to better electrode contact with the paper and also a decrease in the effective paper thickness. Since metal coatings follow the contour of the surfaces on which they are deposited, there is probably a larger plate area than would be true in the case of foil.

Order of Layers

The measured dielectric constant values of the metallized paper depend upon the arrangement of the coated side of the samples in the paper stack that is being measured. In one case the arrangement is as follows: electrode, zinc coating, paper, paper, zinc coating, zinc coating, paper, paper, zinc coating—and continuing in this manner depending upon the number of paper sheets to the other electrode. In the other case the arrangement is electrode, zinc coating, paper, zinc coating, paper, and so forth, to the other electrode.

In the first case, the metal coatings are adjacent to the electrodes, and the paper surfaces are adjoining. In the second case, the paper surface is in contact with a metal-coated surface, and the other electrode is adjacent to a paper surface.

It is probably true that higher electrode pressure would give increased dielectric constant measurements. However, what is desired is the relative dielectric constant when used in an impregnated paper capacitor. This may differ from the values given in Table II both because of the use of a liquid impregnant instead of the air and also because of different effectiveness of contact. However, the foregoing results indicate that metallized paper should give increasing capacitances per unit volume of the dielectric for the same effective gradients.

Table II shows measurements that were made at room temperature of approximately 25 C, a frequency of one kilocycle, and applied voltage of approximately 25 volts. The electrodes were two-in. diameter, ground surface, stainless steel under pressure of ten pounds per

Consecutive exposures to a rising voltage plotted against the number of arcs

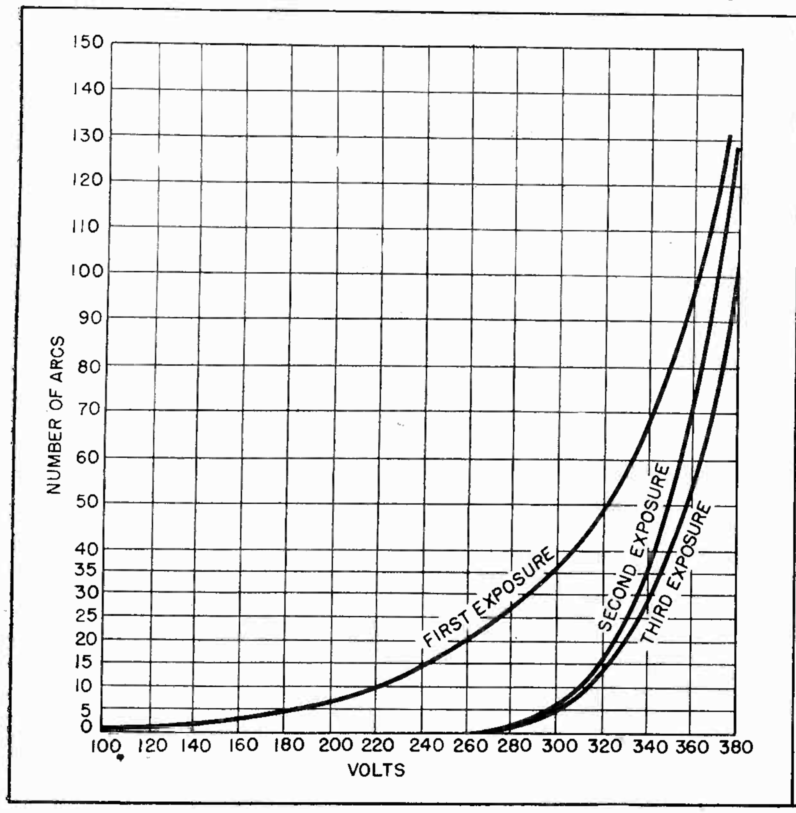

FIG. 3—The effect on a ten-ohm coating with a 50,000-ohm series resistance

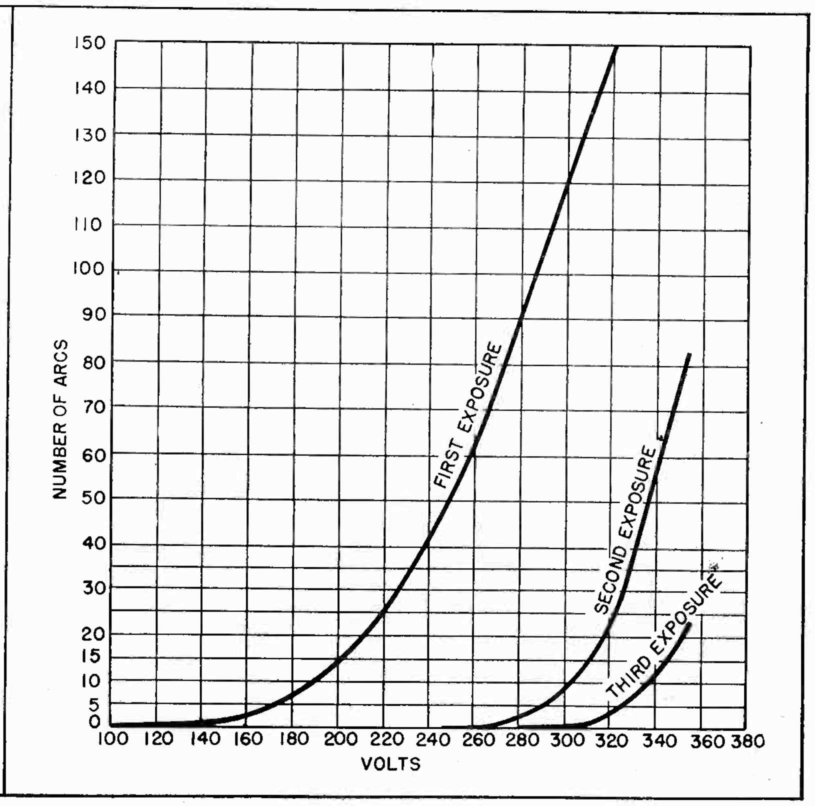

FIG. 4—Discharges through a 20-ohm coating and a 50,000-ohm series resistance

square inch. In the case of the untreated paper the size of the paper sample was approximately 2½ by 3 inches in rectangular form.

Dielectric constant measurements given in the table were calculated assuming a dielectric thickness of 0.4 mil for both the untreated paper and the metallized paper.

Table II

Dielectric Constant of Untreated Paper and Metallized Paper

Number of Paper Sheets	Paper Dielectric Constant	—Metallized Paper— Dielectric Constant (See Note 1)	Dielectric Constant (See Note 2)
20	2.55	....	....
15	2.42	....	....
12	2.33	4.40	3.36
10	2.26	4.23	3.27
9	2.20	....	....
8	2.11	3.92	3.06
7	2.05	....	....
6	1.93	3.66	2.84
5	1.82	....	....
4	1.70	3.14	2.44
3	1.51	....	....
2	1.37	2.43	1.92

(1) Arrangement of metallized paper electrode, zinc coating, paper, paper, zinc coating, zinc coating, paper, paper, zinc coating, and so forth, to the other electrode depending upon the number of sheets in the sample under test.

(2) Arrangement of metallized paper: electrode, zinc coating, paper, zinc coating, paper, and so forth, to the other electrode depending upon the number of sheets in the sample.

Preparation of Sample

In the case of the metallized paper samples, the sample was cut in a circular form approximately $2\frac{1}{16}$ inches in diameter. Tests made on larger size samples indicated that the capacitance measurements were a function of the size of the sample. This was probably due to the fact that the coating increases the electrode area to something larger than the metallic electrodes themselves. Thus it was considered desirable to reduce the size of the sample to approximately the same as the electrode diameters. They were made slightly larger than the electrodes themselves to eliminate possible difficulties due to slight fraying that is obtained at the cut paper edge.

The dielectric constant values given in Table II are averages from a number of measurements. The actual capacitances in any measurement depend upon humidity conditions prevailing at that time and also upon the effectiveness of contact made with the sample.

The resistance of the metal coating is much greater than the usual aluminum foil that is used for electrode material in the manufacture of impregnated paper capacitors. Accordingly, it is important to consider the effect of the increased resistance of the electrode material on the capacitor constants. The principal effect would be on the series resistance or power factor of the capacitor.

The increase in power factor of a paper capacitor using metallized paper may be given as follows:

Assume a capacitor unit as shown in Figure 5.

f is frequency in cycles per second.
R_m is resistance in ohms of metallic coating one-inch wide by 12 inches long.
L is length of capacitor section in feet.
W is active paper width in inches.
C is capacitance in μf of a capacitor having one inch active paper width, one mil thickness of dielectric and one foot long.
P is per-unit power factor (dissipation factor) of capacitor.
C_t is total capacitance in μf of a capacitor section for length L feet.
T is paper thickness in mils — total thickness of dielectric between electrodes.
ϵ' is dielectric constant of material (3.5).
ΔP is percent increase in power factor P of capacitor due to resistance of metallic coating.

Then $C = \dfrac{0.224\ \epsilon'\ (12)}{0.001} 10^{-6} = 0.0094$ microfarad (1)

In Fig. 5,

$$C_s = \frac{C_t}{2} = \frac{CLW}{2T} \text{ in microfarads} \quad (2)$$

$$X_s = \frac{10^6}{2\pi f C_s} = \frac{10^6 T}{\pi f CLW} \text{ in ohms} \quad (3)$$

$$R_s = P X_s = \frac{PT\,10^6}{\pi f CLW} \text{ in ohms} \quad (4)$$

$$R_t = R_m \frac{L}{2W} \text{ in ohms} \quad (5)$$

Then from Eq. 4 and 5

$$\Delta P = 100 \frac{R_t}{R_s} = \frac{50\, R_m L^2 \pi f C}{PT\,10^6} \quad (6)$$

Substituting L from Eq. 2 into Eq. 6 and C from Eq. 1 into Eq. 6 gives

$$\Delta P = \frac{0.017\, R_m f T}{P} \frac{(C_t)^2}{W} \quad (7)$$

For a capacitor to be used at a frequency of 60 cycles per second, an electrode width of two inches, a dielectric thickness of one mil, a metallic coating having a resistance

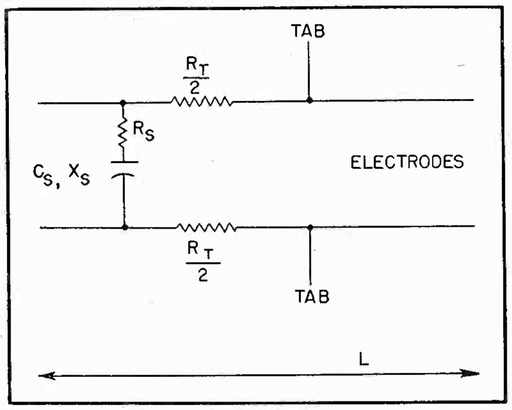

FIG. 5—Electrical factors of a metallized capacitor, for power factor calculation

of ten ohms for a strip one inch wide by 12 inches long and the dielectric power factor being 0.5 percent or 1005 per unit, a capacitor having a capacitance of 0.044 μf would have a ΔP of one percent. For a capacitor with this rating, the power factor as measured across its terminals would be 0.505 percent. The limit in capacitance C_t for any other given percentage increase in power factor ΔP can readily be obtained from Eq. 7, since the increase in power factor is proportional to the square of the capacitance.

Capacitors depending upon voltage rating and total capacitance may be built up from a number of individual units connected in series or parallel. For S series sections and N parallel sections the increase in power factor ΔP, due to the resistance of the metallic coating, is given by

$$\Delta P = \frac{0.017\, R_m f T}{P} \frac{(CS)^2}{(WN)} \quad (8)$$

in which C is the total capacitance in microfarads as measured across the external terminals.

For most applications it is believed that the additional series resistance due to the metallic coating as compared to aluminum foil would not significantly affect the constants of capacitors using metallized paper. In addition, the unit may be designed to minimize such effects.

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COMPARATOR for

High-frequency line impedance measurements in laboratory or field can be simplified by this compact comparison instrument that essentially replaces the slotted coaxial line and sliding-probe voltmeter technique for checking match or determining standing-wave ratio and reactive component

IN matching a load with several adjustable elements, such as an antenna array, to coaxial transmission lines the process may prove to be tedious using the conventional slotted line and probe indicator. At low frequencies such lines become long and inconvenient to construct.

The simple instrument illustrated in Fig. 1 is a comparator consisting of a coaxial T-junction with a current pickup loop symmetrically placed to couple magnetically to the center of the junction. The T-junction joins the generator, the load whose characteristics are to be obtained, and a line terminated with a resistance or reactance equal to its characteristic impedance.

Electrostatic shielding between the coaxial lines and the loop is provided by a number of slots cut in each of the three lines near the center of the junction. The loop may be rotated in the plane of the junction to assume the various positions shown in Fig. 2. The output of the loop is fed to an indicator such as a linear receiver. Assembled and exploded views of the completed comparator are shown in Fig. 3 and 4.

Standing-Wave Ratio

Referring to Fig. 5 the three lines have a common voltage $\bar{E}$ at the center of the T-junction. Hence the impedance of the load line at the junction L is

$$\bar{Z}_L = \bar{E}/\bar{I}_L \tag{1}$$

Since the opposite line is matched,

$$Z_c = \bar{E}/\bar{I}_c \tag{2}$$

and

$$\bar{I}_L = \bar{I}_c\,(Z_c/\bar{Z}_L) \tag{3}$$

The impedance at a voltage minimum is a pure resistance equal to the product of the standing-wave ratio P and the characteristic impedance Z_c of the line, where P is taken to be the ratio of the minimum voltage to the maximum voltage.

By means of the usual impedance transfer equation the impedance may be determined in terms of the resistance at a voltage minimum X located a distance of ρ electrical degrees on the load line.

$$\bar{Z}_L = \frac{P Z_c + j Z_c \tan \rho}{Z_c + j P Z_c \tan \rho} Z_c \tag{4}$$

Combining Eq. 3 and 4

$$\bar{I}_L = \bar{I}_c \left(\frac{1 + j P \tan \rho}{P + j \tan \rho} \right) \tag{5}$$

With the loop in position D (Fig. 2) parallel to the load and matched lines, a voltage will be induced in the loop producing a current $\bar{I}_D$ proportional to the vector difference of the load and matched line currents.

$$\bar{I}_D = T\,(\bar{I}_L - \bar{I}_c) = (T\bar{I}_c) \left(\frac{1 + j P \tan \rho}{P + j \tan \rho} - 1 \right) = (T\bar{I}_c)\, \frac{(1 - P)\,(1 - j \tan \rho)}{(P + j \tan \rho)} \tag{6}$$

where T is a proportionality constant depending upon the frequency, physical dimensions of the comparator components, and the input impedance of the receiver.

After rectification in the re-

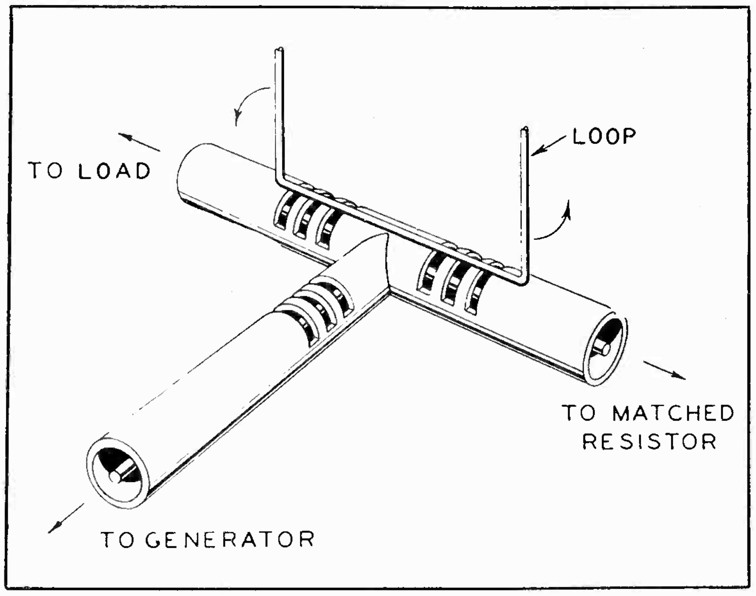

FIG. 1—Simplified drawing of T-junction, showing connections and the pickup loop that can be rotated to couple to them

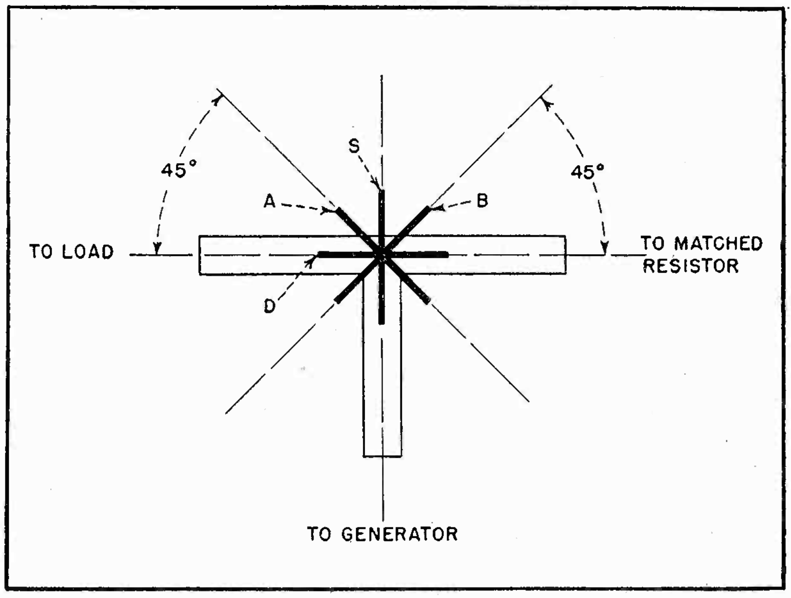

FIG. 2—Detail of the pickup loop positions with relation to the junction, and the notation used in designating position

Coaxial Line Adjustments

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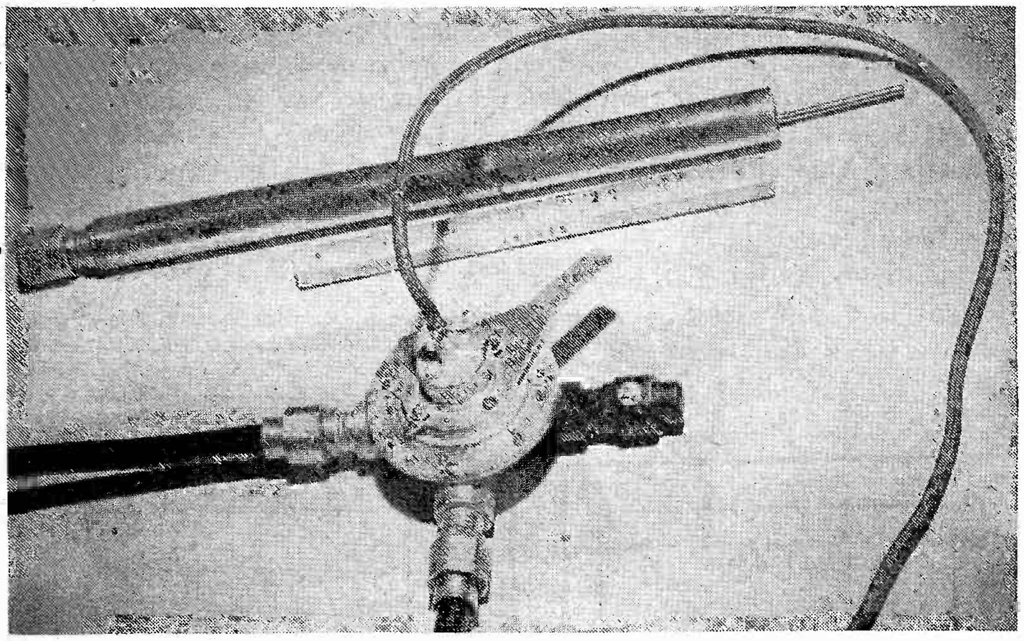


LEFT

FIG. 3—The shorted one-eighth wave coaxial line at the top replaces the matched resistor when determining the algebraic value of the load reactance

BELOW

FIG. 4—Exploded view. Slotted openings in the T-junction cover provide electro-static shielding between the junction (upper center) and the rotating loop at right

ceiver the output current I'_D will be proportional to the absolute magnitude of Eq. 6, or

$$I'_D = T'|I_c| \left(\frac{1 + \tan^2 \rho}{P^2 + \tan^2 \rho} \right)^{1/2} (1 - P) \quad (7)$$

where the proportionality constant T' also includes the receiver gain factor. Similarly, with the loop in position S parallel to the generator line a voltage will be induced in the loop producing a current $\bar{I}_S$ proportional to the vector sum of the load and matched line currents.

$$\bar{I}_S = T(\bar{I}_L + \bar{I}_C) = (T\bar{I}_c) \frac{(1 + P)(1 + j \tan \rho)}{(P + j \tan \rho)} \quad (8)$$

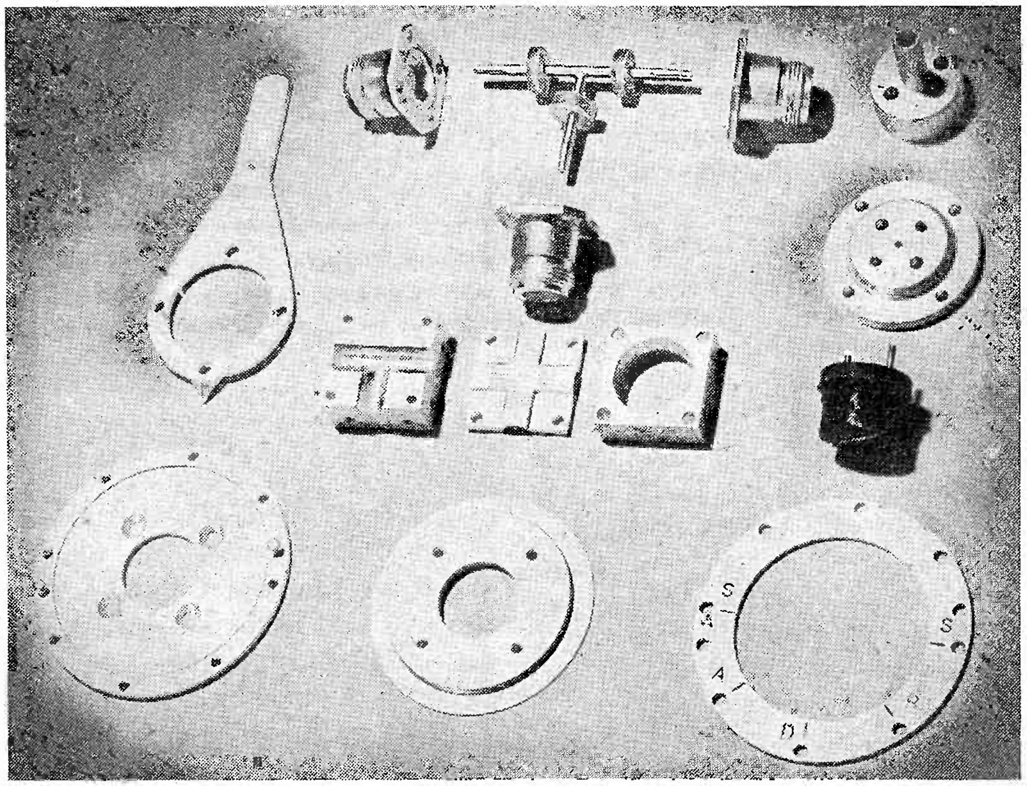
The receiver output current will then be

$$I'_S = T'|I_c| \left(\frac{1 + \tan^2 \rho}{P^2 + \tan^2 \rho} \right)^{1/2} (1 + P) \quad (9)$$

$$\frac{I'_D}{I'_s} = \frac{1 - P}{1 + P} = K \quad (10)$$

The ratio of the receiver output currents for the two coil positions is equal to the magnitude of the reflection coefficient K on the load line.

In practice, the loop is placed in position S and the receiver gain or generator power adjusted to produce full-scale reading on the receiver output meter. The loop is then rotated to position D and the reflection coefficient is directly indicated on the meter as the percentage of full-scale reading. Equation



10 shows that the reflection coefficient reading obtained is independent of the relative position of the standing wave with respect to the comparator. If the receiver is not linear, suitable correction of the meter calibration must be made.

This relationship also may be shown in another manner. The loop currents for the two positions D and S are

$$\bar{I}_D = T(\bar{I}_L - \bar{I}_c) = \frac{T\bar{E}}{Z_L}\left(1 - \frac{\bar{Z}_L}{Z_c}\right) \quad (11)$$

and

$$\bar{I}_S = T(\bar{I}_L + \bar{I}_c) = \frac{T\bar{E}}{Z_L}\left(1 + \frac{\bar{Z}_L}{Z_c}\right) \quad (12)$$

The well-known transmission line equation expressing the current at a point down the line in terms of the load characteristics and line constants is

$$I_p = \underbrace{\frac{I_L}{2}\left[1 - \frac{\bar{Z}_L}{Z_c}\right]\epsilon^{\gamma P}}_{\text{Reflected wave}} + \underbrace{\frac{I_L}{2}\left[1 + \frac{\bar{Z}_L}{Z_c}\right]\epsilon^{-P\gamma}}_{\text{main wave}} \quad (13)$$

Hence the ratio of the receiver output currents for the two loop positions D and S is seen to be the ratio

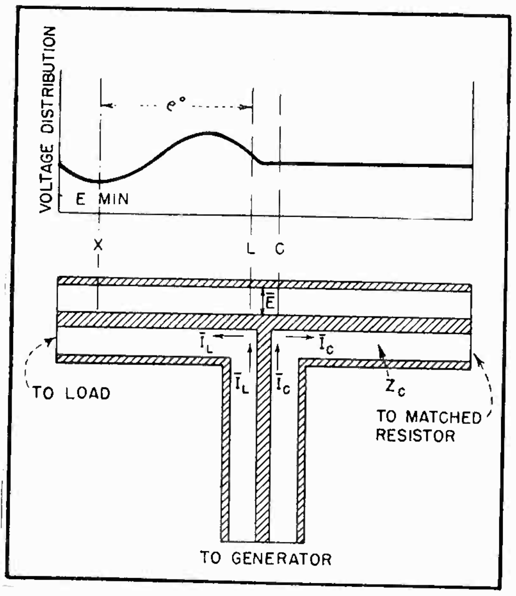


FIG. 5—Graphical representation of the standing wave formed on one arm of the T-junction when the load is not matched

of the reflected wave to the main wave, or the coefficient of reflection.

$$\frac{I'_D}{I'_S} = \left| \frac{\left(1 - \frac{Z_L}{Z_c}\right)}{\left(1 + \frac{Z_L}{Z_c}\right)} \right| \quad (14)$$

Assuming that a matched line may be provided, correct operation is independent of frequency up to the range where the loop couples to an appreciable fraction of a wavelength on the lines. In this region the loop current will not be a function of the currents flowing in the lines at the immediate T-junction only.

To obtain an experimental check on the accuracy of operation, a slotted measuring line was inserted between an adjustable load and the comparator. Standing-wave ratio readings obtained from the two instruments for various loads and frequencies are comparable as shown in Fig. 6 and 7.

Fixed Loop for Matching

For certain applications, such as final matching adjustments of antennas in the field, the comparator may be simplified by fixing the loop in position D. In use, the load matching elements are adjusted in rotation for a null on the receiver output meter. Referring to Eq. 7 it is seen that a null is obtained only when P is unity.

A comparator of this type covering the frequency range of 400 mc to 1,700 mc, in which the receiver is replaced by a fixed crystal and microammeter for simplicity, is shown in Fig. 8. The loop consists of an adjustable quarter-wave tuning stub to which is coupled the fixed crystal. The matched load is a selected resistor equal to the characteristic impedance of the lines used. The exploded view (Fig. 9) shows the construction of the electrostatic screen and other component parts. Although simpler in construction, this modification of the comparator does not indicate the degree of mismatch.

For a given standing wave on the load line the load current and hence the loop current will be

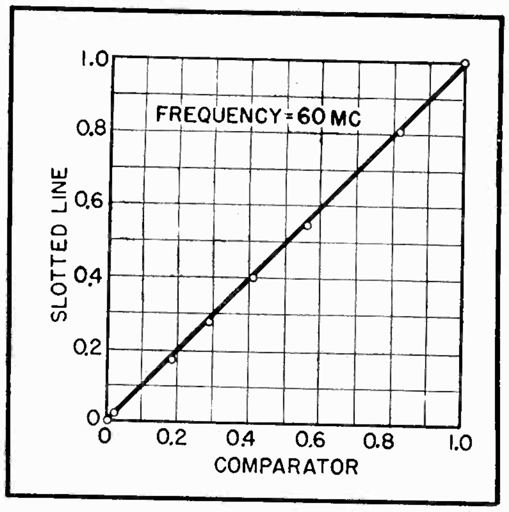


FIG. 6—Standing-wave ratios obtained with a slotted line inserted between adjustable load and comparator at 60 mc

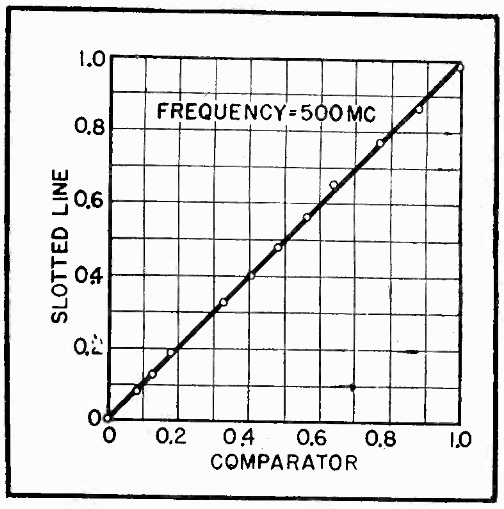


FIG. 7—Good agreement is found at 500 mc between slotted-line and comparator measurements of standing-wave ratios

a function of the relative position of the standing wave with respect to the T-junction. If the line between the load and the comparator is of such a length as to give a voltage minimum at the T-junction ($\rho = 0$) the loop current from Eq. 7 is seen to be proportional to (1-P)/P. For the same load a change in line length of one-quarter wavelength will result in a voltage maximum appearing at the T-junction ($\rho = 90$), and the loop current will be proportional to (1-P).

The ratio of the minimum loop current to the maximum loop current for a given load and a variable shift of the standing-wave along the load line is seen to be equal to the standing-wave ratio.

$$\frac{I_D \text{ min.}}{I_D \text{ max.}} = \frac{(1 - P)}{(1 - P)/P} = P \quad (15)$$

Thus, as a match is approached on the load line by adjustment of the matching elements, the possible meter deflection diminishes rapidly.

Using a square-law crystal detector the relative meter deflection as a function of the standing-wave ratio and its position on the load line is plotted in Fig. 10. The shaded area indicates the possible deflection change for any shift of the standing wave along the line. A constant T-junction voltage E is assumed for these calculations.

Absolute Magnitude of Load Impedance

Other load characteristics may be obtained from the comparator with the rotating loop. The absolute magnitude of the load impedance $|Z_L|$ at the T-junction is found by taking the ratio of the linear receiver output readings for two additional loop positions. From Fig. 2 it is seen that with the loop in position B the loop current is

$$\bar{I}_B = T\left(\frac{\bar{I}_c}{\sqrt{2}} + \frac{\bar{I}_c}{\sqrt{2}}\right) = \sqrt{2}\ T\bar{I}_c \quad (16)$$

since the loop is at an angle of 45 degrees and couples equally with both of the T lines. Components of the load current in the loop are equal and opposite in this case. Similarly, with the loop rotated 90 degrees to position A, the current is

$$\bar{I}_A = T\left(\frac{\bar{I}_L}{\sqrt{2}} + \frac{\bar{I}_L}{\sqrt{2}}\right) = \sqrt{2}\ T\bar{I}_L \quad (17)$$

Forming the ratio and combining with Eq. 3,

$$\frac{I'_B}{I'_A} = \frac{|Z_L|}{Z_c} \quad (18)$$

where $|Z_L|$ is expressed in terms of the characteristic impedance of the lines. In practice the receiver output meter is set to full scale at the loop position giving the larger reading. The loop is then rotated 90 degrees to the other position and the ratio of $|Z_L|/Z_c$, or $Z_c/|Z_L|$ as the case may be, is read directly on the meter as the percentage of full scale deflection.

Resistive Component of Load Impedance

Having obtained the reflection coefficient K and the absolute magnitude of the load impedance $|Z_L|$ from the four loop positions, the resistive component R_L of the load impedance may be found. From Eq. 4

$$\frac{\bar{Z}_L}{Z_c} = \frac{\mathrm{P} + \mathrm{j} \tan \rho}{1 + \mathrm{j}\, \mathrm{P} \tan \rho} = \frac{R_L + \mathrm{j}\, X_L}{Z_c} \qquad (19)$$

Equating the real terms and imaginary terms respectively

$$R_L - X_L \mathrm{P} \tan \rho = Z_c\, \mathrm{P} \qquad (20)$$

and

$$R_L\, \mathrm{P} \tan \rho + X_L = Z_c \tan \rho \qquad (21)$$

Eliminating $\tan \rho$ and solving for R_L/Z_c

$$\frac{R_L}{Z_c} = \left(\frac{\mathrm{P}}{\mathrm{P}^2 + 1}\right)\left[\left(\frac{|Z_L|}{Z_c}\right)^2 + 1\right] \qquad (22)$$

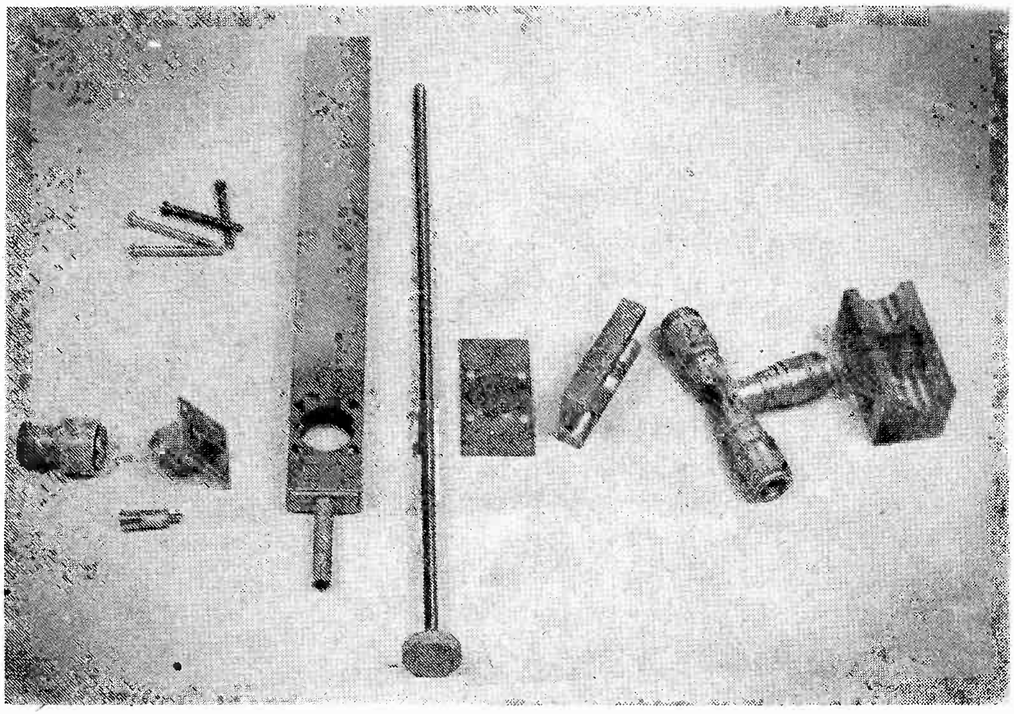


FIG. 9—Exploded view of the uhf comparator

since $\mathrm{P} = (1 - K) / (1 + K)$

$$\frac{R_L}{Z_c} = \frac{(1 - K^2)}{2\,(1 + K^2)}\left[\left(\frac{|Z_L|}{Z_c}\right)^2 + 1\right] \qquad (23)$$

Although the arithmetic value of the reactive component X_L may be derived knowing R_L and $|Z_L|$, the algebraic sign of X_L is not found since the same loop reading of ρ and $|Z_L|$ will be obtained whether the reactive component is positive or negative. Also for some values of the load impedance having a small phase angle, low accuracy is obtained in determining the arithmetic value of X_L.

To obtain the algebraic value of the reactance, the matched resistor (Fig. 5) is replaced with a shorted coaxial line one-eighth wavelength long having the same characteristic impedance Z_c as the T-junction lines. Since the reactance of the eighth-wave shorted stub is $+ \mathrm{j}Z_c$,

$$\bar{I}_c = \bar{E} / + \mathrm{j}\, Z_c \qquad (24)$$

Hence $\bar{I}_c = \bar{I}_L \left(\frac{X_L}{Z_c} - \mathrm{j}\frac{R_L}{Z_c}\right) \qquad (25)$

With the loop in position D,

$$\bar{I}_D = T\,(\bar{I}_L - \bar{I}_c) = T\bar{I}_L\left(1 - \frac{X_L}{Z_c} + \mathrm{j}\frac{R_L}{Z_c}\right) \qquad (26)$$

Likewise, with the loop in position S,

$$\bar{I}_S = T\,(\bar{I}_L + \bar{I}_c) = T\,I_L\left(1 + \frac{X_L}{Z_c} - \mathrm{j}\frac{R_L}{Z_c}\right) \qquad (27)$$

Designating the ratio of the receiver output currents in this case by K'

$$K' = \frac{I'_D}{I'_S} = \left[\left(1 - \frac{2X_L}{Z_c} + \frac{|Z_L|^2}{Z_c^2}\right) \Big/ \left(1 + \frac{2X_L}{Z_c} + \frac{|Z_L|^2}{Z_c^2}\right)\right]^{1/2} \qquad (28)$$

Solving for X_L/Z_c,

$$\frac{X_L}{Z_c} = \frac{(1 - K'^2)}{2\,(1 + K'^2)}\left[\left(\frac{|Z_L|}{Z_c}\right)^2 + 1\right] \qquad (29)$$

The ratio of the receiver cur-

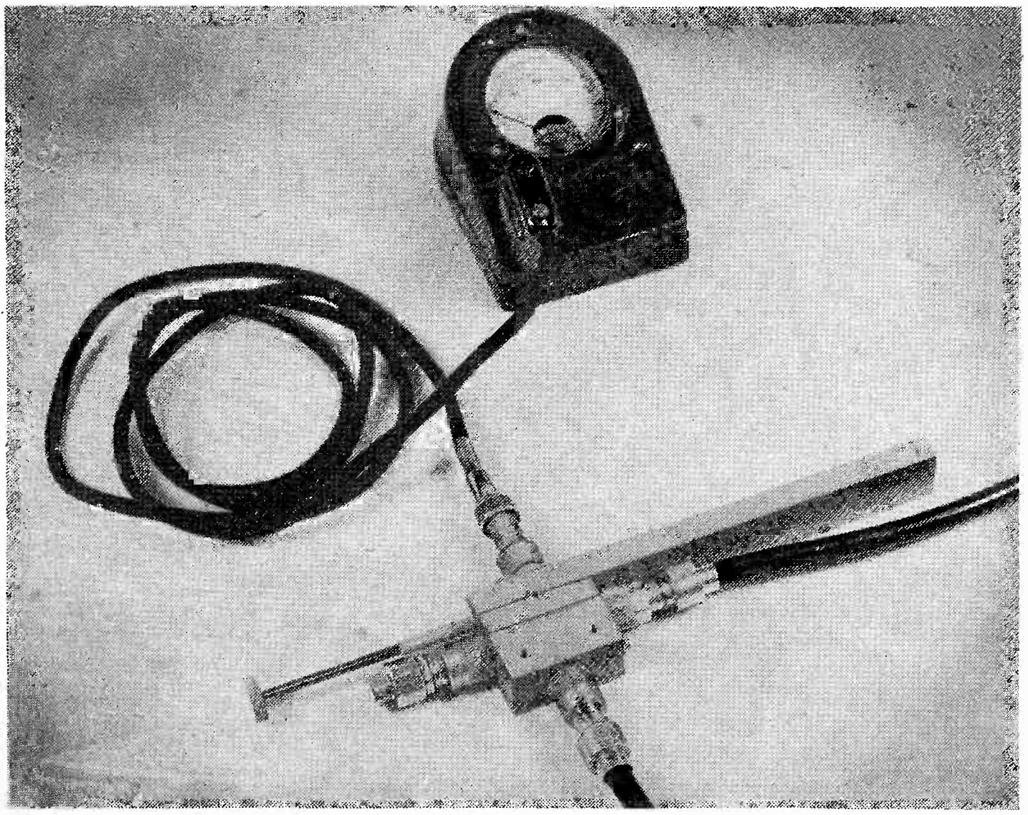


FIG. 8—A comparator designed for use in the frequency range 400 to 1,700 mc, using a self-contained fixed crystal detector and microammeter

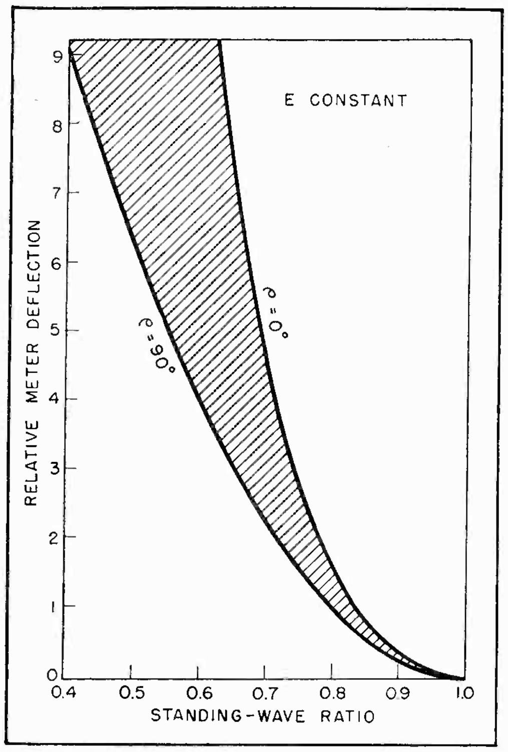


FIG. 10—Relative meter deflection shown as a function of standing-wave ratio and its position on the load arm of the T-junction

rents for the loop positions B and A will be the same whether the stub or the matched resistor is used. It is seen that the equations for the resistive component and the reactive component are identical in form. The adjustable stub may be calibrated in terms of frequency for convenience in use.

Since the reactance of a shorted line θ electrical degrees in length is given by

$$X = + j\, Z_c \tan \theta \qquad (30)$$

it is seen that the stub may be somewhat shorter than an eighth-wave in length if its characteristic impedance is raised, the only requirement being that its reactance be equal to the characteristic impedance of the load line.

For a particular frequency of operation the stub length to give the required reactance may be found quite easily without the use of the slotted measuring line equipment. The load line is replaced by the stub, and the matched resistor connected to the opposite side of the comparator. Since it was shown in Eq. 18 that the absolute magnitude of the load impedance in terms of the characteristic impedance was equal to the ratio of the loop currents for loop positions B and A, the stub is simply adjusted until this ratio is unity.

A chart is given in Fig. 11 from which the resistive and reactive components of the load impedance may be obtained from the various loop positions of the comparator.

Example

As an example of its use, an unknown load and the matched resistor are connected as shown in Fig. 2. The loop is rotated in the four positions to give the current ratios of D/S and A/B (or B/A). For a D/S ratio of 0.46 and a A/B ratio of 0.65 the resistive component of the load impedance in terms of the characteristic impedance is found to be 1.10. The matched resistor is then replaced by the eighth-wave stub and the current ratio D/S (or S/D) determined. Using the same A/B value of 0.65 previously found, it is seen that the reactive component of the load impedance in terms of the characteristic impedance is equal to -0.75 for a S/D ratio of 0.62. For a characteristic impedance equal to 52 ohms the load impedance is then equal to

$$(1.10 - j\,0.75)(52) = 57.2 \text{ ohms} - j\,39 \text{ ohms} \qquad (31)$$

An adjustable impedance was measured with the comparator and the slotted line apparatus at a frequency of 200 mc to provide an experimental check of the accuracy of the comparator. The results are tabulated below.

Comparator	Slotted Line
18.3 + j 6.5	18.2 + j 6.5
44.7 − j 70.4	44.8 − j 67.2
36.2 − j 20.3	38.4 − j 19.3
58.3 − j 100.0	56.8 − j 101.0

Acknowledgment

The author wishes to acknowledge the useful suggestions and valuable contribution by Dr. G. H. Brown in the development of the comparator.

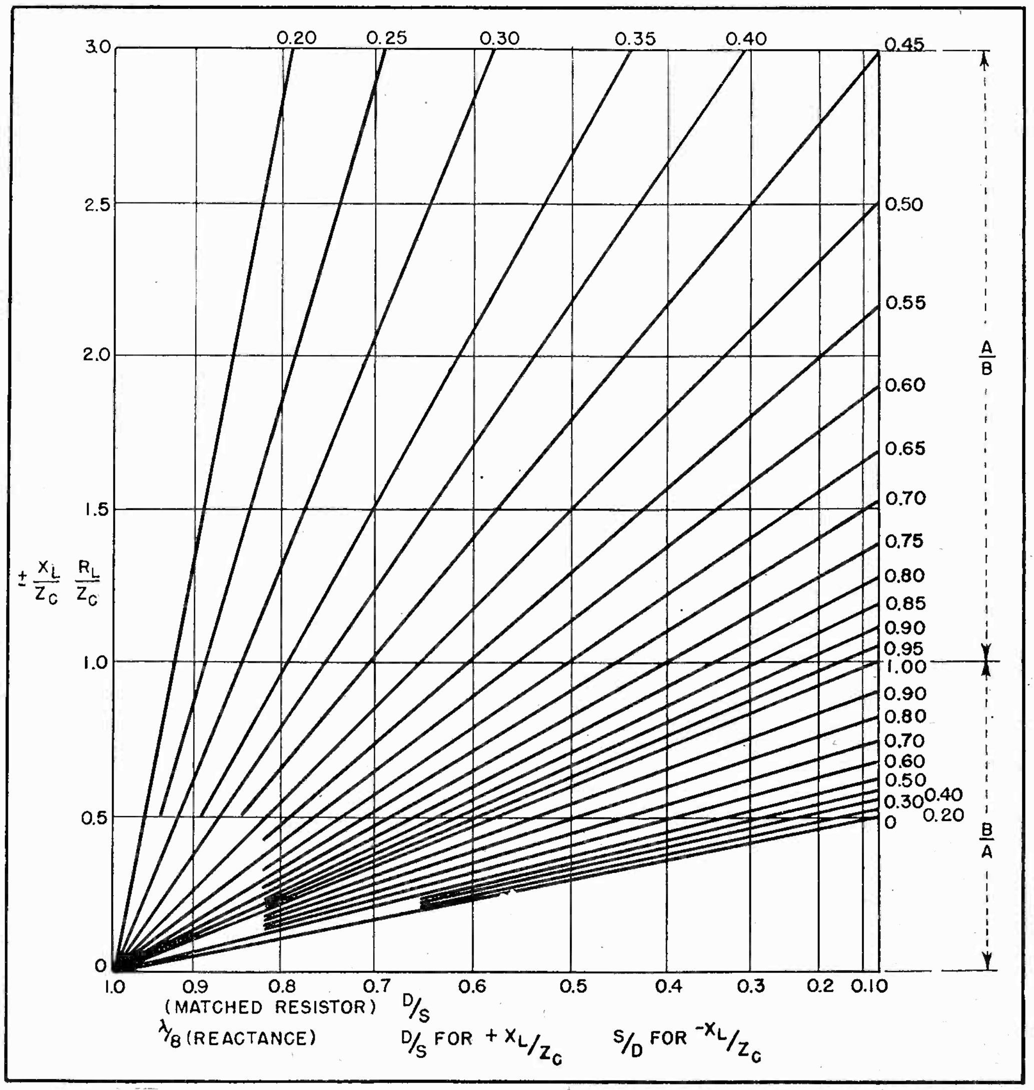
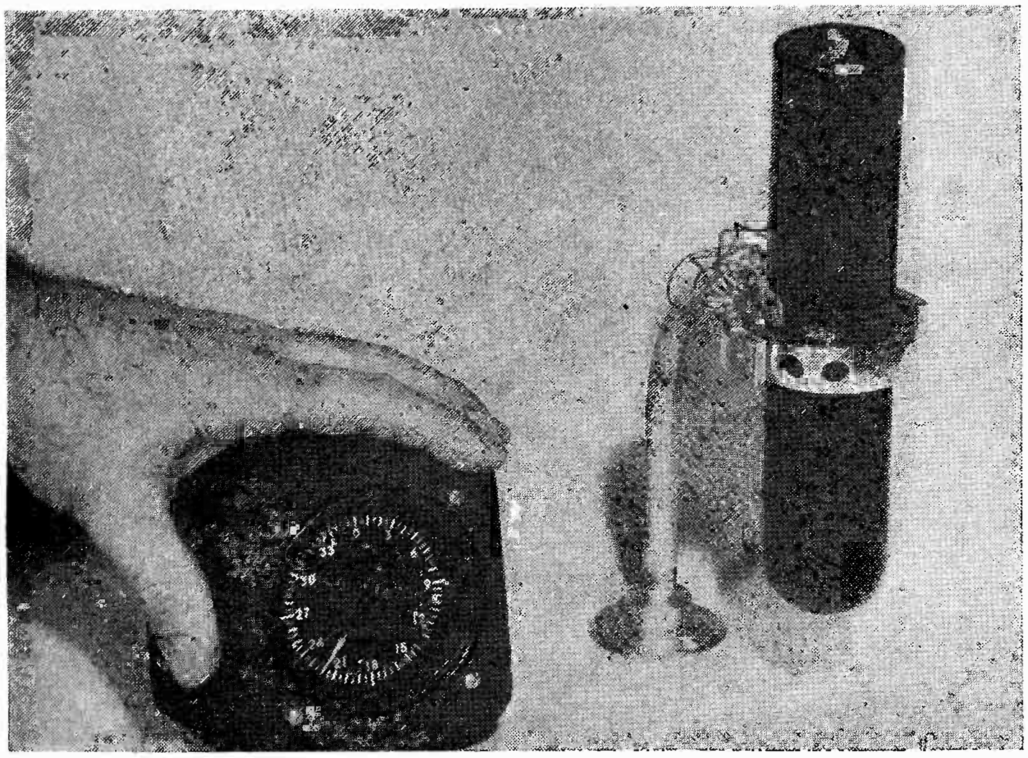


FIG. 11—Chart showing resistive and reactive components of the load impedance as obtained from various loop positions and detector voltage readings

Cathode-Ray Compass

Deflection by the earth's magnetic field of an electron beam impinging upon four targets produces varying target currents. These currents are amplified, resolved, and fed through a servomechanism to the autopilot gyroscope



The Cathotrol tube at the right is swung in gimbals and connected to the direct-reading indicator at left

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If a directional gyroscope is to be used as a permanent reference for an autopilot and its excellent stabilizing characteristics utilized to the fullest extent, a means must be provided to eliminate errors caused by rotation of the earth, latitude effects, and precession introduced by friction in the tilt axis. Of the many possible types of compass that may be used in connection with an autopilot, an electron beam directed against a multiple target and deflected by the earth's magnetic field seems most feasible because it has negligible inertia and high sensitivity. A compass employing such a beam is also easy to manufacture and adjust.

The cathode-ray compass or Cathotrol employs a modified form of cathode-ray tube as its chief element. Four targets are used. During the development of this tube it has been continuously reduced in size and there are no indications that the practical minimum has yet been reached. A cross section of the electron gun is shown in Fig. 1. The cathode-ray beam intensity is modulated at 400 cycles by means of the grid. Anode 1 is used as the accelerator and anodes 2, 3, and 4 are used as focusing electrodes. In this application it is necessary for the beam to strike the exact center of the targets when no magnetic field is applied. Since it is impossible to attain exact alignment of the components during assembly, small centering electrodes are placed ahead of the electron gun for final electrostatic adjustments.

The electron gun is located at one end of the tube and the cathode rays strike four target plates located at the opposite end as shown in Fig. 2. These targets consist of four 90 degree sectors. With no magnetic deflection the cathode ray strikes the center of these targets and equal amounts of current pass through all target sectors.

The tube is mounted in gimbals, suspended so that the electron beam is perpendicular to the surface of the earth and therefore at right angles to the horizontal component of the earth's magnetic field.

Theory of Operation

The vertical component of the earth's field has no effect on the cathode ray in normal operation since the beam is directed towards the center of the earth. The horizontal component of the earth's field always deflects the beam toward the west if the beam is directed downward. The amount of this deflection varies with latitude, but the only consequence is a

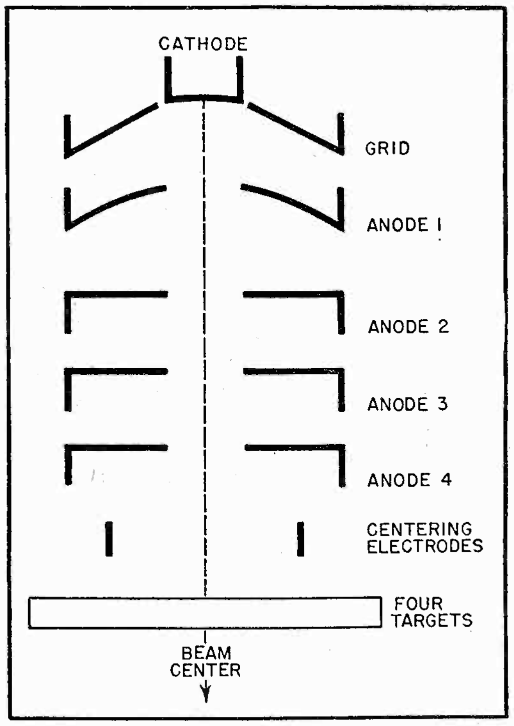


FIG. 1—Cross section of the electron gun, showing position of the elements

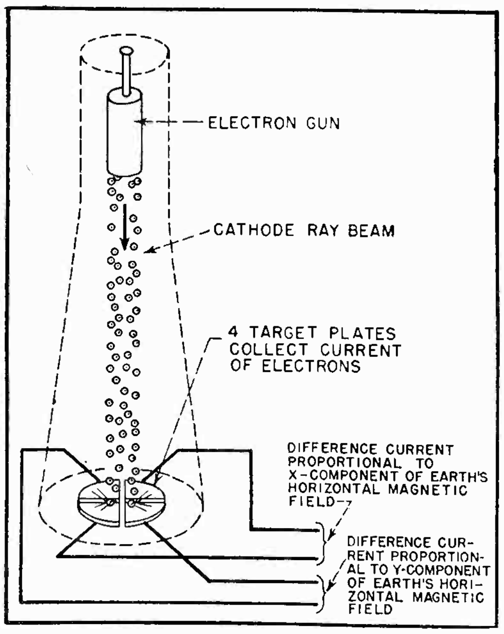


FIG. 2—Simplified diagram of the tube, showing relative position of the electron gun and the target plates

change in sensitivity. As the tube turns, the beam remains stationary, but the targets turn, thus changing the currents collected by the individual sectors. The relation of the beam to the target plates indicates the amount of rotation of the tube.

Opposing target plates are connected as shown in Fig. 3 through the primary of a transformer, the center tap of which is the B+ return of the tube. The output of each transformer is the difference between the 400-cycle currents to opposing targets and is proportional to the components of the magnetic field at right angles to a line through the center of these targets.

The tube is so oriented in the airplane that a line through the centers of two opposing targets is parallel to the longitudinal axis of the plane and a line through the other plates would be parallel to the lateral axis. The output of the two transformers is then proportional to the two components H_x and H_y of the earth's horizontal field, and it is possible to obtain the plane's magnetic heading. In order to convert this information into the plane's heading, square potentiometer resolvers are used. The only restrictions in their design are that the turns of wire must be parallel, the wipers must wipe in a complete circle, and their electrical and geometric centers must coincide.

The voltage applied across the X potentiometer by its transformer is proportional to the X component of the earth's field or $V_x = 2KH \cos \theta$, when K is a constant depending on deflection sensitivity, focal spot and transformer characteristics; H is the horizontal component of the earth's field; and θ is the angle between earth's field and plane heading. Similarly, the voltage across the Y potentiometer is $V_y = 2KH \sin \theta$. The potentiometer wipers are 90 degrees apart. Hence, the voltage between one wiper and the center of its potentiometer varies as the sine of ϕ and the voltage between the other wiper and the center of its potentiometer varies as the cosine of ϕ, where ϕ is the angle of rotation of the wiper from the zero position.

The output of the two wipers is

$$V = V_x \sin \phi - V_y \cos \phi$$

Replacing V_x and V_y by their equivalents

$$V = 2KH \cos \theta \sin \phi - 2KH \sin \theta \cos \phi$$

When

$$\theta = \phi,\ V = 0$$

Since the two wipers are connected mechanically and rotate together it is possible to find a position where the output V is zero. When this condition is achieved the

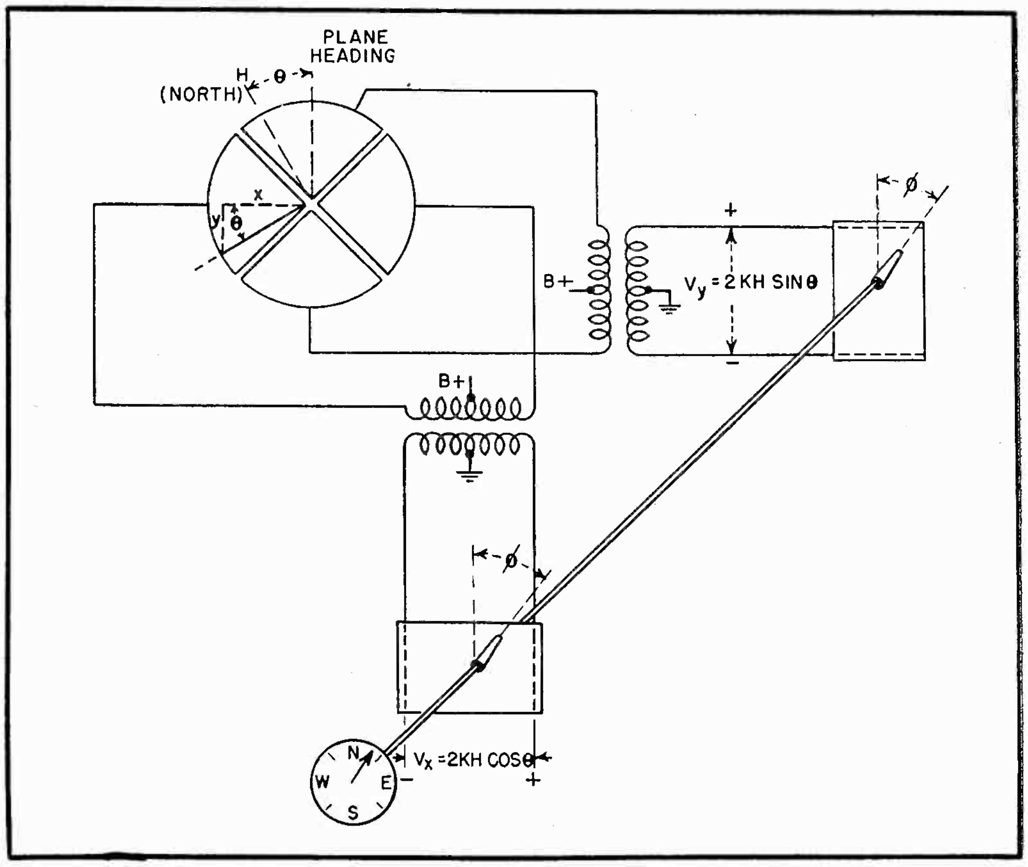


FIG. 3—Resolving portion of the system showing targets, transformers, and resolvers connected by a common shaft to the indicator

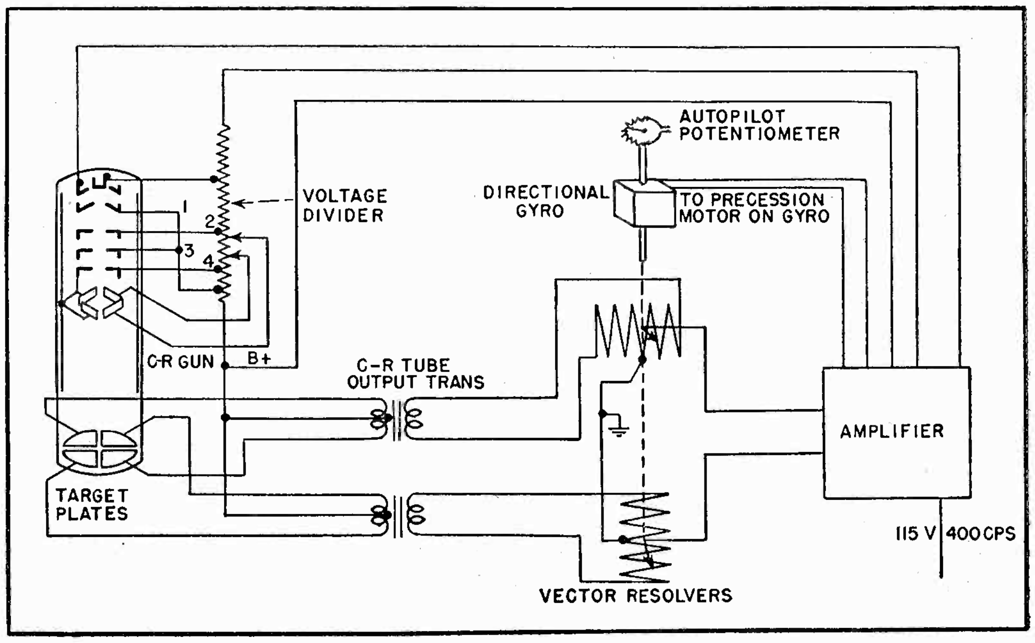
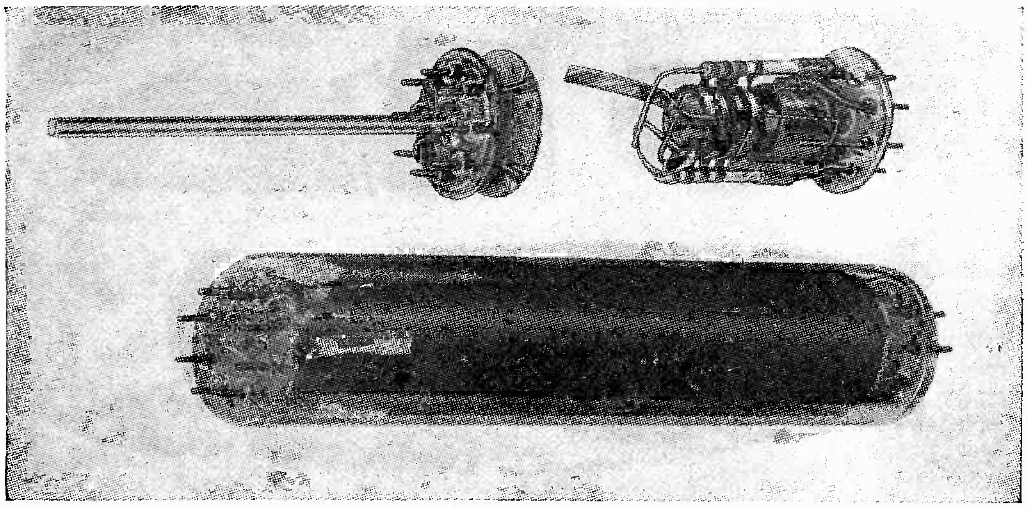


FIG. 4—Complete navigational system for accurate directional flight, showing the interconnection between gyro and compass resolver; precession motor and autopilot potentiometer

angle ϕ of the potentiometer is equal to θ and is therefore the angle between the magnetic field and the plane's heading. When ϕ and θ are not equal a voltage is applied, the sign of which depends upon whether θ is greater or less than ϕ. This output then is fed into an amplifier and a discriminator and into a servomotor that precesses the directional gyroscope until the two angles are again equal. This connection is shown in Fig. 4.

The two potentiometer wipers are mounted on the vertical axis of the directional gyroscope. The potentiometers themselves are secured to the case. As long as the directional gyroscope and the compass are aligned no signal is fed into the precession motor. As the plane turns the potentiometers move to a new position relative to the wipers. As they are being moved, however, there is a difference, voltage being supplied to the two potentiometers which exactly compensates for this movement and the output is still zero.



The tube out of its protective case, with target element (left) and electron gun (right) shown in detail above. The tube is one inch in diameter and seven inches long

Connection to Autopilot

Fastened to the gyroscope case, but with means provided for circular movement, is a center-tapped autopilot potentiometer with its wiper fastened to the vertical axis of the gyroscope. When the wiper is off center the output voltage is fed into a discriminator amplifier and then into the autopilot. The servos then turn the airplane until the autopilot potentiometer is on center again.

It is possible to turn the autopilot potentiometer mechanically to a new heading. The autopilot potentiometer wiper will pick up a signal and turn the airplane to the new heading. The compass and the directional gyroscope still maintain their original relationship and there will be no precession signal from the cathode-ray compass. When the gyroscope precesses to an erroneous position a voltage appears on the autopilot potentiometer wiper which turns the plane to an erroneous heading. However, there now appears across the compass potentiometers a change in voltage that is proportional to the magnitude of the off-course angle. The gyroscope is then precessed by the compass until the compass potentiometers' output is zero. A voltage of opposite polarity appears on the autopilot potentiometer wiper and the plane is returned to its original heading.

Accuracy

This compass, like many others that depend upon the horizontal component of the earth's magnetic field, is mounted pendulously in gimbals in order that the electron beam be perpendicular to this field. Because of this mounting it occasionally is subjected to oscillations that introduce small errors caused by the vertical component of the earth's field. If the output of the amplifier is fed into relays the error resulting from oscillations will occur first in one direction and then in the other depending entirely on time, and the integrated result will be zero. If the output of the amplifier is fed directly into the precession motor a modulated precession is achieved. Since the errors are linear up to plus or minus 2 or 3 degrees the throttling range is restricted to these limits. High angular momentum and low precession rate of the gyroscope and short period of oscillation of the compass tube result in a zero integrated error.

Although voltage changes are encountered in aircraft the compass must not be affected by them. With voltage changes of 25 percent the changes in angle have been consistently less than ½ degree. It is also reasonably independent of changes in field intensity. The output is linear with magnetic field intensities from zero up to values well above the maximum terrestrial field, so that the compass can easily measure angles to the desired accuracy.

Since compasses are not read to better than ± 1 degree it did not seem advisable to design one better than this. Therefore the present model was designed so that the errors are well within ± 1 degree around the 360 degree circle. The sensitivity is better than 0.25 degree (off-course signal necessary to produce a correction) and the consistency of holding a course then is much better than 1 degree. There is no northerly turning error of the type found in needle compasses.

Other useful applications are foreseen for the device. The compass tube can be driven in both axes to align itself with the earth's field. This effect might be helpful in determining dip and latitude. By using rebalance coils it can measure intensity and has already been used to detect fields as small as one-half milligauss.

The cathode-ray compass and the slave directional gyroscope system has been flown many thousands of miles and has satisfactorily demonstrated its ability to detect small changes in heading.

Acknowledgment

Many people have contributed to this development, and special acknowledgment is made to Dr. Waldo Kliever, Director of Research, Richard R. Syrdal, Senior Design Engineer, and Merle Ludwig, Design Engineer, all of Minneapolis-Honeywell Regulator Company, and Dr. Henry Hartig of the University of Minnesota.

TELEMETERING From V-2 Rockets

Output of 1,000-mc receiver in ground station of time-modulated pulse telemetering system contains trains of pulses spaced according to instrument readings in rocket. Circuits for decoding these pulses into individual voltages for recording are given here

Part II

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The first installment of this two-part paper covered the basic problem of telemetering instrumentation from a rocket during flights well up into the ionosphere. General details were given for the time-modulated pulse system developed by the Rocket Sonde Research Section of the Naval Research Laboratory to meet the limited allowance for size and weight of the rocket-borne equipment yet provide reliable telemetering over ranges in excess of 100 miles. Finally, the circuit of the airborne unit was presented and analyzed in detail. Ground station circuits will now be taken up.

The pulses transmitted from the airborne unit are received by the ground station antenna, amplified by the receiver, and passed on to the decoder units for separating the channels and presenting the channel information for analysis. The signal as received may contain signals other than those transmitted by the airborne unit, such as spurious noise peaks and radar interference. Therefore, the signal, upon entering the decoder, first passes into a pulse discriminator which limits receiver noise and distinguishes the proper pulses on the basis of their duration. Pulses of a duration greater or less than 0.8 microsecond are automatically eliminated at this point.

The circuit diagram of the pulse width discriminator in the ground station decoder is given in Fig. 5, and pulse waveforms at various points in this circuit are shown in Fig. 6. The signal from the receiver, at point *A*, contains pulses of the proper duration as represented by pulse 2 in Fig. 6, pulses of insufficient duration as represented by pulse 1, pulses of excessive duration as represented by pulse 3, and receiver noise. During operation, potentiometer R_1 in Fig. 5 is adjusted so that the bias on the grid of V_1 is low enough to limit the average receiver noise and yet allow pulses to cause V_1 to conduct.

The inverted signal on the anode (at *B*) is coupled to the grids of two normally conducting triodes, V_{2A} and V_{2B}. When V_{2A} conducts, its anode is at a negative potential with respect to ground, keeping V_3 cut off. A negative pulse at point *B* renders V_{2A} nonconducting for the pulse duration, but the rate of potential rise of its anode is limited by the charging rate of the shunt capacitance C_A through R_2 and R_3, as illustrated at *C* in Fig. 6. Only pulses with the proper duration or greater allow point *C* to rise high enough to cause V_3 to conduct. The negative pulse developed on the anode of V_3 is coupled to the coincidence tube V_4 through a short time constant circuit. Only the positive surge generated at a point *E* can have any effect on V_4 because point *E* is normally at cutoff potential. The effect on V_4 also depends on the coincidence signal at point *G*.

A negative pulse at point *B* renders V_{2B} nonconducting as it did V_{2A}, and the rate of potential rise at point *F* is also limited. Because the anode of V_{2B} is normally at a lower potential than that of V_{2A} by virtue of the difference in cathode potentials, it takes a pulse of greater duration to allow V_{5A} to conduct than it does to allow V_3 to conduct. The limits have been designed so that only pulses of excessive duration cause V_{5A} to conduct and cause a negative pulse at point *G*. Thus for input pulses of excessive duration, the positive surge on point *E* at time t_6 has no effect on the anode of V_4, because of the coincident negative surge at point *G*.

Input pulses of the proper duration produce a positive surge at point *E* without the blocking negative surge at point *G*, but the resulting signal at point *H* is not in as stable a form as desired. Tubes V_{5B} and V_6 are added to convert the positive surge at point *E* to a stable, uniform pulse to be passed to subsequent decoder circuits.

When a pulse of proper duration is received, the positive surge at point *E* causes a negative surge to appear at point *H* which is coupled to the grid of the normally conducting tube V_6 and cuts it off. A positive surge appears at point *K*, and the common cathode bias developed by current through R_6 drops

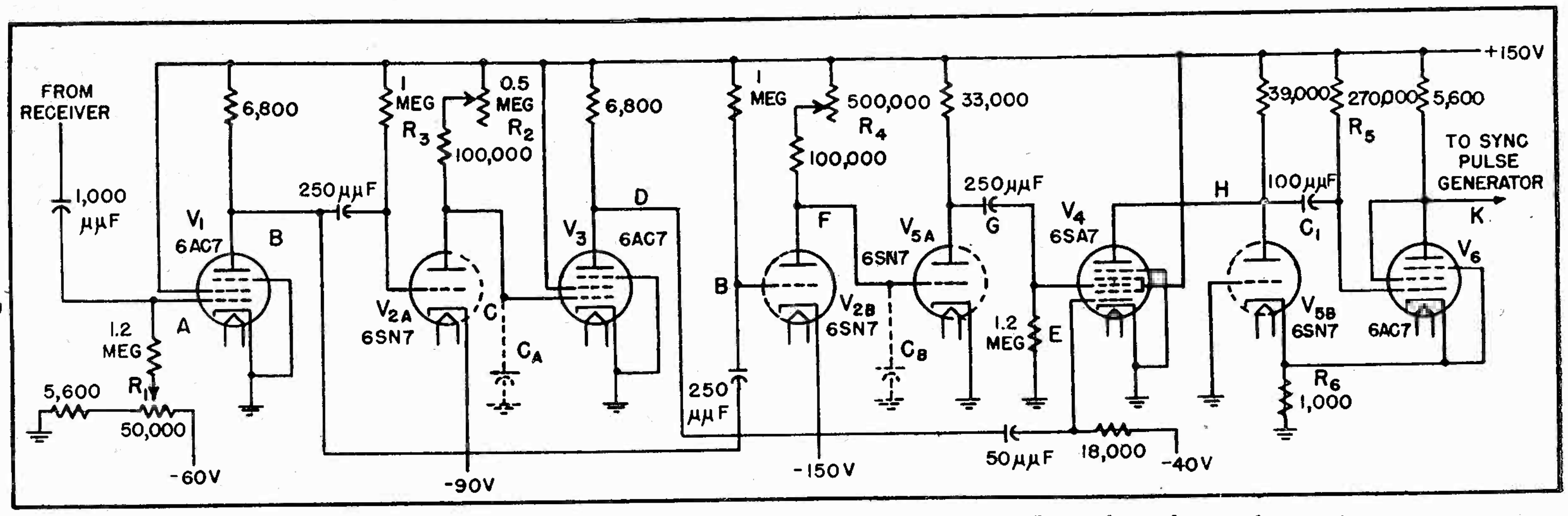

FIG. 5—Circuit of pulse width discriminator used in ground station of V-2 rocket telemetering system

until V_{5B} conducts, causing an additional negative surge at H to hold the grid of V_6 below cutoff.

Tube V_{5B} continues to conduct after V_4 ceases conduction, and point H is held down. The potential on the grid of V_6 immediately begins to rise according to the exponential charging rate of C_1 with current flowing through R_5. When the potential at this point reaches the control region of the grid, V_6 conducts, common cathode bias is produced, V_{5B} is cut off, and a positive surge appears at point H, driving V_6 to full conduction and causing a negative surge to appear at point K. The values of C_1 and R_5 have been designed so that the duration of the positive pulse at K is from 7 to 10 microseconds.

The range of discrimination can be controlled from the pulse discriminator panel by adjusting R_2 and R_4. The values of these resistances control the charging rate of C_A and C_B and therefore control the pulse durations required to cause V_3 and V_{5A} to conduct as at C and F in Fig. 6. Control R_2 sets the minimum limit of the duration of the acceptance band, which can be from 0.75 to 10 microseconds. Maximum control R_4 can be set to pass from 0.8 to 12-microsecond pulses.

Shunt capacitances C_A and C_B are created by leads and tube elements.

The Decoder

The circuit diagram in Fig. 7 shows the remaining stages of the decoder in the ground station, along with two of the metering channels, and Fig. 8 gives waveforms at various points in the circuit. The video signal from the pulse width discriminator to the decoder is very similar to the form of the signal as it left the pulse-time modulator in the airborne unit, and the sequence of operations in the decoder is very closely the reverse of what occurs in the pulse-time modulator.

The first decoder operation is that of generating a synchronizing pulse marking the beginning of each sampling group. This marker provides a means of directing each channel to its proper output. The relatively long period between pulse groups offers the means of generating the synchronizing pulse.

During the period in the sequence just before a pulse group is received, tube V_2 is nonconducting but its anode is held to ground potential because of current flowing to the grid of tube V_{3A}. At time t_1 (Fig. 8), the first pulse in the ensuing pulse group causes V_2 to conduct fully during the pulse;

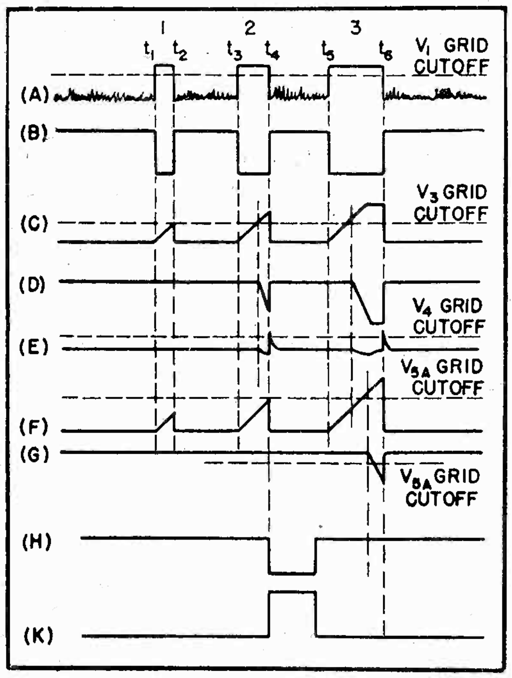

FIG. 6—Waveforms at various points in pulse width discriminator circuit of Fig. 5

because of the high resistance of R_1, the anode potential drops very close to the cathode potential, discharging C_1 in the process. The grid of V_{3A}, now far below its cutoff potential, begins to rise slowly as C_1 becomes charged with current through R_1. However, the time necessary to charge C_1 through R_1 is long enough to assure that the grid of tube V_{3A} does not reach the conducting region before pulse 2 occurs, at which time tube V_2 again discharges C_1.

This sequence is repeated until the last pulse in the group is reached, tube V_{3A} remaining nonconducting all the while. The interval from the last pulse of one group to the first pulse of the next is long enough to allow the potential at point C to rise until tube V_{3A} conducts. Conduction begins at time t_x in Fig. 8.

The values of C_1 and R_1 are chosen to make the start of conduction occur approximately 400 microseconds after the last pulse of a group arrives. Conduction then continues until the first pulse of the next group arrives and the cycle is repeated. Signals D and E are therefore generated on the anodes of V_{3A} and V_{3B}. Signal D occurs at very nearly the same position in the cycle as signal A in Fig. 4 of Part I. Signal D serves the purpose in the decoder that signal A does in the airborne pulse-time modulator.

Channel Separator Circuits

Signal D of Fig. 8 is at the input of the channel 1 separator, which is designed to generate positive pulse H, beginning at time t_1 and ending at time t_2 for every pulse group. The positive surge of signal D occurring at t_1 initiates this action, but the only signal from which t_2 can be obtained is signal A, which must first be inverted by tube V_1 before being coupled to the separator.

Channel 1 separator is a blocked multivibrator consisting of V_{4A}, V_{5A}, and V_{5B}. Tube V_{5B} normally conducts fully, causing a positive cathode bias on V_{5A}. The grid of V_{5A} is returned to ground through R_2, keeping V_{5A} cut off. The negative pulses at point B do not affect the conduction of V_{5A} because of the positive cathode bias.

Signal D is coupled to V_{4A} through a small time constant circuit, and appears at point F in the form shown at F in Fig. 8. The positive surge causes V_{4A} to conduct, producing a negative surge at point G and at the grid of V_{5B}. This tube is cut off, causing a positive surge at H and removing the positive bias on the cathode of V_{5A}. Simultaneously a negative pulse occurs at B which would prevent the complete triggering of the multivibrator were it not for the fact that the positive pulse at point F is of greater duration than the negative pulse at B. At the termination of the negative pulse at B, the cathode bias has not yet been restored; therefore, V_{5A} becomes conducting as V_{4A} becomes nonconducting. The low potential at the anode of V_{5A} and the grid of V_{5B} is therefore retained, keeping tube V_{5B} cut off.

The multivibrator remains in this temporary condition until negative pulse 2 occurs at point B at time t_2. Current in tube V_{5A} is then cut off; a positive surge occurs at point G, causing the grid of V_{5B} to rise; V_{5B} conducts, and a negative surge occurs at point H. The cathode bias returns and V_{5A} stays cut off, further negative pulses at B having no more effect until the cycle is repeated. This process generates the signals at G and H on the anodes of V_{5A} and V_{5B}. Since the time $t_2 - t_1$ is the measurement interval of channel 1, the signal at H contains channel 1 data entirely separated from the data of other channels.

Channel 2 separator functions exactly like channel 1 separator, with signal G initiating the action at time t_2 in the same manner that signal D initiated action in channel 1 separator at time t_1. The output of channel 2 separator (signal M) contains successive measurements from channel 2 entirely separated from the other channels. Subsequent channels operate in the same manner, using a signal from each preceding channel to initiate the action, and using signal B to stop the action. The cycle continues until the last channel separator action is completed, and the system then remains quiet until the next pulse group is received.

Metering Circuits

The function of the metering circuits in Fig. 7 is to convert the information as it appears at point

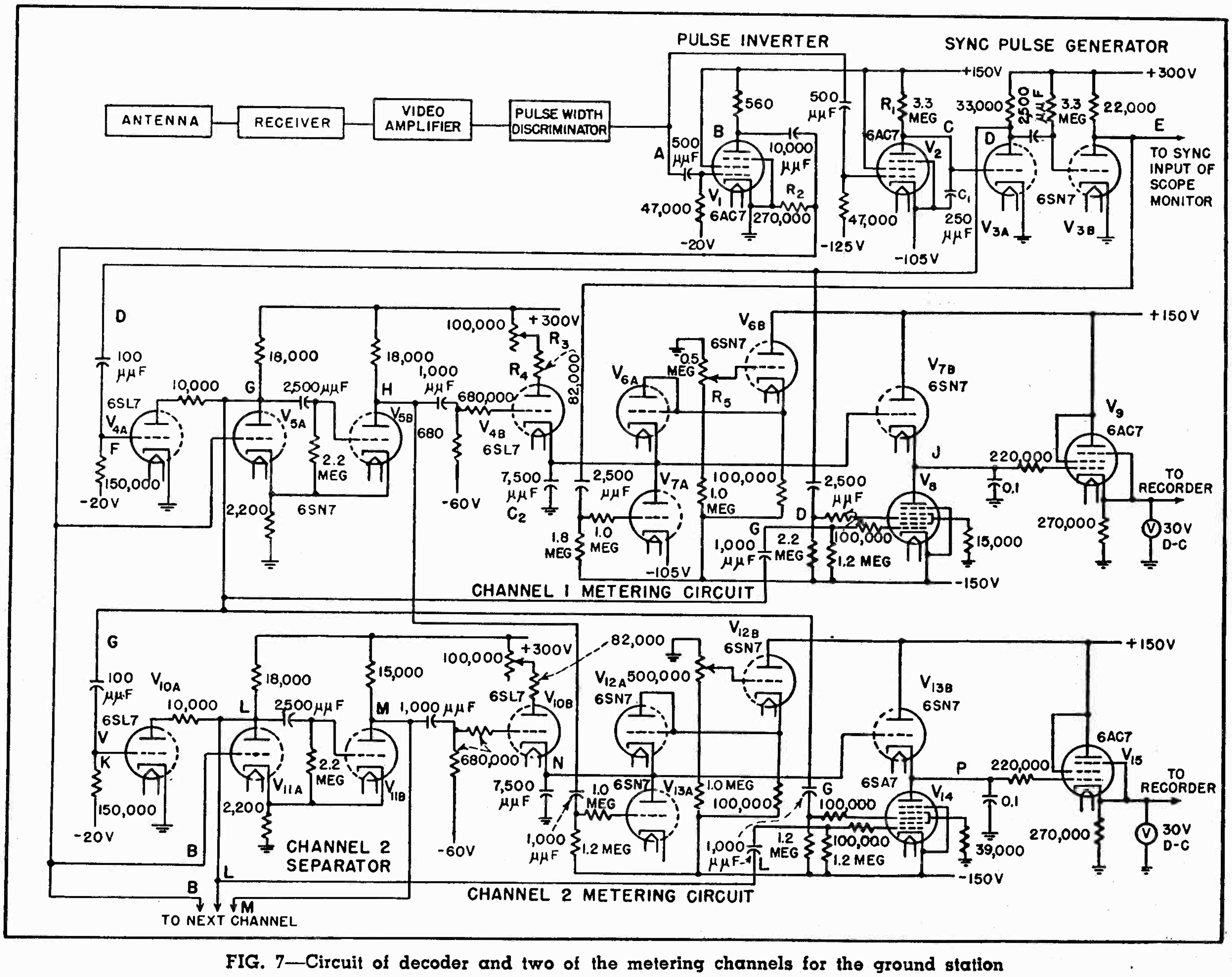

FIG. 7—Circuit of decoder and two of the metering channels for the ground station

H, M, etc, to voltages whose values are the same as those originally transmitted. Converting the duration of the positive pulse at H to a voltage requires the use of a capacitor which charges at an approximately linear rate for the duration of the pulse. In channel 1 metering circuit, C_2 is charged in such a manner, with current passing through V_{4B} which is normally cut off except for the duration of the positive pulse H. Capacitor C_2 begins to charge from the same reference potential on each cycle.

Just before C_2 begins to charge, point I is brought down to the reference level by tubes V_{6A}, V_{6B}, and V_{7A}. Tube V_{7A}, which is normally cut off, conducts from time t_x until t_1' because of the positive signal E at that time, and C_2 is thereby discharged to the reference level determined by V_{6B}. The cathode potential of this tube is supplied from a low impedance; therefore, when the potential of point I falls to the cathode potential, diode V_{6A} immediately clamps point I at the reference potential. Point I remains in this condition until time t_1' when V_{7A} is cut off and V_{5B} begins conducting. The potential of point I rises according to the charging time of C_2 with R_3, R_4, and the resistance of V_{4B}. At time t_2' V_{5B} is cut off and point I becomes isolated at the final potential that it reached during charging. This potential is held until t_x', when the next positive pulse at E occurs and point I is again discharged, repeating the cycle.

The signal which appears at point I is shown in Fig. 8. The intelligence of channel 1 has been reconverted to a steady voltage at this point except for the discontinuity from time t_x until t_2'. This discontinuity is removed by the action of V_{7B} and V_8. Tube V_{7B} acts as a cathode follower and V_8, which normally conducts, acts as the cathode resistor of V_{7B}. Point J follows any level set at point I except during the discontinuity. Point J cannot follow the potential at I during its drop to the reference level since the cathode resistor, tube V_8, is rendered nonconducting during that interval. Signal D on one of the control grids keeps V_8 cut off from time t_x until t_1', and then signal G keeps it cut off from time t_1' until t_2'. Thus the voltage at J remains at a constant value until a new level has been reached at point I.

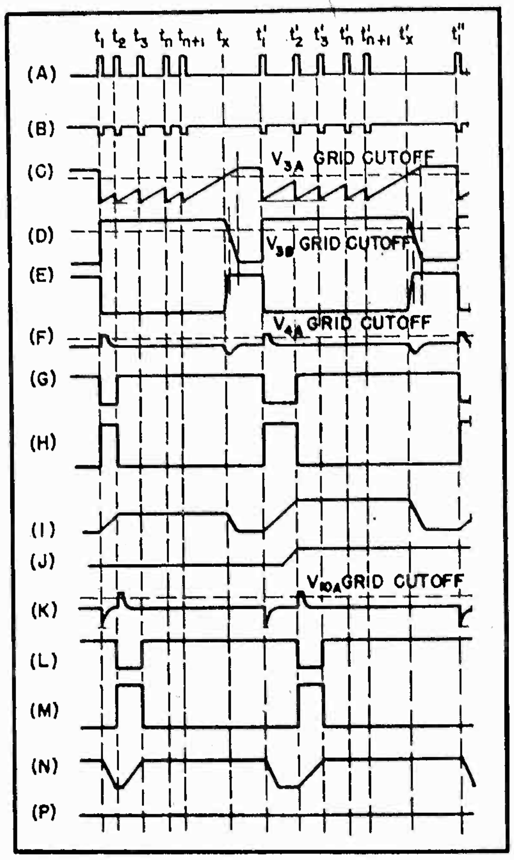

FIG. 8—Waveforms at various points in the decoder circuit of Fig. 7

The voltage at J without the discontinuity is much more preferable for recording than the voltage at I. It is, therefore, the voltage J which is passed through cathode follower V_9 to the various recording instruments.

The metering circuits for the succeeding circuits operate in the same manner, except that where signals D and E operate in channel 1, signals G and H will operate in channel 2, signals L and M will operate in channel 3, and signals of the same sequence operate from channel to channel for all succeeding channels.

The output circuits are capable of supplying currents up to 10 milliamperes for the recording instruments. The manner in which the output completely follows signals which change rapidly from cycle to cycle is shown at J in Fig. 8, and the manner in which the output remains constant when the signals are unchanged from cycle to cycle is shown at P.

To align the telemetering system, adjustments are provided in each metering circuit. Potentiometer R_8 is adjusted so that the meter reads zero when the channel input leads to the airborne transmitter are grounded. Potentiometer R_5 is adjusted to give full-scale deflection of the meter when 5 volts is applied. After these adjustments are made, a curve of output versus input is run with points at half-volt intervals. This curve is referred to the calibrating voltage and a complete record of alignment is then preserved.

Response and Accuracy

The response of the system to change in data voltage is limited by the telemetering sampling rate. It is still possible, however, to obtain data from voltages varying at a rate higher than the sampling rate. The telemetering link responds fully in any period to the instantaneous data voltages at the moment of sampling. The string galvanometers of the recorder respond to frequencies up to 1,000 cycles. Of course, specific attention must also be given to the response characteristics of the instrumentation for the various experiments.

The use of calibration voltages eliminates errors due to change in the overall response of the system, replacing a relatively indeterminate error by one which is easily estimated. The use of a voltage regulator tube in conjunction with a resistance divider makes it possible to maintain the calibration voltage constant to within ± 1 percent.

It is not a simple matter to estimate the magnitude of error introduced into recovered data by the difficulties involved in reading the photographic record. The magnitude is plainly a function of the reader, the clarity of the record, the focus of the recording spot, and the magnitude of the maximum deflection. Combining data recovery errors with calibration errors, it appears that a calibrated accuracy of roughly ± 5 percent may be expected of the telemetering system. Future refinements in technique and equipment are expected to reduce the overall error to about ± 2 percent.

Finally, to the system errors there must be added those introduced by the instrumentation of the various experiments.

Electronic Switch for

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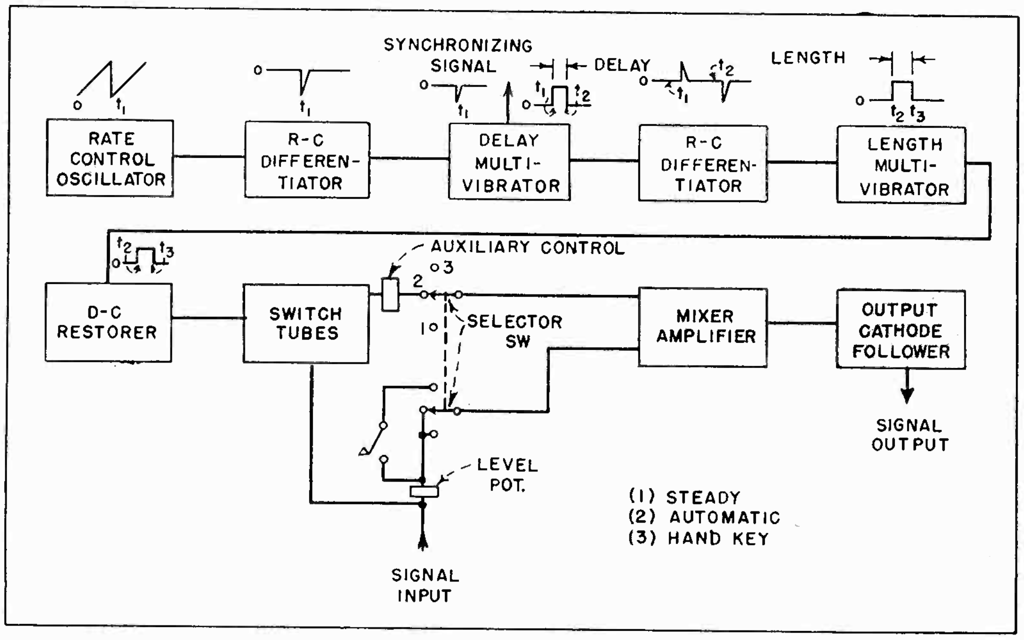


FIG. 1—Block diagram of pulser

IN RECENT YEARS, laboratory work in the audio and ultrasonic frequency ranges has required the use of pulse techniques in many acoustical and electrical experiments. Various types of pulsers have been described in the literature[1]. Five desirable characteristics, however, are not all included in the devices described to date. These desirable factors are:

(1) Pulse length variable, by means of a calibrated adjustment, over a suitably wide range.

(2) Pulse rate similarly adjustable over a suitably wide calibrated range.

(3) Pulse length and rate adjustments entirely independent of one another.

(4) Synchronizing pip for oscilloscope trace synchronization, the pip occurring a suitable and adjustable length of time before the beginning of the pulse. Control independent of pulse rate and length.

(5) A means for introducing a steady-state signal upon which pulses may be superimposed, often required in studying high-gain systems utilizing automatic volume control.

The device described below was built to meet the above requirements and for general laboratory use. In addition, the following specifications were set up and are fulfilled:

(a) Pulse length, or closure

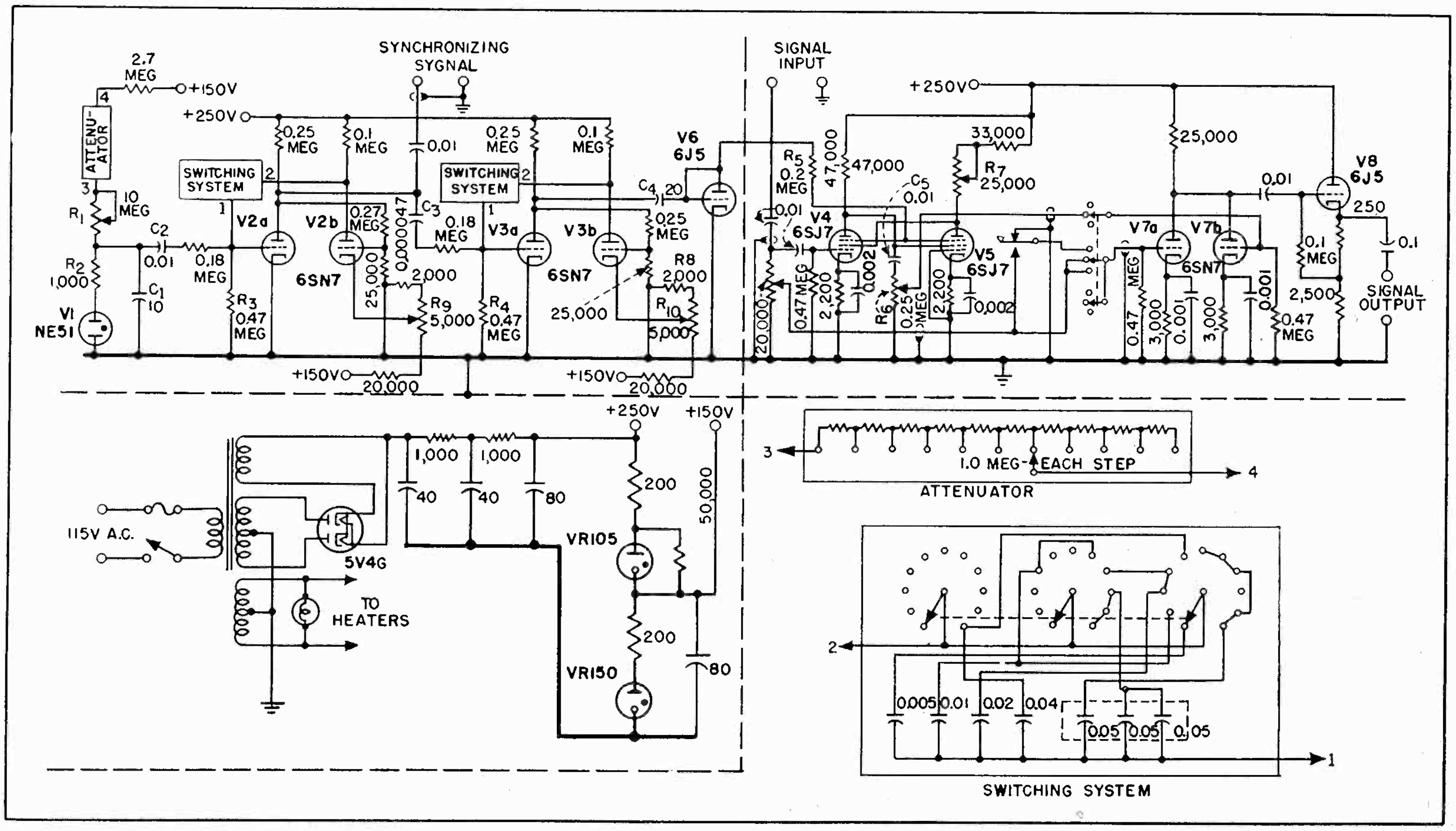


FIG. 2—Schematic diagram of pulser

the Production of Pulses

Circuit provides variable pulse length, variable pulse rate, variable delay of synchronizing pip, and a means for introducing a steady-state signal upon which pulses may be superimposed, in a generator designed for laboratory use

time, adjustable in steps between 5 milliseconds and 250 milliseconds.

(b) Pulse rate, or interval between closures, adjustable in steps between 0.6 second and 2.9 seconds, with an auxiliary control providing intermediate repetition rates throughout this rane.

(c) Delay between the initiating pip, which is also used for oscilloscope sweep synchronization, and the start of the pulse adjustable in steps between 5 milliseconds and 250 milliseconds.

(All of the above adjustments are independent of one another).

(d) Frequency range of the signal to be switched, 1 kc to 100 kc.

(e) Maximum peak output voltage, approximately 5.

(f) Dynamic range of pulse output, 30 db.

(g) Steady state non-pulsed signal, automatically pulsed signal or a hand-keyed output pulse available by the operation of suitable switches.

(h) A visual signal indicating when a pulse is initiated.

Operating Principle

A block diagram of the circuit components employed in the pulser appears in Fig. 1. Voltage waveforms, and times of occurrence, observed in various portions of the system are indicated above the components.

A gas-tube R-C sawtooth oscillator is used as the rate control. The oscillator output is differentiated and the resulting negative voltage pulses are used to trigger a delay multivibrator and to provide synchronizing pulses for oscilloscope sweep synchronization.

The delay multivibrator remains fired for the interval of time t_1 to t_2. The differentiated output consists of a positive pip at time t_1 and a negative pip at time t_2 as shown. The negative pip triggers the length multivibrator at time t_2 and this remains fired for the time interval t_2 to t_3.

The rectangular, positive output pulse from the length multivibrator is impressed through a d-c restorer to the suppressor grids of the switch tubes. The restorer provides a suitable cutoff bias for the switch tubes except during the interval t_2 to t_3, when the switch tubes are rendered conducting by the positive length-multivibrator pulse.

The switch circuit has been described elsewhere[2]. This circuit has a useful dynamic range of about 30 db and has negligible switching transient output over the range of signal levels employed.

The signal input may be connected for steady, automatic, or hand-key operation by means of a selector switch. With this switch in position *1* the input signal is applied directly through the level potentiometer and the mixer amplifier to the grid of the output cathode follower. This position is incorporated for convenience in observing the non-switched input signal and, in effect, shorts out the electronic switch.

With the selector switch in position *2*, a non-switched output of any level from zero to maximum may be obtained as in position *1*. The output of the switch tubes is added to this in the mixer amplifier. An auxiliary control regulates the maximum amplitude of the switch-tube output. By means of the two controls, any desired relative level of pulsed and non-pulsed signals may be obtained.

In position *3*, a hand key may be used to turn the output on and off.

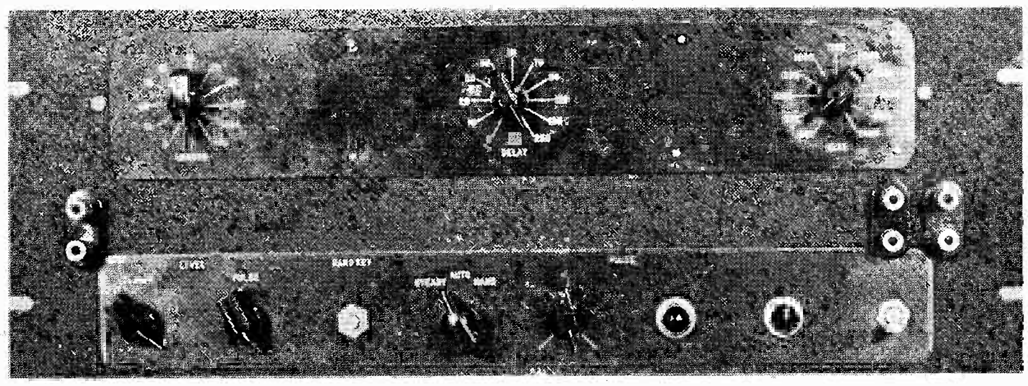


FIG. 3—Front view of laboratory model

The schematic diagram of the pulser appears in Fig. 2. The gas-tube R-C sawtooth oscillator comprised of V_1, C_1, and R_1 plus the attenuator will be noted in the upper left of the figure. In operation, C_1 charges through R_1 and the attenuator until the drop across C_1 reaches the ignition voltage of V_1. Tube V_1 then fires and discharges C_1 through protective resistor R_2 until the extinction voltage of V_1 is attained, after which the above cycle is repeated. The repetition rate is determined by the calibrated attenuator and the intermediate control R_1.

The discharge time constant of R_2C_1, is very much smaller than the charge time constant so that a sawtooth oscillator output voltage is obtained. This is differentiated by C_2 and R_3 and the resulting negative voltage pip is used to trigger the delay multivibrator V_{2a} and V_{2b}. The length of the positive delay multivibrator output pulse appearing at the plate of V_{2a} is controlled by the associated capacitor switching system. The front edge of this pulse occurs at the instant V_1 fires and is used for synchronizing.

The delay multivibrator output is differentiated by C_3 and R_4 and the negative voltage pip resulting at the end of the pulse is used to trigger the length multivibrator V_{3a} and V_{3b}. The length of the positive length multivibrator output pulse appearing at the plate of V_{3a} is controlled by the associated capacitor switching system.

It is evident from the above that the repetition rate, delay, and length of pulses are all independently adjustable.

The switching pulses from the length multivibrator are impressed on the suppressor grids of the switch tubes V_5 and V_6 through C_4 and R_5. The output side of C_4 is connected to ground through V_6, which acts as a d-c restorer or charging rectifier. By this means, the suppressors are maintained at a sufficient average negative potential with respect to ground as to cut off the switch tubes except during the pulse intervals.

The operation of the switch tubes is described in detail elsewhere[2]. The signal to be pulsed is impressed on the grid of V_4. The output pulses appear at the plate of this tube and are impressed across R_6 through C_5. Resistor R_7 is an adjustable type which is used in initially adjusting the switch for minimum, no-signal, switching transient output.

The operation of the selector switch was described under the discussion of the block diagram. Tubes V_{7a} and V_{7b} are the mixer tubes previously mentioned, and V_8 is the

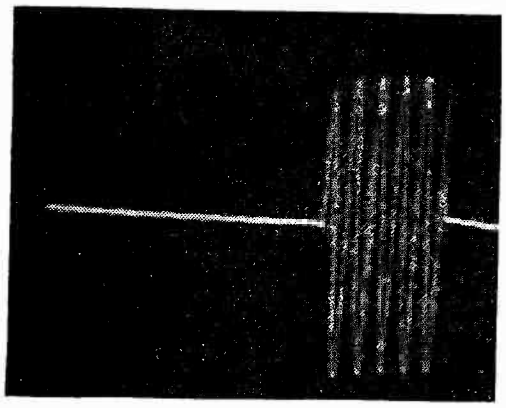


FIG. 4—Pulsed 1-kc signal, showing 10-milliseconds delay from the start of the sweep at the left and 5-milliseconds pulse length

output cathode follower. A VR-stabilized power supply, details of the attenuator, and the capacitor switching system complete the diagram.

Construction and Alignment

A front view photograph of the laboratory model appears in Fig. 3. Synchronization pips are obtained at the terminals at the left, while the two pairs of terminals at the right are signal input and signal output connections.

At the upper portion of the panel will be noted, reading from left to right, the pulse length control, the pulse delay control (the delay being measured in time from the time of occurrence of the synchronization pip), and the pulse rate control. The calibration of all of these controls is in milliseconds.

Near the bottom of the panel, reading from left to right, will be noted the two level controls; steady, R_8, and pulse, R_6. To the right of these controls is the hand key. This is a normally open pushbutton switch. The steady, auto, hand switch is the selector switch of Fig. 1, and provides pulser operation as previously described. The knob to the right of the selector switch is the intermediate value pulse rate control, R_1. The rate oscillator tube V_1 is mounted behind the dial light to the right of the knob. This provides a visual check as to the instant at which this tube fires and, consequently, a check as to the instant at which the synchronizing pip occurs.

All other controls are screwdriver adjustments which are mounted on the rear of the chassis.

In the alignment process the device is first turned on and allowed to warm up. The vertical plates of an oscilloscope are connected to the sync output terminals and the delay multivibrator control, R_9, is adjusted until rectangular output pulses are observed on the oscilloscope for all positions of the rate and delay control settings. In addition, it should be noted that the flashing of V_1 occurs simultaneously with the synchronizing pulses. The oscilloscope is then connected to the output terminals and the length multivibrator control R_{10} is adjusted so that symmetrical output pips are

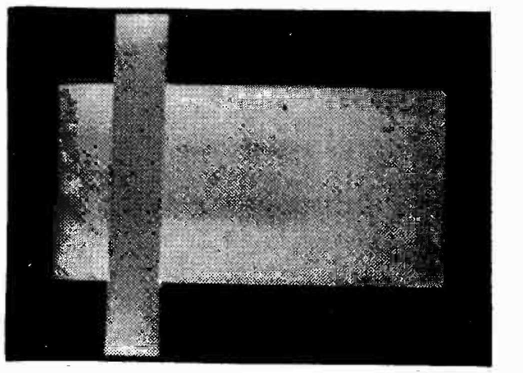


FIG. 5—Pulse superimposed on a 100-kc steady state signal

obtained for all combinations of rate, delay, and length settings.

After the multivibrators have been adjusted, the switching transient control R_7 in the plate of V_5 is adjusted for minimum no signal output with an oscilloscope connected to the output terminals.

Waveforms that should be obtained for each of these adjustments are indicated on the block diagram.

Figure 4 and Fig. 5 are photographs of the test results obtained with the device. In Fig. 4 a 1-kc oscillator was connected to the input of the pulser. The pulse length control was set at 5 milliseconds and the pulse delay control at 10 milliseconds. It will be noted that 5 cycles of the 1-kc signal appear within the pulse envelope as should be the case for this pulse length and signal frequency. The length of the delay is indicated by the length of the trace in front of the pulse. The clean edge at the beginning and conclusion of the pulse should be noted. This is due, in great part, to the transientless switch incorporated in the device.

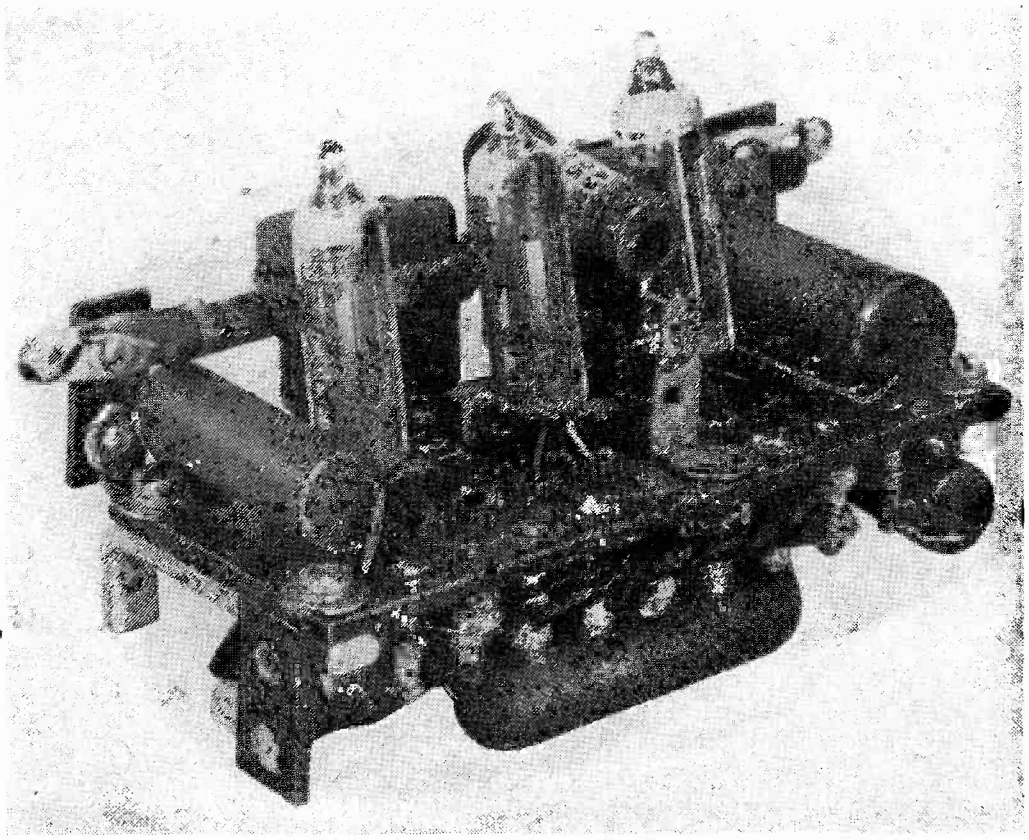
Figure 5 is a photograph of the results obtained with a 100-kc oscillator connected to the input terminals of the pulser. For this case, the background level control was adjusted so that the pulses observed appear superimposed on a normal steady signal. This mode of operation is very useful in determining the response of high-gain amplifiers, incorporating avc controlled by the average signal, to pulse signals.

References

(1) Scheuch, D. R., and Cowan, F. P., Laboratory Pulse Generator With Variable Time Delay, *Rev. Sci. Inst.*, p 223, June 1946.

(2) Butz, Jr., A. N., Surgeless Volume Expander, ELECTRONICS, p 140, Sept. 1946.

A Q of about 15 at 80 cps is obtained in this electronic filter by using selective feedback across the amplifier. Subminiature 6K4's are used to take full advantage of the saving in space made possible by the R-C network over an L-C type



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R-C BANDPASS Filter Design

Relationships between circuit parameters of a parallel-T R-C network, used as the feedback loop in an amplifier that gives the narrow bandpass characteristics of an L-C circuit, are determined. Design curves and applications to low-frequency filters are presented

AN ELECTRONIC FILTER with narrow bandpass characteristics can be made using the R-C parallel-T network in a feedback amplifier. By choice of component values different from those that produce the usual null characteristics, the bandpass characteristics obtained with this circuit are more desirable for many applications than those produced by the usual L-C filter.

Selective Negative Feedback

Considerable interest has been shown in the application of resistance-capacitance parallel-T networks for feedback in vacuum tube amplifiers. The arrangement was first presented by H. H. Scott[1] for use as a selective circuit and more recently A. E. Hastings[2] has offered an excellent theoretical analysis. However, most of the effort in this field has been toward the use of the parallel-T network with parameters chosen to produce an absolute null at the operating frequency. The purpose of this paper is to describe the excellent practical results achieved using the circuit in a selective frequency filter under different operating conditions.

As commonly used, with the circuit designed to produce a complete null, the output of the network can be used as a source of degenerative feedback voltage for all frequencies except that at which null occurs. Transfer characteristics so produced are sharply selective forming a cusp shaped curve at the desired frequency. Though this shape is excellent for selected applications such as wave analyzers, engineers find that most needs demand the ordinary L-C type of resonance curve of broader top and steeper sides. Less stability is then required of all frequency determining circuits and yet adequate attenuation is realized at short distances from the selected frequency. As will be shown, this type of operation can be obtained from parallel-T networks when the circuit parameters are chosen properly.

Circuit Analysis

It will first be advisable to review the equations which describe the operation of the parallel-T network and establish design constants. For simplification, in the circuit shown as Fig. 1, the series resistances will be considered equal, as will the series capacitances. The shunt impedances will bear relations to be proven, that produce the frequency characteristics described in this paper.

The following four circuital equations can now be written substituting βE_1 for E_0

$$E_1 - I_1(R - jK/\omega C) + I_3(-jK/\omega C) = 0$$
$$E_1 + I_2(KR - j/\omega C) - I_3 KR = 0$$
$$\beta E_1 + I_3(R - jK/\omega C) - I_1(-jK/\omega C) = 0$$
$$\beta E_1 + I_2 KR - I_3(KR - j/\omega C) = 0$$

If the determinant of the coefficients of the variables E_1, I_1, I_2, and I_3 in the above four equations is set equal to zero and the resulting equation solved for β, the following relation obtained is the necessary condition to be met if the variables are to have values other than zero

$$\beta = \left\{KR^3 - (2K^2R/\omega^2C^2) + j\left[(K/\omega^3C^3) - (2K^2R^2/\omega C)\right]\right\} / \left\{KR^3 - (2KR/\omega^2C^2) - (2K^2R/\omega^2C^2) - (R/\omega^2C^2) + j\left[(K/\omega^3C^3) - (2K^2R^2/\omega C) - (2KR/\omega C) - (R^2/\omega C)\right]\right\}$$

If R is set equal to $1/\omega C$, then

$$\beta = \left\{(K - 2K^2) + j(K - 2K^2)\right\} / \left\{(K - 2K - 2K^2 - 1) + j(K - 2K - 2K^2 - 1)\right\}$$

which reduces to

$$\beta = \frac{2K^2 - K}{2K^2 + K + 1}$$

This equation shows that at a frequency where $R = 1/\omega C$, β is real and has a magnitude dependent only on K. If $K = 0.5$, $\beta = 0$, and the circuit exhibits a complete null. It has been shown elsewhere that under these conditions the network produces an abrupt phase reversal, changing from 90 degrees to a value of 270 degrees at the null point. If K is less than 0.5 there is only a partial null, and network phase shift attains a value of 180 degrees as is shown by the real, negative value of β. Reversal from 90 degrees to 270 degrees occurs more gradually as the slope of the curve decreases with K.

Figure 2A shows the resulting effect of K on the network phase characteristic, and Fig. 2B indicates its effect on the attenuation vs frequency characteristic. Data for both sets of curves were obtained experimentally. Discrepancies which are evident in measurement of attenuation in Fig. 2B compared to the derived relation of β are attributed to experimental error and the finite resistance of capacitors used.

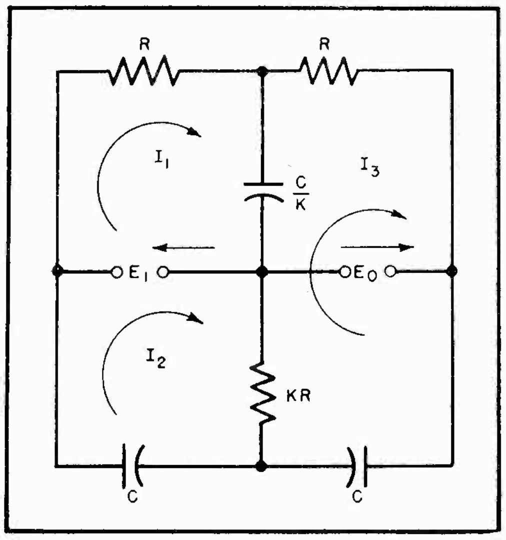

FIG. 1—Basic parallel-T R-C filter

Filter Circuit

If the parallel-T network is used for a source of feedback in a vacuum tube amplifier, a small amount of regeneration will be obtained at the selected frequency when $K < 0.5$. At frequencies on either side, the magnitude of the feedback signal increases, but its phase is then approaching 90 or 270 degrees, and so the regenerative effect decreases. As the frequency moves farther from the center value, the phase becomes such that degeneration occurs and the amplifier produces a large degree of attenuation.

When gain of the amplifier is kept below the value which will produce oscillation due to regeneration at the center frequency, an excellent filter is obtained whose characteristic is similar to that of L-C circuits. Opposing effects of attenuation and phase characteristics at the center frequency produce a relatively broad topped curve, while its sides are steep. A filter circuit may be designed with values of effective Q up to 100 and at frequencies well

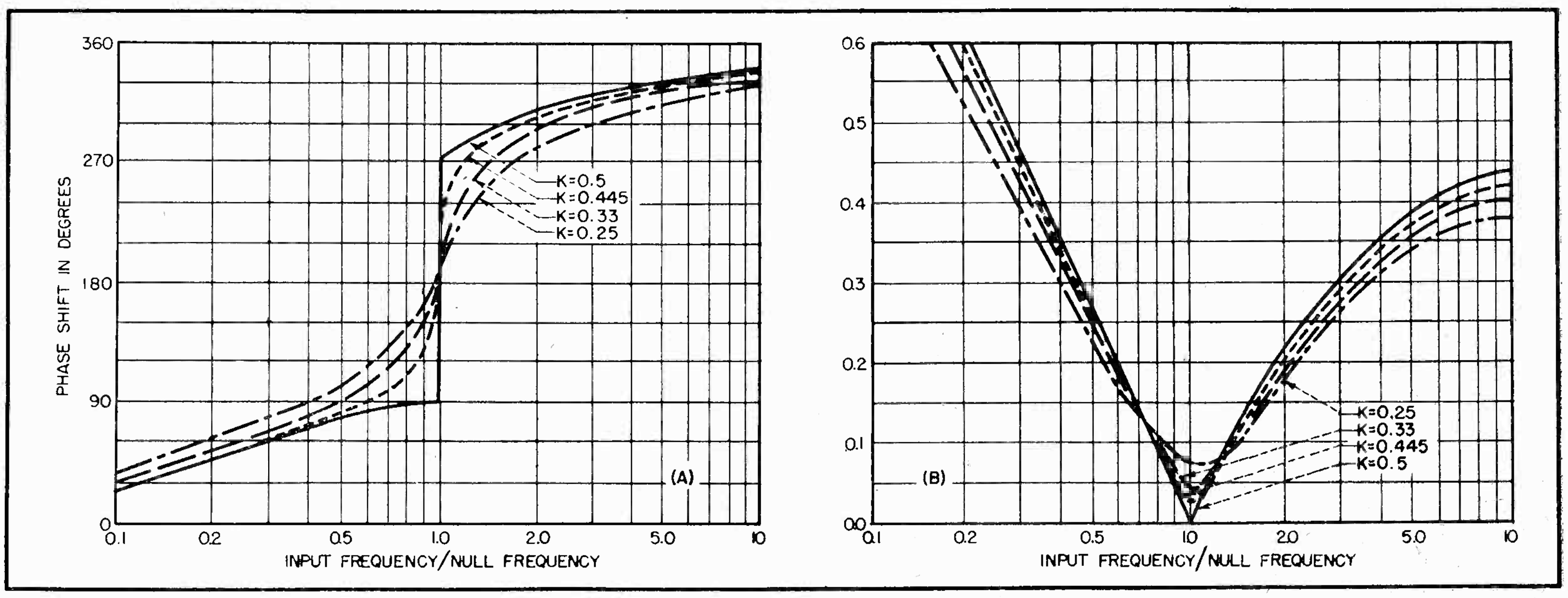

FIG. 2—By choice of the K the phase and amplitude characteristics of an R-C filter can be made similar to those of an L-C filter

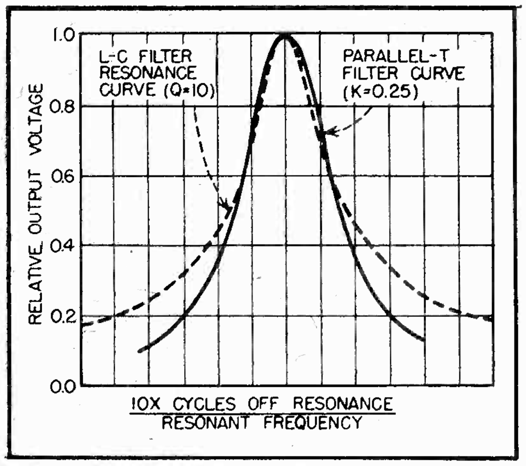

FIG. 3—Comparison of R-C and L-C filter characteristics

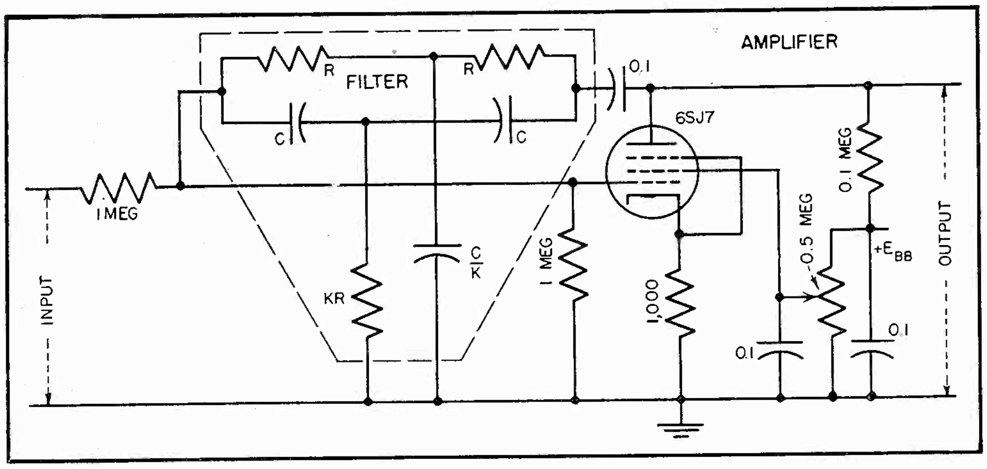

FIG. 5—Typical low-frequency electronic filter is amplifier with R-C network for feedback

removed from the center the attenuation is greater than that of an L-C circuit. Typical filter characteristics are shown in Fig. 3.

Filter Amplifier Design

A filter amplifier can be designed from the formulas derived above. Sharpness of the selectivity will be proportional to the effective gain of the amplifier, so this is the first consideration. Depending upon whether a moderate or a very large Q is desired, a triode or a pentode amplifier will be chosen. For a high degree of stability, the amplifier may have three stages and employ a large amount of additional degenerative feedbacks which is not a function of frequency.

After design of the amplifier and calculation of its gain A a value of K will be chosen that gives a network transmission β substantially less than $1/A$, so that oscillation or instability is avoided. This value of K can be determined from the graph of Fig. 4. Upon examination of the curve, it may be seen that β increases in value until a maximum is reached at $K = 0.207$. At this point β has a value of 0.0934, which is the largest practical value for filter amplifier design. The circuit resistances and capacitances are then chosen according to the desired frequency $f_0 = 1/2\pi RC$. Further adjustment of the selectivity can then be made by varying the amplifier gain, or by changing the value of K, which involves the simultaneous change of the two shunt arms KR and C/K. If only one of the shunt arms is changed, there will be an accompanying change in frequency as well as selectivity.

A typical pentode amplifier circuit with parallel-T feedback appears in Fig. 5. For f_0 of 60 cps with R of 265,000 ohms, C of 0.01 μf, and a K of 1/3, Q was between 2 and 20 depending on the amplifier gain controlled by the screen potential. Such a filter would present very difficult design problems with L and C components and would be very large and heavy. A particular design problem of this type of filter is that of maintaining zero phase shift in the amplifier at its low operating frequency. This condition is obviously necessary, because it is the phase characteristic of the network that controls filter operation. A d-c amplifier would most efficiently solve this problem

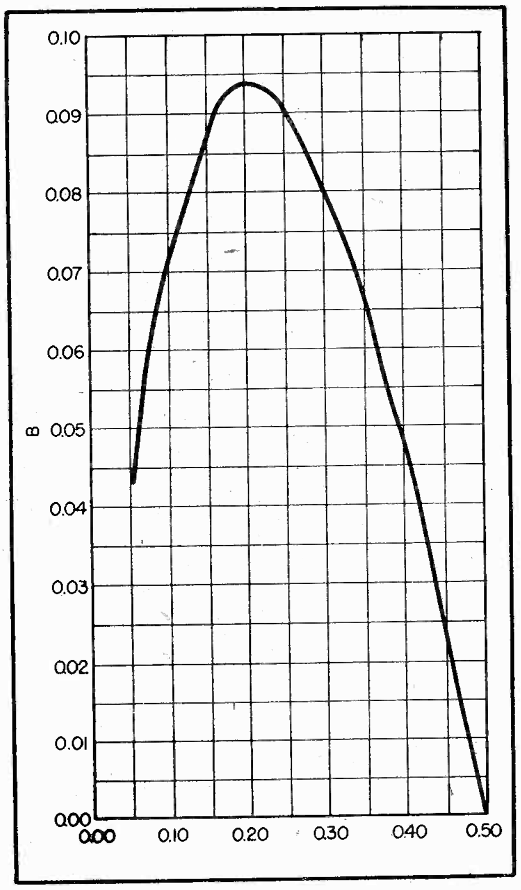

FIG. 4—Feedback as a function of filter selectivity (abscissa is K)

by eliminating all low-frequency phase shift and removing the need for bulky coupling capacitors.

Advantages of Filter

A filter designed in this manner has advantages of small circuit components at all frequencies and a very desirable selectivity characteristic. Because only resistive and capacitive components are required, the problem of temperature compensation is relatively simple and moisture has little effect. Due to these features, this circuit is vastly superior to an L-C filter at audio and low ultrasonic frequencies. At higher frequencies, it will operate equally well, but the L-C networks begin to show their advantages. Compared to other types of R-C filters, the circuit described in this paper has definite advantages in circuits demanding a selectivity of relatively broad peak and steep sides. Also, consideration of attenuation and phase characteristics shows that with an amplifier of fixed gain, a higher amplitude ratio of passed to rejected frequencies is obtained, because degeneration is about the same in either case, while the parallel-T filter supplies additional gain due to regeneration at the passed frequency.

The author acknowledges research done by Kenneth Jenkins of Oakland, California, who upon the author's suggestion carried out work which culminated in the development of the subject circuit.

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SHF Heterodyne

Description of a portable instrument that can be used in the range 450 to 10,000 mc with a maximum error not exceeding 0.05 percent. The butterfly oscillator is checked at 5-mc points with a crystal that allows use of the equipment as a frequency standard accurate to 0.001 percent

THE heterodyne frequency meter to be described was developed primarily for use in the range 2,000 to 10,000 mc. It has, however, a useful range of 450 to 10,000 mc, the fundamental range of the heterodyne oscillator being 450 to 900 mc.

The incorporation of a crystal calibrating circuit makes possible frequency measurements with a maximum overall error of ±0.05 percent; the heterodyne oscillator may be finely tuned by a gear reduction system, allowing measurements of frequency modulation and frequency increments of 0.01 percent. The instrument illustrated stands 12 inches high, 18 inches long, 6 inches deep, and is conveniently portable for laboratory use.

Measurement Methods

Frequency in the range 2,000 to 10,000 mc is commonly measured with tunable resonators, or wavemeters, of several types: coaxial-line, cylindrical-cavity, or transition. These devices may be used as transmission or absorption elements. They are relatively small, light-weight, and simple.

The instrument described in this paper is considerably more complex than the devices named above, but it has greater utility, greater sensitivity, is self-calibrating, and operates over a wide frequency range. It can also be used as a low-power-level frequency standard of ±0.001 percent accuracy.

The block diagram of the heterodyne frequency meter shown in Fig. 1 illustrates the components of the instrument and their function.

The unknown frequency F_1 in the range 450 to 10,000 mc is coupled into mixer no. 1, which is also coupled to the heterodyne oscillator. This oscillator has a calibrated dial and its frequency F_2 can be continuously varied between 450 and 900 mc. Thus F_1 may be measured by the usual heterodyne method; a series of values of F_2 is observed for which an audio beat note with F_1 is heard in the phones connected to amplifier no. 1.

In general, audio beats are heard if $nF_2 = mF_1$, where $n = 1, 2, 3 \ldots$, and $m = 1, 2, 3 \ldots$. In this case the audio beat notes are loudest when $m = 1$. If F'_2 and F_2'' are values of F_2 for two adjacent values of n, and if $m = 1$, then

$$nF_2' = F_1 \quad (1)$$

$$(n+1)\,F_2'' = F_1 \quad (1a)$$

and

$$F_1 = \frac{F_2'\,F_2''}{F_2' - F_2''} \quad (2)$$

If F_1 is known approximately, then n is known for a particular value of F_2 and it is only necessary to determine the value of F_2 in order to determine F_1. It can be done in a single operation, thus making the measurement a simple one. The accuracy of measurement of F_1 is equal to the accuracy of determination of F_2, which in this case is ±0.5

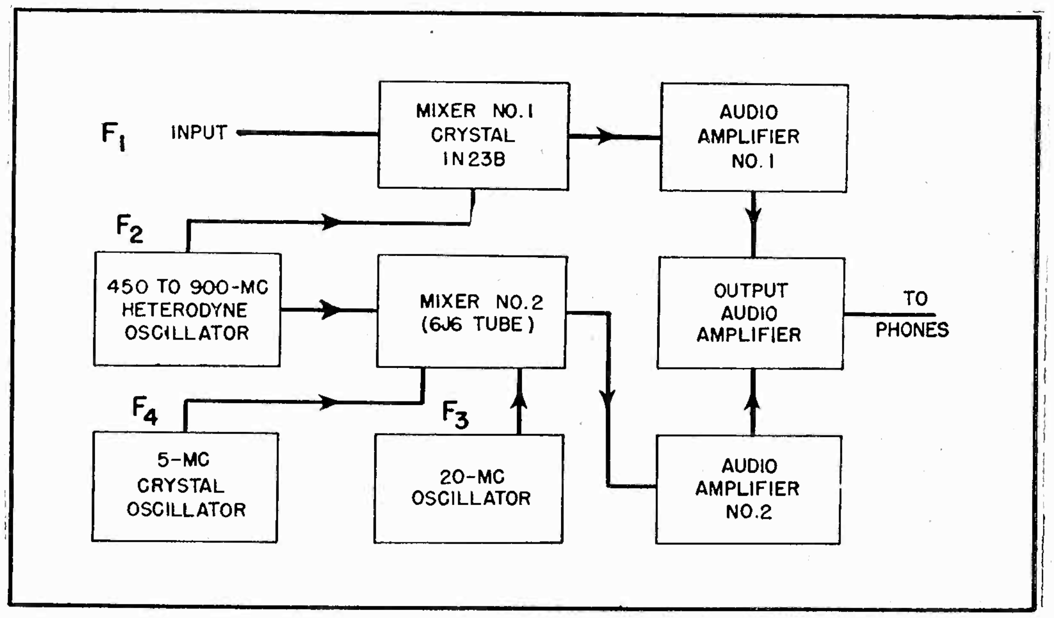

FIG. 1—Block diagram of the frequency meter. Gain controls allow the user to select the desired beats to be fed into the output audio amplifier

The work reported in this paper was done at the Radio Research Laboratory, Harvard University, under contract with Division 15 of the National Defense Research Committee.

Frequency Meter

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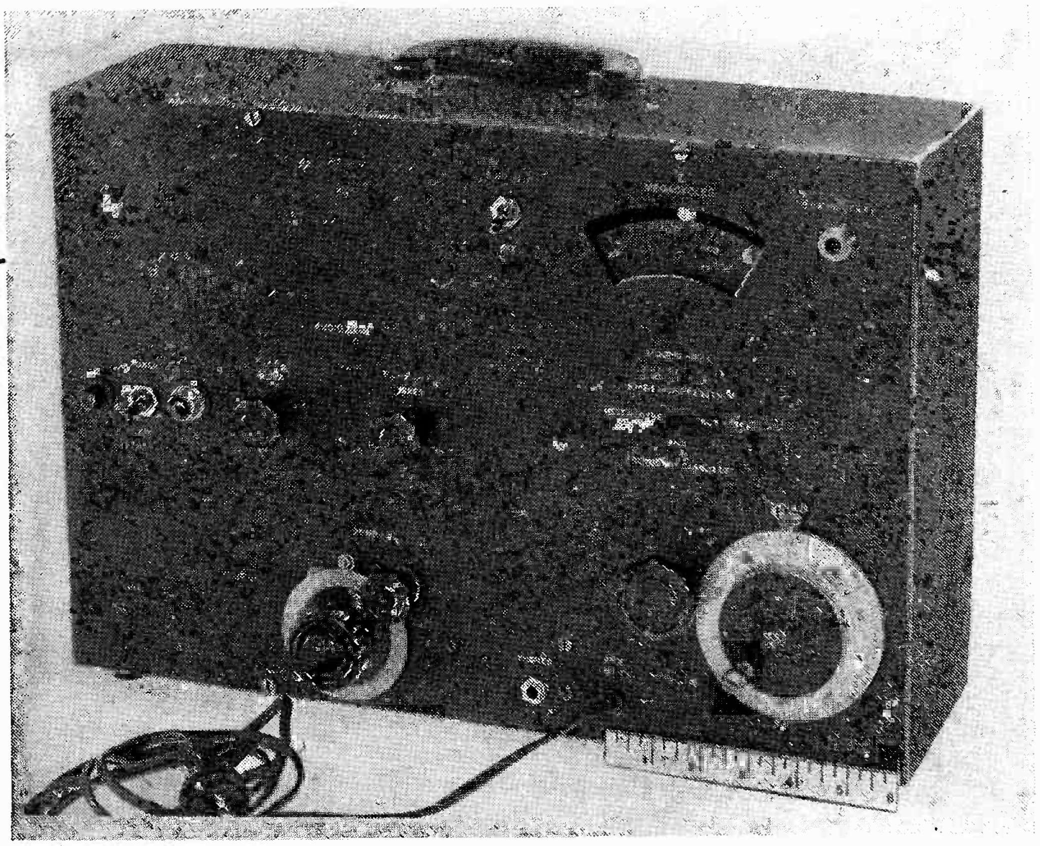

SHF heterodyne frequency meter and frequency standard

percent—the normal dial calibration accuracy of the heterodyne oscillator.

Crystal Calibrator

In order to determine F_2 more accurately it is necessary that a special calibration circuit be employed. A crystal oscillator whose frequency F_4 is 5 mc $\pm$0.001 percent is used as a standard and coupled to mixer no. 2. Also coupled to this mixer is a 20-mc oscillator whose frequency F_3 may be slightly varied. The coupling between these two oscillators is sufficient to allow F_3 to be locked-in with $4F_4$ when they are adjusted to zero beat by means of the mixer, audio amplifier no. 2, and earphones. The heterodyne oscillator is also coupled to mixer no. 2, and as F_2 is varied, there will be heard in the phones audio beat notes every 5 mc in the range of the heterodyne oscillator. These check points are beats between F_2 and nF_4 and accurate to within $\pm$0.001 percent. By linear interpolation between them F_2 may be determined at any point on the dial to within $\pm$0.05 percent.

Because the heterodyne oscillator dial calibration accuracy is only $\pm$0.5 percent, it is possible for 5-mc check point frequencies to be ambiguous over most of the range; such an impasse is avoided by turning off the crystal oscillator and first finding a reference point with only the 20-mc oscillator.

Separate audio channels and gain controls for the two mixers are used so that the instrument can be used without the calibration circuit for rapid measurements without high accuracy, and the dial calibration of F_2 may be quickly checked without hearing interfering beats with unknown frequencies. Adjacent check points and a beat with an unknown frequency can be identified separately and then heard together with minimum interpolation errors.

The instrument may be used as a frequency standard by setting F_2 to any of the 5-mc check points in its range. This will determine F_2 to an accuracy of $\pm$0.001 percent. Mixer no. 1 will generate harmonics of these standard frequencies up to 10,000 mc and these signals can be taken from the F_1 input connector.

The complete schematic diagram of the instrument aside from the conventional power supply, is shown in Fig. 2 and described below.

Circuit Description

The heterodyne oscillator and mixer no. 1 are mounted in an aluminum alloy casting fitted with a tight cover for r-f shielding. Figure 3 shows this unit with the cover removed. The oscillator is a type 6F4 triode tube operating in a butterfly circuit[1] that combines mechanical simplicity with compactness and avoids sliding r-f contacts. The butterfly rings are 2 inches in diameter and there are three in the stator stack. The rotor is also a stack of three plates and has an insulated shaft and ball bearing support. The rotor requires 90 degrees rotation to vary the frequency from 450 to 900 mc and is coupled to the panel tuning control by a 30-to-1 reduction worm gear; it is also connected through a 450-to-1 reduction to the panel fine tuning and interpolation dial control.

The frequency dial is 6½ inches in diameter and is directly calibrated in terms of F_2; the interpolation dial is 4½ inches in diameter and has 100 equal divisions and a hair line index. The whole mechanical system is spring loaded in order to eliminate backlash.

Frequency Stability

The oscillator has good mechanical and plate voltage stability. The plate, heater, and cathode chokes have been experimentally chosen to give smooth oscillator operation over its entire range. Incidental frequency and amplitude modulation is very small, the check points being very pure beat notes over the entire range. Since there are no sliding contacts, no noise is evident as the oscillator is tuned.

Adequate r-f shielding of the oscillator is obtained by use of the cast housing and tight cover, L-C filters in all power leads entering the oscillator cavity, and additional shielding of the worm gear system. It is necessary to prevent leakage of r-f power in order to avoid a serious noise problem; many parts of the oscillator drive mechanism could be paths of random r-f current flow, giving rise to broad bands of noise to be picked up by the mixers and amplifiers.

Mixer no. 1 as illustrated consists of a type IN23B crystal coupled inductively to the heterodyne oscillator and in series with the coaxial line input of F_1, the unknown frequency. A d-c load resistance across which are developed audio beat frequencies is mounted outside of the casting.

The 5-mc crystal oscillator is of conventional electron-coupled design. It uses a 6AK5 miniature pentode and a 5-mc temperature-compensated quartz plate with a variable pressure plate that allows the frequency F_4 to be set against a primary or secondary frequency standard. This oscillator will maintain its accuracy to within ±0.001 percent for normal (±20 C) temperature variations. A panel switch cuts the plate supply on or off.

Secondary Calibrator

The 20 mc oscillator is a conventional Hartley circuit using a type

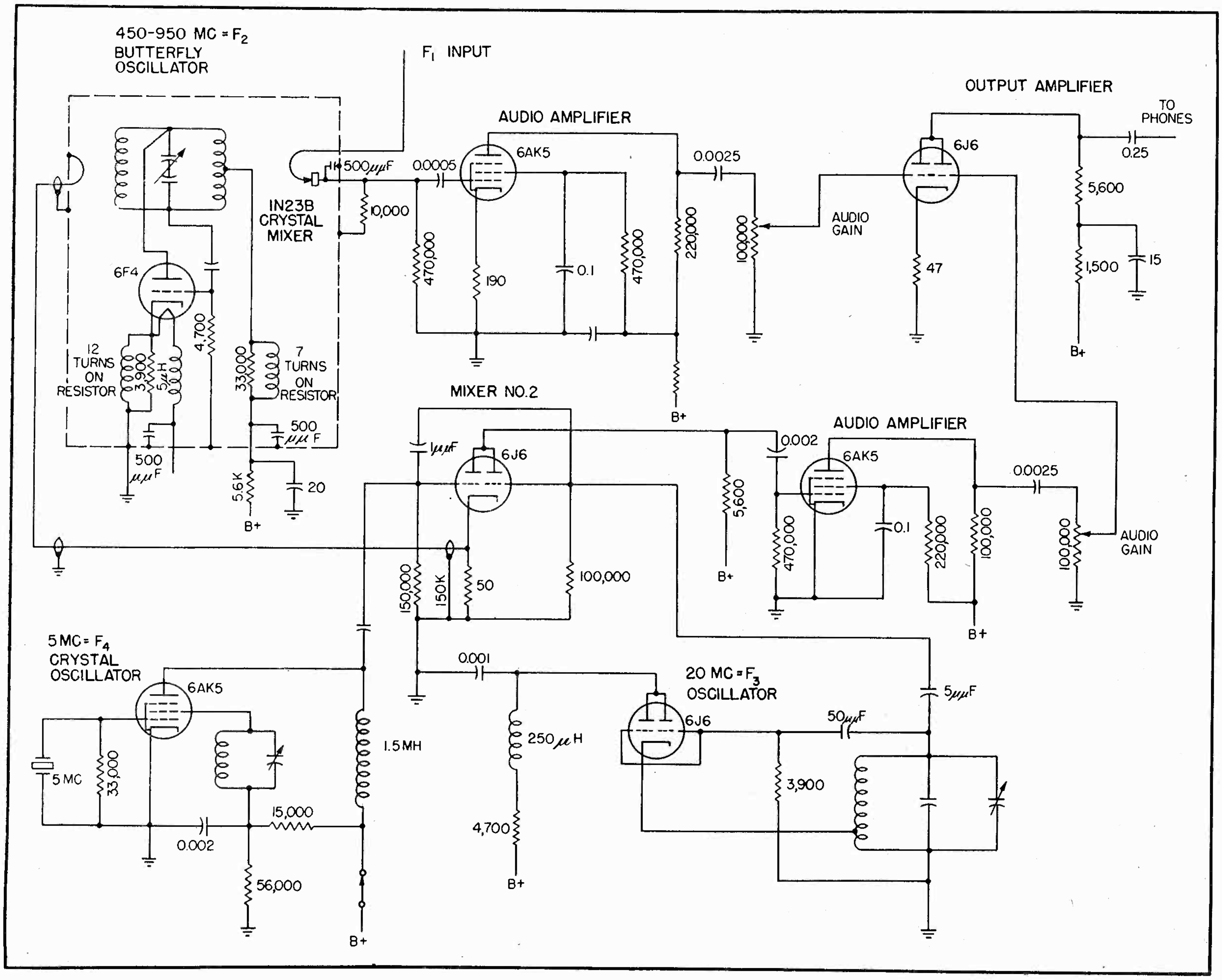

FIG. 2—Complete schematic diagram of the heterodyne frequency meter. The power supply, not shown, has two outputs suitably isolated to prevent coupling between units of the equipment

6J6 miniature dual triode with the elements connected in parallel. It is slightly tunable by means of a panel trimmer control.

Mixer no. 2 is a type 6J6 miniature dual triode using each grid and the cathode as three separate inputs. The crystal oscillator and the 20 mc oscillator are each capacitively coupled to a grid and to each other. The heterodyne oscillator is coupled in by means of a loop in the cavity feeding a 50-ohm coaxial line terminated in a 50-ohm disc resistor that is also the cathode resistor of the 6J6 tube. This connection gives low impedance coupling and prevents reaction on the heterodyne oscillator.

Audio amplifiers no. 1 and no. 2 are each conventional resistance-capacitance coupled 6AK5 pentode amplifiers with separate gain controls on the panel. They each feed into separate grids of the 6J6 output audio amplifier to which high impedance earphones are capacitively coupled.

The power supply is quite conventional, with resistance-capacitance filters used to decouple various components. The method of decoupling has not been indicated in the diagram, all leads to the plate power supply being marked B+.

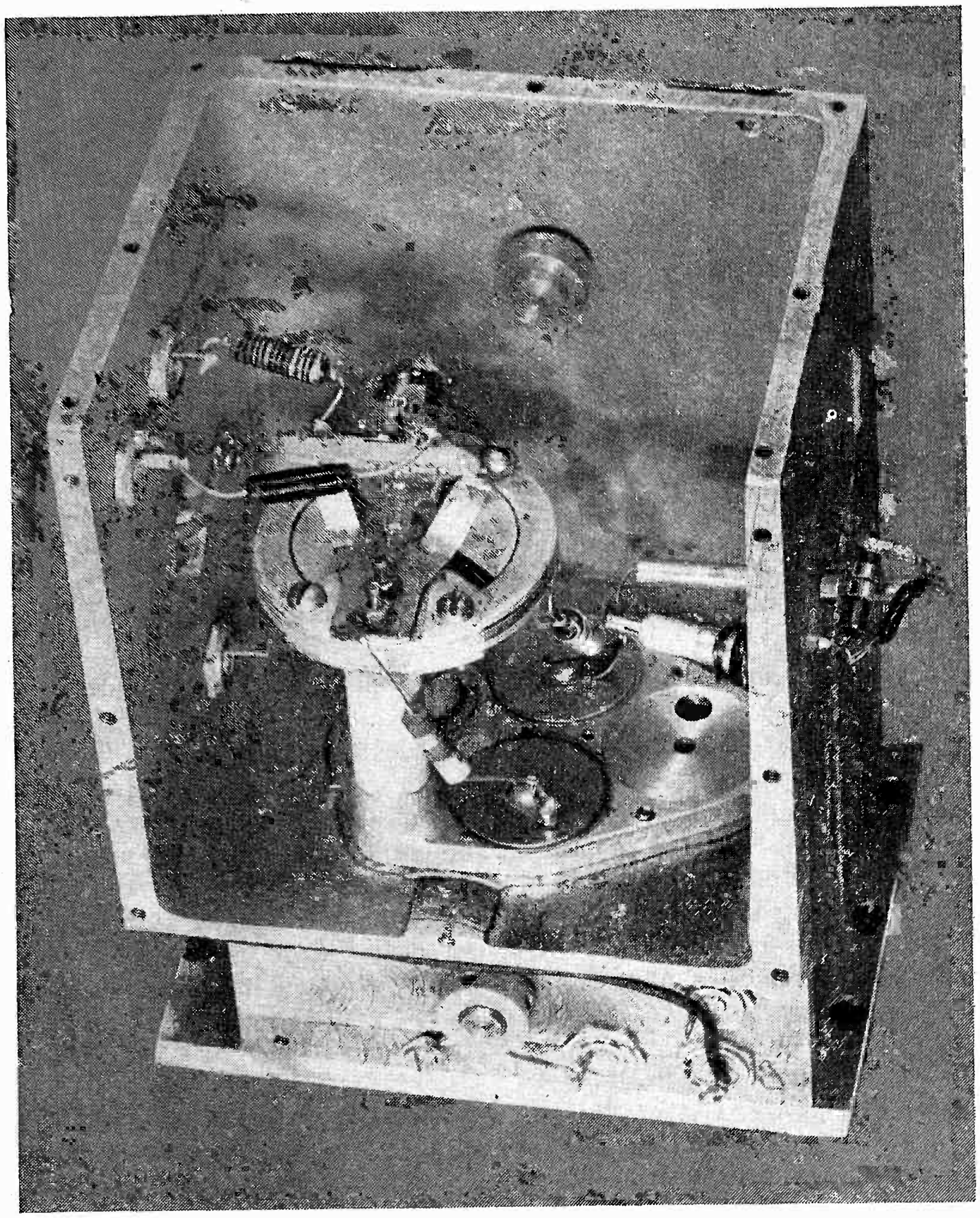

FIG. 3—Detail of the 450 to 900-megacycle butterfly oscillator. Cathode and plate chokes are wound on resistor bodies. The coupling loop and crystal at the right are represented by mixer No. 1 in the block diagram, while the load resistor for the circuit is just outside the cast housing

Limitations to Accuracy

It has been stated that the maximum overall measurement error of this heterodyne frequency meter is ±0.05 percent, and this can be simply proved. The accuracy of measurement is the accuracy of determination of F_2. Points of ±0.001 percent accuracy are placed on the F_2 dial every 5 mc by the calibration circuit. Linear interpolation must be used to determine F_2 between these points. The tuning curve of F_2 is not truly linear, the deviation from linearity in the vicinity of 450 mc being −0.03 percent of frequency at the midpoint between two adjacent check points; at 750 mc the deviation is 0.0 percent; at 900 mc it is +0.02 percent. Any backlash errors can be eliminated by proper technique. The interpolation dial can be accurately read only to about ⅓ of a division, thus causing an error of about ±0.01 percent of frequency. Thus the total error arrived at by adding ±0.03 percent for dial nonlinearity, plus ±0.01 percent for interpolation dial errors, plus ±0.01 percent for other errors gives ±0.05 percent. Because of the improved F_2 dial linearity this total error is only ±0.02 percent in the F_2 range of 650 to 800 mc.

By improving the dial linearity of the heterodyne oscillator and by using more closely spaced check points, it is possible to construct a frequency meter similar to this one with an error of measurement of 1 part in 10^5.[2]

No adequate measurements of the sensitivity of this instrument have been made; it varies widely over the range and is of the order of 0.01 microwatts at 200 mc and 10 microwatts at 10,000 mc.

Acknowledgment

The author wishes to acknowledge the helpful suggestions of H. E. Overacker, A. P. G. Petersen, and W. B. Wholey.

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Wideband I-F Amplifiers

Advantages of high gain with wide bandwidth can be obtained from stagger-tuned coupling networks provided compensation is made for extraneous frequency-selective feedback through the tubes. Design considerations and procedure are presented

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IMAGE REJECTION ratio[1] is one of the important performance characteristics in the development of wide-range tunable superheterodyne receivers for the uhf and shf regions (300 to 30,000 megacycles). If a tunable receiver is to be a truly single-dial, single-signal receiver, all spurious responses, the most important of which is the image response, must be reduced to below the level where objectionable interference may be encountered.

Two major components of a system which introduces attenuation to the image response are (1) an r-f preselector and (2) an i-f amplifier which removes the image frequency sufficiently far from the desired signal frequency that advantage can be taken of the selectivity of the r-f preselector.

To determine the image rejection obtained with a given intermediate frequency, one simply determines the ratio of the response in the r-f passband to the response at two times the intermediate frequency from the passband. Increased rejection is obtained with higher i-f.

Design Parameters

Information required by a designer of an i-f amplifier is (1) frequency, (2) bandwidth, (3) gain, (4) off-band rejection. The frequency is obtained by joint agreement between preselector and amplifier designers. In receivers under consideration, a minimum image rejection ratio of at least 60 db is desired. A family of curves which aid in the selection of the required number of preselector circuits and intermediate frequency is shown in Fig. 1[2]. Curves are for maximum insertion loss in the r-f passband of three db (L_o) and give the insertion loss of the filter at any frequency f outside the center of passband f_o.

For example, if a 70-db image rejection ratio is required, and for design considerations of tracking and oscillator stability the r-f bandwidth is 50 mc, it can be seen from Fig. 1 for $n = 1$ that a single-tuned preselector will be unsatisfactory regardless of intermediate frequency. If two tuned circuits ($n = 2$) are used, the parameter $x = (f - f_o)/\Delta f$ is taken from the curve to be equal to 20 for 70-db rejection. Because $\Delta f = 50$ mc and $f - f_o = 2f_{i-f}$, then $f_{i-f} = 20 \times 50/2 = 500$ mc. For three tuned circuits ($n = 3$) $f_{i-f} = 4.6 \times 50/2 =$ approximately 120 mc.

Agreement must be reached on the relative complexities involved in the two alternatives. In the particular case to which the above figures refer, a three-cavity preselector, and an i-f amplifier, centered at 160 mc were chosen. Bandwidth is generally dictated by the intelligence to be received. In this case, 20 mc was used.

The overall gain required is a function of the receiver application. For general monitoring of a portion of the radio-frequency spectrum, which was desired, reception of signals down to noise level is required. Sufficient gain must therefore be included to bring the receiver noise up to a level at which the second detector is operating linearly. Total gain is thus a function of the noise figure of the receiver. The 160-mc i-f amplifier used as an example in this article incorporated between 90 and 100-db voltage gain from input grid through the second detector.

Off-band rejection requirements are determined by the specific application, but in general, the requirement of high gain requires a large number of stages, and (as will be seen later) the circuits which must be used to obtain the combination of high gain and large bandwidth are such as to insure excellent skirt rejection.

Amplifiers Above 100 Mc

Design of amplifiers operating above 100 mc is one which is as much a mechanical problem as an electrical one, if lumped constant interstage networks are to be used.

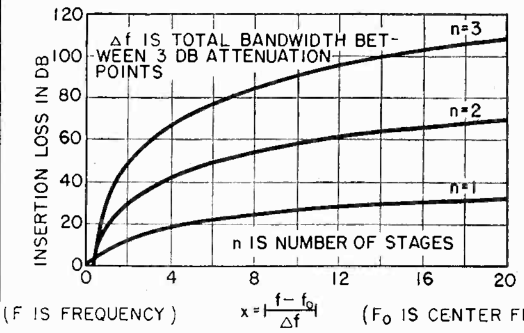


FIG. 1—Normalized curves for selecting number of preselector circuits for a specified skirt rejection

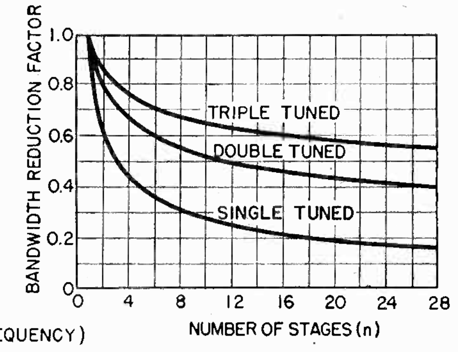
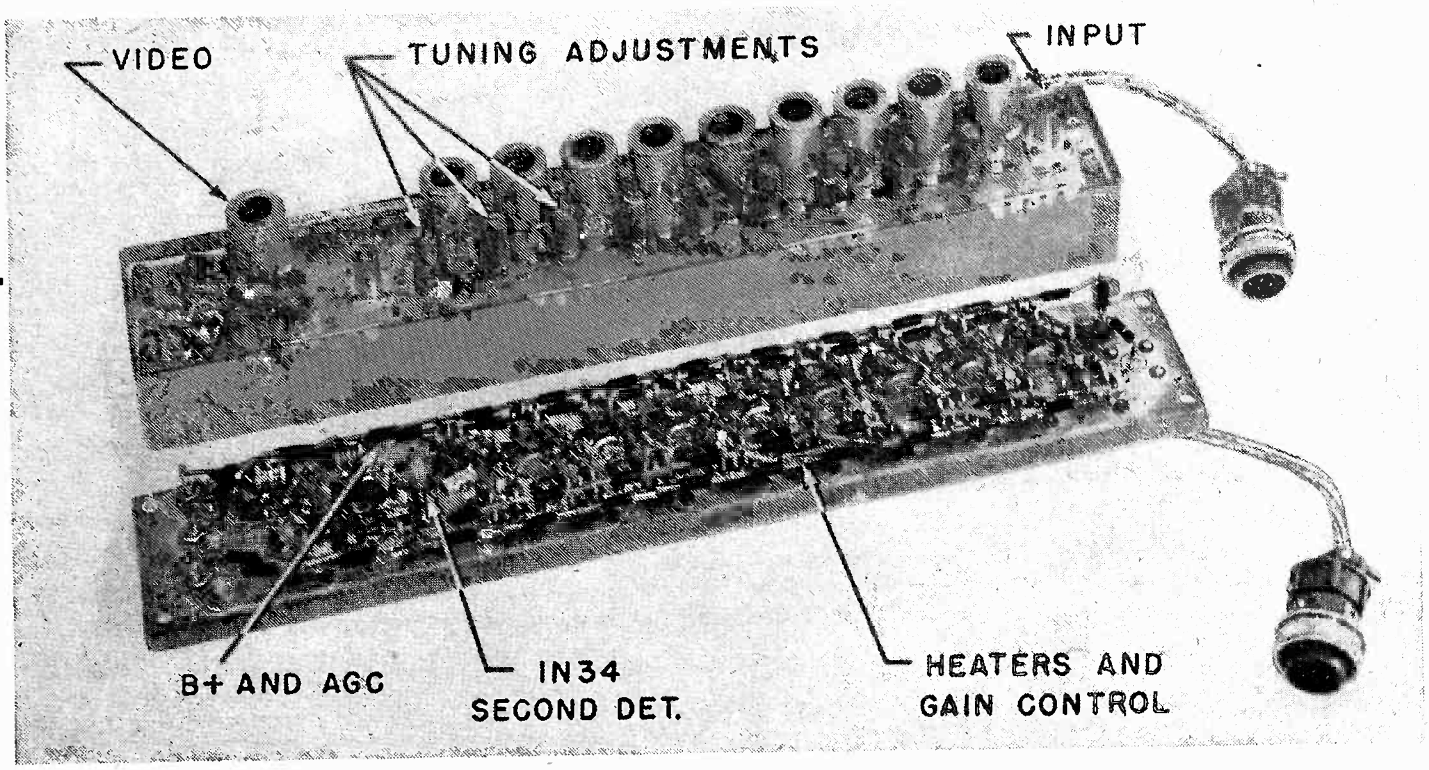


FIG. 2—Degree of narrowing of passband introduced by multiple couplings all tuned to the same center frequency

above 100 Mc



Construction of stagger-tuned i-f amplifier for 160 mc shows minimum of wiring and little interstage shielding

These networks must be kept compact with the fewest and shortest possible leads. If a design is used which deviates from these requirements, experience has shown that regeneration troubles invariably arise, and their elimination results in mechanical layouts which are cumbersome, difficult to build, and even harder to service. For the above reasons, a highly desirable type of coupling is the single-tuned network using tube and stray capacitances as shunt capacitance and a variable inductance for tuning. This network can be constructed in extremely small space with very short leads.

The disadvantage of this coupling is that the gain-bandwidth product[3] of a single-tuned network is low compared to more complex networks, off-band rejection is also low, and overall bandwidth of a series of single-tuned stages becomes rapidly smaller as the number of stages is increased. Figure 2 shows the degree of narrowing as a function of the number of cascaded stages for single-tuned coupling as well as for double and triple tuning. There is a definite advantage in the use of more complex coupling networks, completely aside from the fact that their gain-bandwidth products are higher to start with, because of less rapid narrowing with increasing number of stages, but unfortunately, these networks are difficult to realize at high frequencies.

If single-tuned circuits are used, it can be shown that if both high gain and large bandwidth are required, the resultant amplifier rapidly becomes uneconomical and under certain conditions impossible of construction. Figure 3 shows the number of stages required to realize given bandwidths and gains using cascaded single-tuned coupling. With gains of 100 db and bandwidths greater than 4 mc, the cascaded single-tuned amplifier is impractical.

Stagger-Tuned Circuits

To retain the simplicity of the single-tuned amplifier and to obtain the desirable gain-bandwidth product and slower narrowing of the overall bandwidth of multituned networks, stagger tuning is used. By properly adjusting tuning frequencies and damping of individual single-tuned stages, results approaching those obtainable with multituned coupling can be obtained with little sacrifice of simplicity.

The theory of stagger tuning has been adequately covered in the literature[4] so no derivations will be included in this paper. The method has proved to be exceedingly powerful in the simple solution of most present wideband, high-gain amplifier problems.

In discussing stagger tuning, it is convenient to express the gain-bandwith product in units of $g_m/2\pi C_T$ and call this the gain-bandwidth factor. The gain-bandwidth factor for a single-tuned stage is, therefore, unity[3].

A STAGGERED PAIR of overall bandwidth Δf and geometrically centered at f_0 consists of two single-tuned stages of dissipation factor $D = 1/Q$ and tuned at frequencies $f_o\alpha$ and f_o/α respectively. Where δ is less than 0.3

$$D = 0.707\delta$$
$$\alpha = 1 + 0.333\delta$$
$$\delta = \Delta f/f_0$$

The stage gain times overall bandwidth factor of this combination will be unity. Figure 2 shows that the corresponding factor for two cascaded stages is only 0.64. In addition, overall selectivity function of the staggered pair will be, in

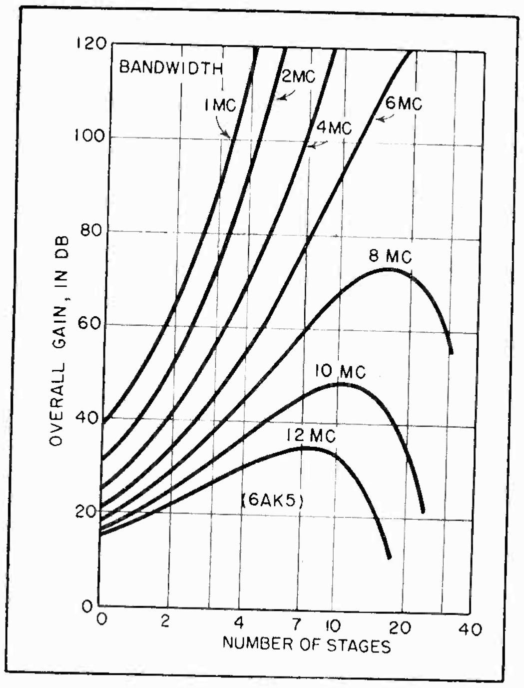


FIG. 3—Curves relate the three functions total gain, bandwidth, and number of stages for cascaded single-tuned couplings

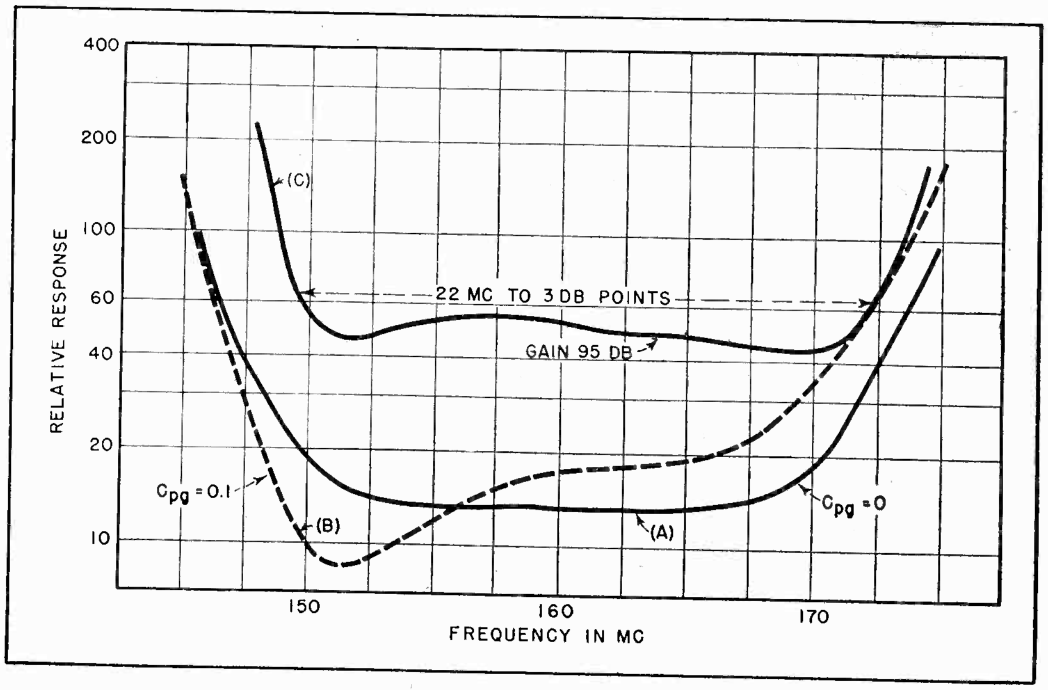


FIG. 4—Because of selective loading from feedback within the tube, the response (A) of a nine-stage amplifier of three triples was distorted (B) Response curve (C) of the amplifier after readjustment of staggered frequencies and damping

both absolute value and phase, that of a transitionally-coupled[5], double-tuned circuit. For this reason overall bandwidth decreases more slowly as staggered pairs are cascaded than for identically tuned stages. Figure 2 gives the narrowing factor for staggered pairs and triples by using the double-tuned and triple-tuned curves respectively where n is the number of pairs or triples.

A STAGGERED TRIPLE of overall bandwidth Δf and geometrically centered at f_0 consists of two single-tuned stages of dissipation factor D staggered at $f_0\alpha$ and f_0/α and one single-tuned stage of dissipation factor δ centered at f_o. Where δ is less than 0.3

$$D = 0.5\delta$$
$$\alpha = 1 + 0.433\delta$$
$$\delta = \Delta f/f_0$$

The stage gain times overall bandwidth factor of this combination will be unity, and the overall selectivity function will be, in both absolute value and phase, that of a transitionally-coupled triple-tuned circuit. Three cascaded single-tuned circuits would give a corresponding factor of only 0.54. It is also seen that the overall bandwidth decreases even more slowly as triples are cascaded.

It is possible to carry the staggering to n stages, but in the practical case the pair or triple is normally used and if more gain is required than can be obtained in this manner additional pairs or triples are used in cascade.

Calculating Circuit Values

As an example of the design of an amplifier, the following requirements are set: $f_o = 160$ mc, overall bandwidth $\Delta f_A = 20$ mc, overall gain $G_A = 100$ db. As a first approximation, assume four triples are required. From Fig. 2, each triple must be $\Delta f_T = \Delta f_A/0.76 = 20/0.76 = 26.3$ mc wide. For 6AK5's, $g_m = 5{,}200$ μmohs, $C_T = 11$ μμf, so that the stage gain (G_S) times the bandwidth per triple (Δf_T) is

$$G_S\Delta f_T = g_m/2\pi C_T = \frac{5{,}200 \times 10^{-6}}{2\pi 11 \times 10^{-12}} = 75 \times 10^6$$

and the stage gain is $75 \times 10^6/26.3 \times 10^6 = 2.86$ or 9.1 db, and overall gain (for four sets of triples giving 12 stages) is $9.1 \times 12 = 109$ db.

$$\delta = \Delta f_T/f_0 = 26.3/160 = 0.158$$
$$f_1 = f_0\alpha = f_0(1 + 0.433\delta) = 160(1 + 0.433 \times 0.158) = 170.9 \text{ mc}$$
$$f_2 = f_0/\alpha = f_0/(1 + 0.433\delta) = 160/(1 + 0.433 \times 0.158) = 150 \text{ mc}$$
$$f_3 = f_0 = 160 \text{ mc}$$
$$D = 1/Q = 0.5\delta = 0.5 \times 0.158 = 0.079$$
$$Q_1 = Q_2 = Q = 1/0.079 = 12.7$$
$$Q_3 = 1/\delta = 1/0.158 = 6.33$$
$$R_1 = Q_1/2\pi f_1 C_T = \frac{12.7}{2\pi 170.9 \times 11 \times 10^{-6}} = 1{,}060 \text{ ohms}$$
$$R_2 = Q_2/2\pi f_2 C_T = \frac{12.7}{2\pi 150 \times 11 \times 10^{-6}} = 1{,}210 \text{ ohms}$$
$$R_3 = Q_3/2\pi f_3 C_T = \frac{6.33}{2\pi 160 \times 11 \times 10^{-6}} = 560 \text{ ohms}$$

The parameters of the amplifier are thus determined. (A staggered pair would be designed similarly by using the constants previously presented for it.) The selectivity of the tuned circuits must be realized, thus the calculated resistances must be changed to take into account the tube's input conductance and finite coil Q. In stagger-tuned amplifiers centered in the vicinity of 30 mc, it is customary to use damping resistors one five-percent RMA size higher than that calculated in order to compensate for losses external to the damping resistor.

Extraneous Damping

Unfortunately, at frequencies above 100 mc, the effect of the grid-plate capacitance becomes of increasing importance. The effect of this feedback path is to distort the selectivity curve, tilting it with greater gain at the low end of the band and less at the high. At frequencies below 100 mc, it is usually sufficient to compensate for conductive and susceptive components of fedback admittance by retuning the grid circuit to the proper frequency and readjusting the damping.

As the center frequency is raised, this type of correction becomes less effective. Figure 4 shows the calculated selectivity curves of an ideal amplifier using three triples to obtain a 20-mc bandwidth at 160 mc, and of the same amplifier with the feedback included and with the individual stages retuned to the calculated stagger frequency and with the damping adjusted to the theoretical values. This calculation must be carried out stage by stage as the effect is cumulative. Feedback capacitance was assumed to be 0.1 μμf, which is about twice the normal value in a 6AK5, and was chosen to magnify the effect. However, actual experimental results show this tilting to be of such magnitude as to require additional compensation.

If the values of tuning frequencies and loading are varied from the theoretical, the passband can no longer be maintained flat without great sacrifice in gain. However, if small dips and peaks are allowable, a good compromise can be obtained by designing the amplifier for a slightly wider band than required, about ten percent, and adjusting the damping empirically to obtain the optimum result. The new values of loading are difficult to calculate because of their dependence on the value of the grid-plate capacitance, which may vary from tube to tube and stage to stage by a considerable percentage. It can be shown that the fedback admittance has conductive and susceptive values of the form

$$G_f = B_{gp}\,\frac{g_m B_L}{G_L^2 + B_L^2}$$

$$B_f = B_{gp}\,\frac{1 + g_m G_L}{G_L^2 + B_L^2}$$

where G_f and B_f are the conductive and susceptive portions of the admittance of the grid circuit as the result of a grid-plate susceptance $B_{gf} = C_{gp}$. Also B_L and G_L are the conductive and susceptive portions of the plate load admittance. Because G_L must always be positive, it may be seen that the B_f is always positive (or capacitive). However, because B_L may take either sign, being negative below resonance of the plate circuit and positive above, the conductive component varies widely with frequency.

The effect is noted especially in the case of stagger tuning; if the grid circuit is tuned to a lower frequency than the plate circuit, grid-plate capacitive feedback produces a negative damping in the grid and when the grid is at a higher frequency, a positive damping. This loading changes with frequency and so the selectivity curve of the tuned circuit is distorted. This distortion, when magnified by successive stages, produces the results shown in Fig. 4.

Compensation

As mentioned above, it is difficult to calculate correction factors because of the uncertainty of the value of C_{gp}. Despite the importance of feedback with conventional tubes above 100 mc, a good compromise can be obtained by empirical adjustments. Figure 4 shows the selectivity curve of the 160-mc amplifier whose design was discussed. The following table shows the effect of feedback and tube loadings on the values of the parameters

	Frequency	
	Calculated	Adjusted
High	170.9	172.5
Low	150	149
Center	160	160

	Resistance	
	Calculated	Adjusted
High	1,060	2,700
Low	1,210	820
Center	560	820

This amplifier had a gain, including loss in the second detector, of about 95 db which is quite close to the predicted gain, showing that the compromise was made with but little sacrifice.

An important acheivement in the use of single-tuned circuits is in the mechanical construction. No interstage shielding is required, and the layout is relatively clean and simple. Several types of tuning mechanisms have been used as shown in Fig. 5. Fig. 5A shows a coil used at 200 mc, the inductance variation being accomplished by spreading the turns of the beryllium copper spring coil. The rod diameter was ⅛ in. Figure 5B shows a conventional brass slug-tuned coil used at 160 mc, which tuned over about 30 mc. The important features of the mechanical construction of the amplifier are the extremely short lead lengths, no wiring being used, the components themselves providing connecting wires, and the care in selection of grounding points.

References

(1) Image rejection, as used in this paper, is the ratio of input to the receiver required to produce standard output with that input signal different from the receiver midfrequency by twice the intermediate frequency to that input required to produce the same output with the input signal at the receiver midfrequency. The image frequency is higher than the desired signal when the receiver local oscillator is lower than the received signal, and vice versa.

(2) Richards, P. I., Universal Optimum Response Curves for Arbitrarily Coupled Resonators. *Proc. I.R.E.*, p 624, 34.

(3) Gain-bandwidth product is the product of center-frequency voltage amplification times the bandwidth between 3-db points. For a pentode with a single tuned coupling network, it can be shown that this product is $g_m/2\pi C_T$, where g_m is the tube's transconductance and C_T is the total capacitance across the tuned circuit; this ratio is independent of center frequency.

(4) Wallman, H., Stagger Tuned I-F Amplifiers, Radiation Laboratory, Mass. Inst. Tech., Report 524, Feb. 1944. Also R. F. Baum, Design of Broad-Band I-F Amplifiers, Jour Appl Phys, Part I, p 519, Part II, p 721, 17. Wallman's analysis leads to the formulas given in this paper as well as those for any bandwidth regardless of center frequency, and are extremely simple to use to obtain flat-topped response. Baum's paper describes an interesting approach which leads to useful results for the general case of n-circuits with a response curve exhibiting peaks and dips within the passband.

(5) Transitional coupling is defined as that coupling at which the first three derivatives of the transfer impedance are zero.

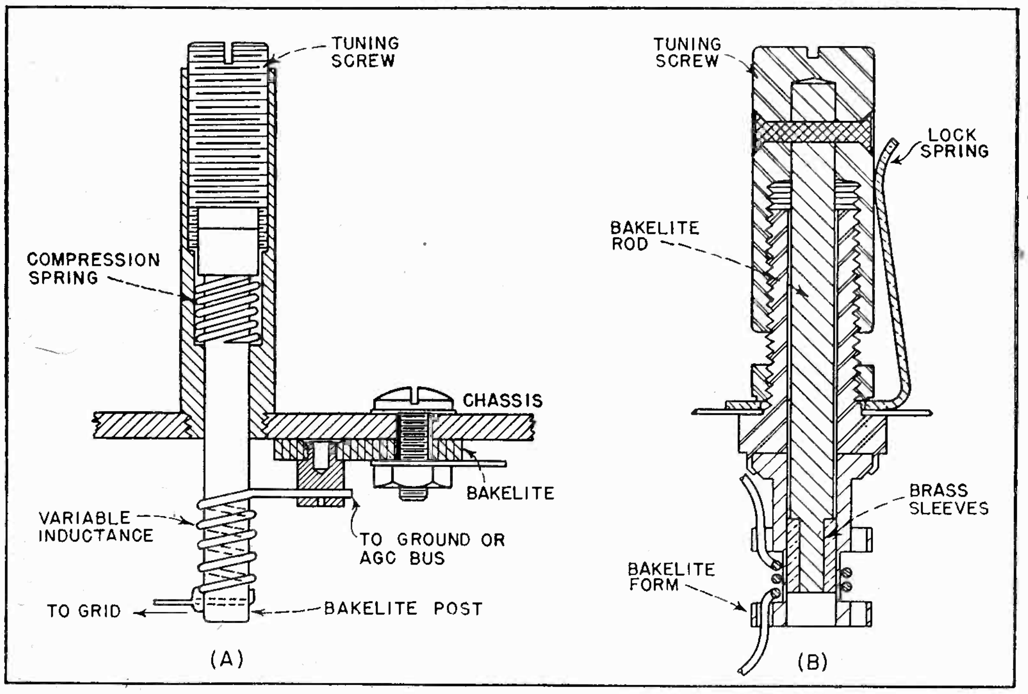


FIG. 5—Two methods of tuning inductors in the vicinity of 100 mc. (A) The coil length is varied. (B) The coupling to a loop is varied

Reverberation Time NOMOGRAPHS

By R. C. COILE

Colton & Foss, Inc.
Washington, D. C.

Areas of materials in room are measured and number of absorption units of each material is found with first nomograph. Total absorption units are then combined with room volume on second nomograph to obtain directly the reverberation time in seconds

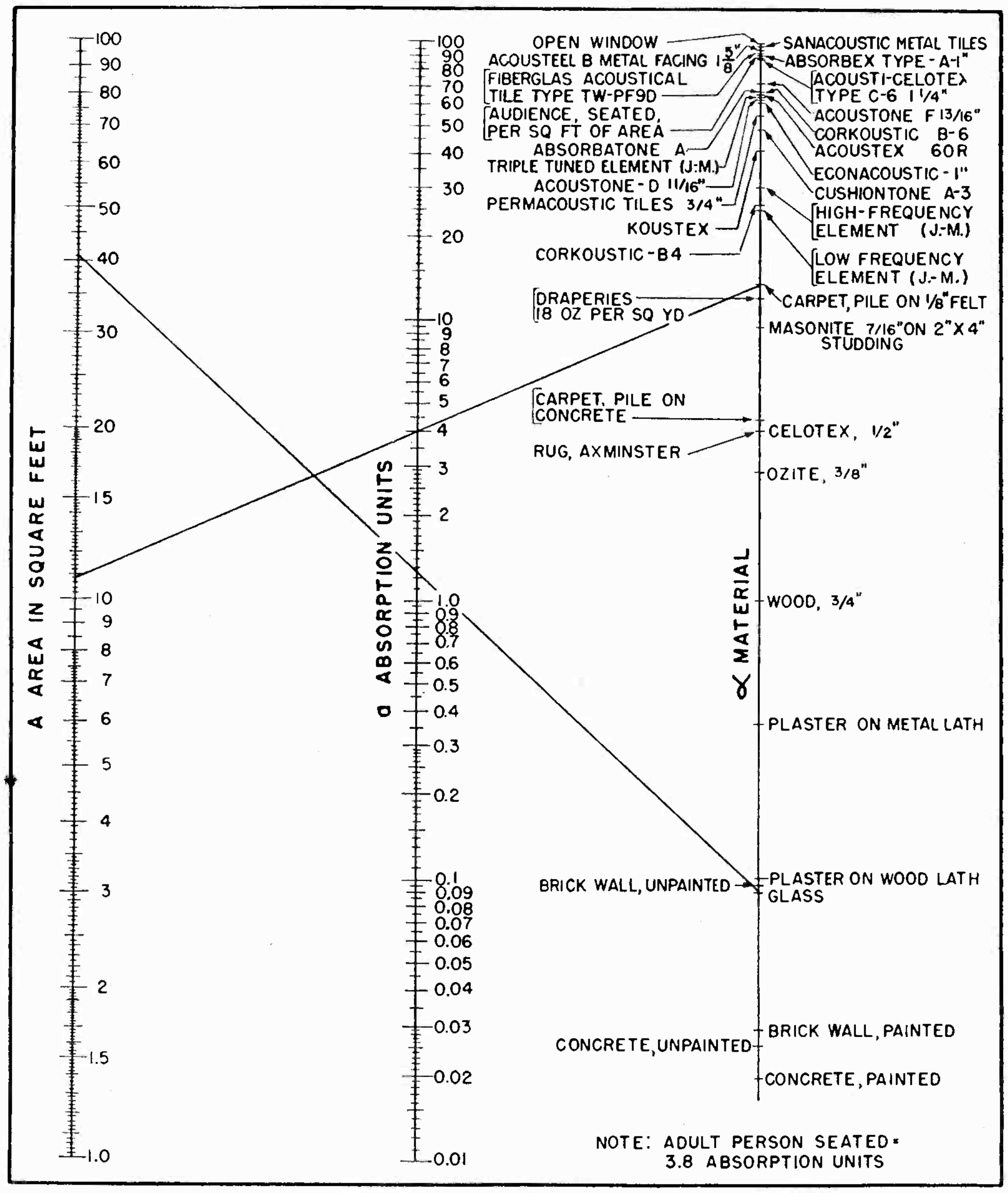


FIG. 1—Acoustical absorption nomograph, based up $a = A\alpha$, **where** α **is the acoustical coefficient of the material**

REVERBERATION TIME is the length of time required for the intensity of a sound to drop to one-millionth of its original intensity, which corresponds to a change of 60 decibels. The reverberation time of a room may be computed, knowing the dimensions of the room and the acoustical absorption coefficients of the different surfaces, from

$$T = \frac{0.049\,V}{A \log_e \left(\frac{1}{1-\bar{\alpha}}\right)} \qquad (1)$$

where T is the reverberation time in seconds, V is the volume of the room in cubic feet, A is the total surface area in square feet, $\bar{\alpha}$ is the average absorption coefficient of the room and is equal to $(A_1\alpha_1+A_2\alpha_2+\ldots)/(A_1+A_2)$, and α_1 is the absorption coefficient of area A_1.

This expression may be simplified[1] into an approximate expression accurate enough for the calculation of reverberation time of most rooms

$$T \cong 0.049\frac{V}{a} \qquad (2)$$

where V is the volume of the room in cubic feet, and a is the number of absorption units in the room computed by adding the absorption of each surface: $a = A_1\alpha_1 + A_2\alpha_2 \ldots$

Two nomographs have been designed to facilitate rapid calcula-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No. 11C11961—1-1/2″
OCTAL
No. 9905—1-5/16″ Black
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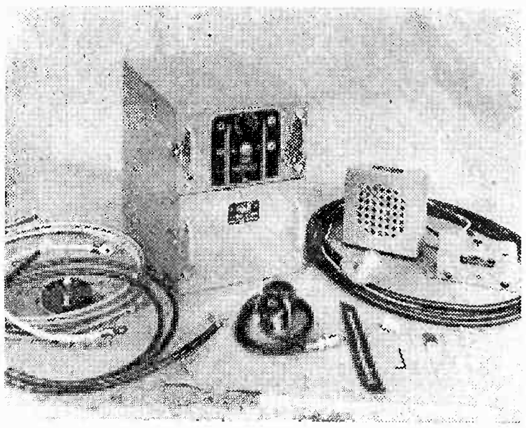
No. 54A11955—6 Prong
No. 54A11957—7 Prong
LOKTAL
No. 6972—1-5/16″ Black
No. 52A12354—Mica
LOKTAL
No. 6933—1-5/16″
MINIATURE
Chassis clinch
No. 53E11767
No. 8134
CONDENSER
No. 54A11897
CONDENSER
No. 54A11523
WAFER
No. X154
4 Prong
No. Z154
6 Prong
No. Y154
5 Prong
No. U154
7 Prong
No. A154—7 Prong (large)

TUBES AT WORK

Edited by VIN ZELUFF



All items needed for a two-way radio installation in a taxicab

Intermittent Mobile Tube Ratings

IMS STANDS for intermittent mobile service such as in aircraft, where transmitter design factors of minimum size, light weight, and exceedingly high power output for short intervals are the primary requirements, even though the average life expectancy of tubes used in such transmitters is reduced to about 100 hours.

According to RCA, IMS ratings are based on operation where the transmissions have maximum "on" periods of 15 seconds followed by "off" periods of at least 60 seconds, except that it is permissible to make equipment tests with maximum "on" periods of 5 minutes followed by "off" periods of at least 5 minutes provided the total "on" time of such periods does not exceed 10 hours during the life of any tube.

Two-Way Taxicab Radio Circuits

DESIGNED for mobile taxicab service, in the frequency range from 152 to 162 megacycles, the Comco 210 transmitter-receiver possesses some interesting circuit arrangements.

The transmitter is crystal controlled and uses narrow swing frequency modulation. The receiver is a dual-conversion crystal-controlled superheterodyne with 17 tubes and 24 tuned circuits and has a sensitivity of better than one microvolt. It has a bandwidth of 32.5 kc for 2 × down (6 db) and 106 kc for 1,000 × down (60 db).

Transmitter

A block diagram of the transmitter is shown in Fig. 1. Filament type tubes permit instant heating. The crystal controlled oscillator section of the 3A5 tube supplies r-f voltage to the 2E25 balanced modulator grids. The plates of the modulator tubes are connected in parallel and the output circuit tuned to that of the crystal. The output of the audio section of the 3A5 tube is fed to the modulator grid, thru a low-frequency network. The a-f voltage so impressed on the grids causes a relative phase shift in the output frequency of the modulators.

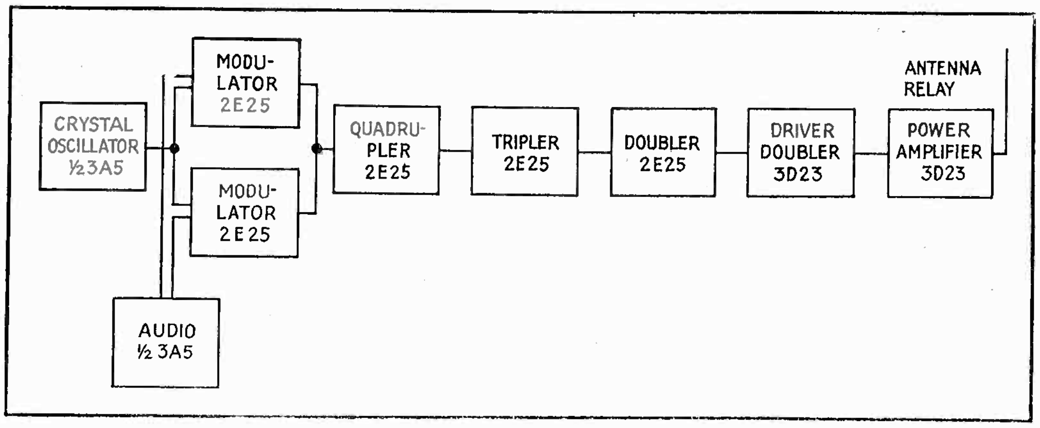


FIG. 1—Stages of the f-m transmitter for mobile service; both transmitter and receiver are on one chassis

The next three stages, using 2E25 tubes, result in an overall frequency multiplication of 24 times. Following these, a 3D23 driver doubles the frequency and provides excitation to the final 3D23 power amplifier. This stage connects to the antenna through a changeover relay which permits receiver operation when not transmitting. Meter shunt resistors are connected in the grid return of the various stages and, with a selector switch, permit the use of a single meter for checking grid drive and tuning all circuits except the antenna.

The receiver block diagram is shown in Fig. 2. The amplified signal from the 9001 r-f stage is impressed upon the first mixer, a 6AK5. Proper injection voltage is obtained from the 1T4 fourth doubler stage, at a frequency sixteen times that of the 1T4 crystal oscillator. The output from the first mixer is coupled to the second 6AK5 mixer, which obtains its injection voltage from the second doubler.

Double Limiter

Output from the second mixer is amplified through three i-f stages, using 1T4 tubes. The third i-f stage is coupled to the first 1T4 limiter, from which point the avc voltage which is applied to the two mixer and three i-f stages is also obtained. Overall gain from the antenna to the first limiter grid is sufficient to provide saturation of the grid by internal set noise.

The second limiter is transformer

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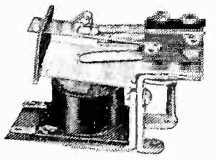
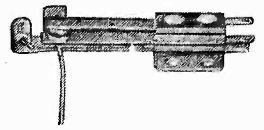
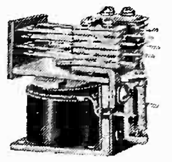

Series 100 Snap-Action Relay


Guardian Featherub Switch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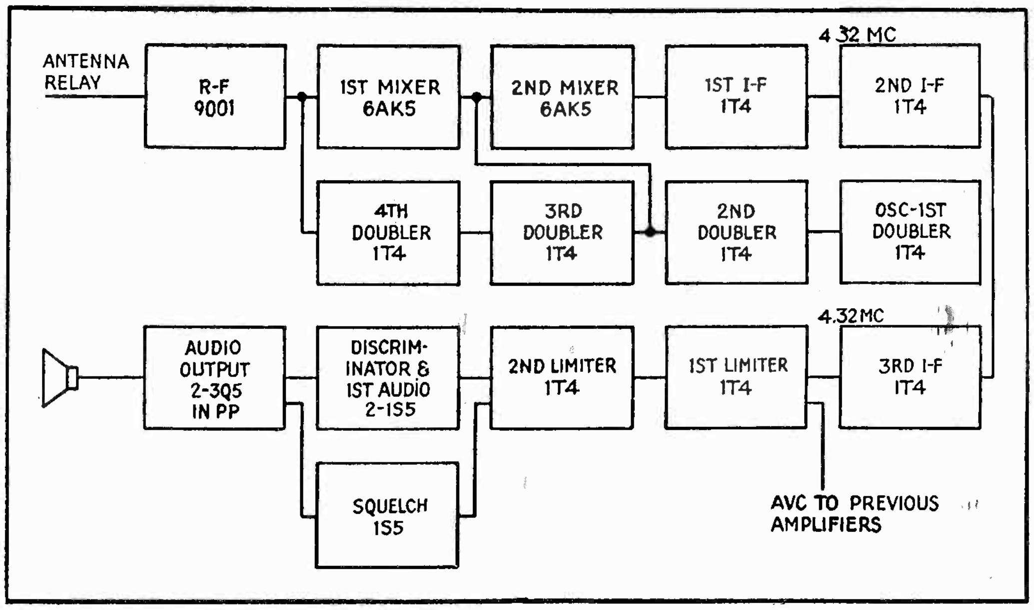


FIG. 2—In the Communications Company receiver, the same crystal oscillator is used for each mixer. The first mixer uses the sixteenth harmonic and the second mixer uses the fourth harmonic

coupled to the diode plates of the two type 1S5 tubes. The pentode sections of these tubes serve as pushpull a-f amplifiers for the out-of-phase audio voltage developed across the discriminator diode load resistors. Two 3Q5 tubes serve in the pushpull audio output stage.

Squelch Circuit

In the absence of a signal, the limiters are saturated by shot noise and considerable a-f noise voltages are developed in the plate circuit of the second limiter tube. This noise voltage is coupled through a high-pass filter to the grid of the 1S5 squelch tube. This filter removes the low-frequency audio components below 12,000 cps, preventing the possibility of carrier modulation tripping the squelch. After amplification by the pentode section of the 1S5 squelch tube, the noise voltage is applied to the 1S5 diode. The negative voltage developed across the diode load resistor is used to bias the pushpull a-f tubes near cutoff.

When a signal is received of sufficient strength to override the noise level, the noise voltage from the second limiter disappears. Thus the cutoff bias is removed and the 3Q5 tubes are restored to normal bias and operation. Positive squelch operation is further obtained by means of a relay in the plate and screen supply circuit of the 3Q5 tubes which operates when the bias is applied from the squelch circuit. In the squelched condition, the relay is open and the relay contacts short the speaker voice coil circuit to ground. Upon receiving a signal, the relay is closed, and in addition to removing the ground from the voice coil circuit, it closes the circuit to the red indicator lamp on the control panel.

On single-channel operation, the squelch circuit is so adjusted that a sharp whistle in the microphone causes the red lamp to flicker thus giving the driver a means of checking both transmitter and receiver circuits for correct operating conditions.

In addition, the receiver is so designed that adjustment of the transmitter frequency may be made using the readings of the receiver discriminator circuit which has previously been checked against the headquarters transmitter. This technique eliminates the need for any frequency checking equipment except at headquarters, unless crossband operation is used.

AFC At 10 Centimeters

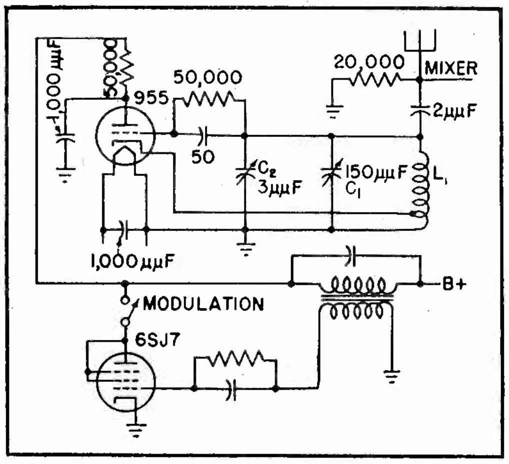
AUTOMATIC frequency control of a centimeter-wave oscillator is done by G.E.C. of Great Britain by first feeding a small part of the output of a velocity-modulated oscillator operating near 10 centimeters into a cavity resonator. The resonant frequency of the cavity is varied at 50 cps by an oscillating plunger in its base and the output voltage is rectified and fed into a phase discriminator.

If the mean resonant frequency of the cavity is the same as that of the oscillator, the discriminator voltage is zero, but if the frequencies are different an out-of-balance voltage is produced by means of which the oscillator frequency is automatically adjusted to equal the mean frequency of the cavity.

Frequency Meter for 50 to 600 Mc

By J. W. WHITEHEAD
Yorkshire, England

ALTHOUGH absorption wavemeters are available for the measurement of transmitter frequencies operating up to and around 50 cms, heterodyne wavemeters for the calibration and adjustment of receivers at these frequencies are not readily available. To meet this need, United States Army type BC-221 frequency meters were modified to cover the band from 50 to 600 mc.



New r-f oscillator and modulator circuits for the BC-221

The new circuit is shown in Fig. 1. The existing r-f oscillator is removed and is replaced by an electron-coupled circuit incorporating a 955 acorn tube. A new inductance L_1 is wound with an internal diameter of $\frac{5}{16}$ inch, composed of three turns of 0.05-inch diameter silver-plated copper wire. Together with other associated components, this is mounted on the main tuning capacitor C_1.

The fundamental frequency range of this oscillator is from 50 to 100 mc, and large harmonics up to at least the sixth are readily generated. The antenna to mixer coupling

(continued on p 166)

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INDUSTRIAL CONTROL

Edited by VIN ZELUFF

Radar for River Towboat Traffic

MARINE RADAR on river towboats has been given winter tests in experimental runs on the Ohio and Mississippi rivers. The tests were conducted by the Ashland Oil and Refining Company, the U. S. Coast Guard and Sperry Gyroscope Company.

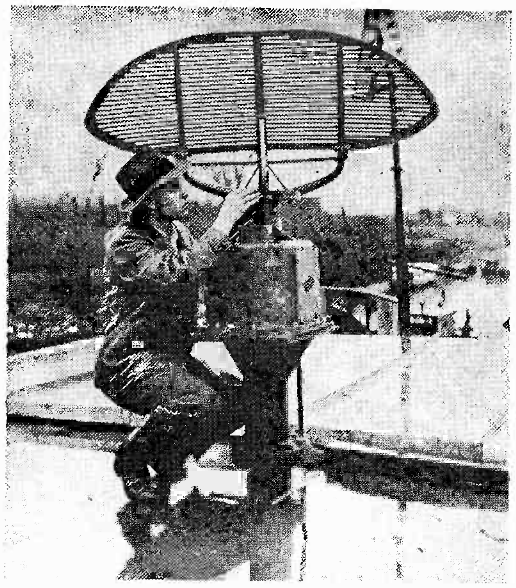
River navigation is carried on under extremely close restrictions compared to navigation on the open sea and ever since the first steamboat trip from Pittsburgh to New Orleans, river pilots have been unable to navigate in heavy fog. The only thing a pilot can do is to stay tied to the bank until the fog lifts, which may be any time from one to twelve hours. There have been instances of boats being fog-bound for as long as two days. Fogs are particularly prevalent in the Ohio Valley in the autumn and may limit visibility to less than 20 or 30 feet. One-thousand foot length of barges out in front of the towboat is not uncommon.

Capt. Kent Booth, master of the *Tri-State* towboat used in the tests, said the Sperry radar showed clearly the shore line of the river, approaching craft which were beyond view, boats tied to the bank, bridges and power lines crossing the river, locks and dams and other objects.

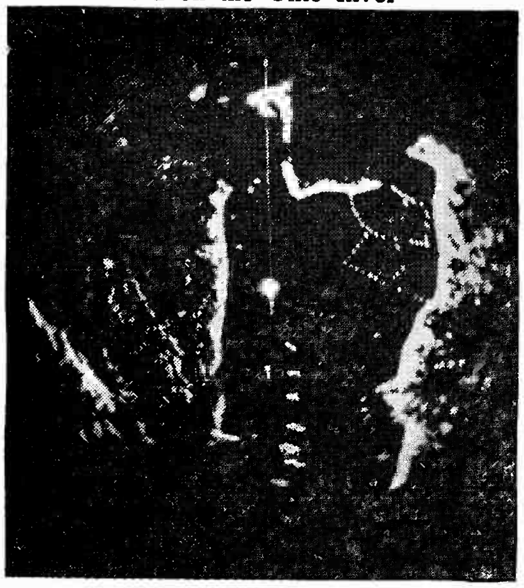
One incident that convinced the master of radar's sensitivity occurred on a night run between Pt. Pleasant and Kenova, West Virginia. "At one point," he said, "something showed up on the radar scope that we thought was a buoy. We looked out but couldn't see any buoy light, and then ordered the searchlight turned on it. It was a gallon oil can."

The radar set aboard the *Tri-State* is identical to the equipment which has been through all-weather testing aboard Interlake's ore-carrier *Armstrong* in the Great Lakes and Sperry's laboratory yacht *Wanderer* in the Atlantic, the lakes, rivers, harbors and canals.

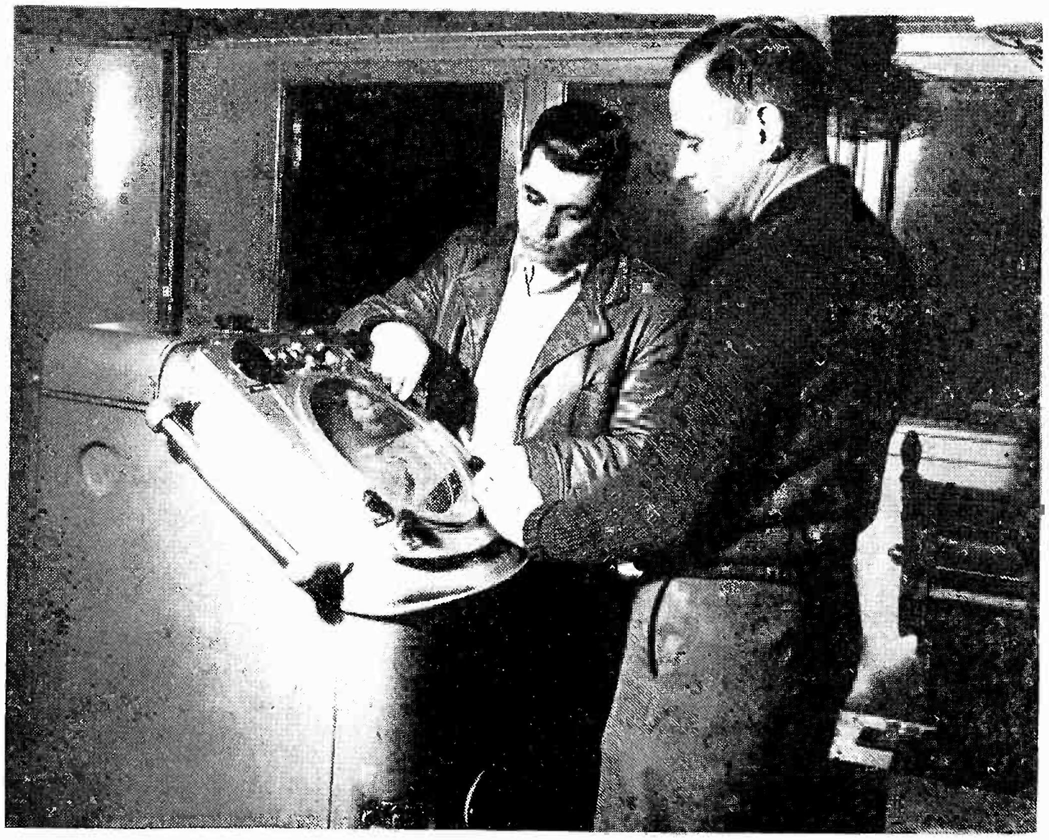
The Coast Guard installed radar targets at four points along the Ohio to aid in checking the operation of the radar aboard the *Tri-State*.



Radar antenna aboard the *Tri-State* for its trial run as a commercial navigation aid on the Ohio River



Advantages of radar on inland rivers are illustrated by this ppi presentation. The center dot shows the ore-carrier *Frank Armstrong* after passing seven vessels anchored because of fog. Ahead, to left of heading flasher, are a lookout station and buoy. At right is a log boom and pilings. Near Sault Ste. Marie Canal, 18 anchored vessels were passed in the fog



Movement of Ashland Oil's river barges in fog is speeded up by this Sperry radar. Capt. Booth, right, of the *Tri-State*, discusses the ppi with an engineer

Electronic Seismograph

By R. L. ARRINGDALE

Director of Research
Diamond Instrument Co.
Wakefield, Mass.

THE FIELD of seismology is divided roughly into two branches; prospecting, which is used by the larger

(Continued on p 178)

THE ELECTRON ART

Edited by FRANK ROCKETT

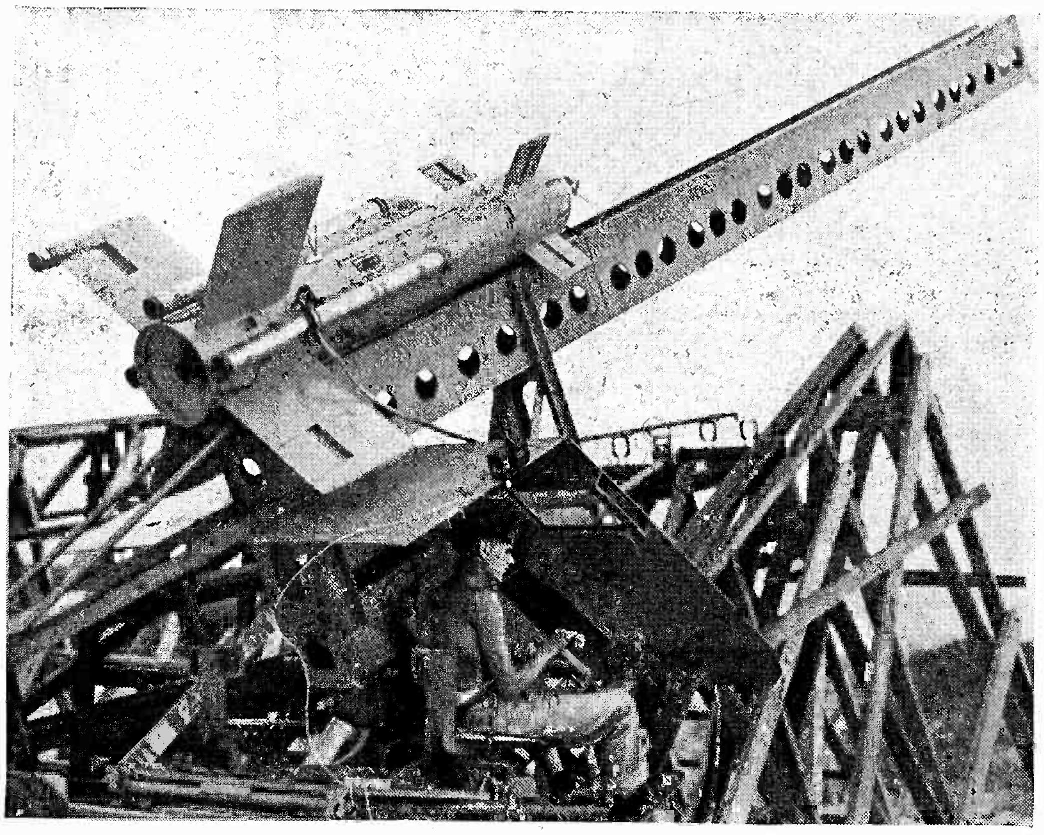
Pilotless Airplane and Missile Control

HIGH-SPEED, high-altitude aircraft and missiles cannot be satisfactorily controlled directly by human pilots. Such pilotless airborne vehicles include rockets to the stratosphere and moon, mail delivery rockets, aircraft undergoing severe flight testing, and guided missiles, either projectiles or bombs. Application and improvement of these vehicles require extension of electronic techniques used to control their flight.

Functions of Pilot

Performance provided by electronic plots can be broken down into several functions.[1] As all aircraft or missiles are intended to reach a particular objective, the piloting mechanisms must provide *target detection*. Detection may be performed in a number of ways, either by orientation of the launching of the missile, as was used in several glide bombs and rockets, or by detecting heat, by television (ELECTRONICS, p 268 Jan 1946), or by radar (ELECTRONICS, p 268 Feb 1946).

It is necessary to track the target to correct for variations in flight path or target position. That is, an additional function of *acquisition* needs to be added to the search function. Associated with target acquisition is a computer to anticipate necessary changes in trajectory. In the case of the television bomb (ELECTRONICS, p 482 Nov 1945), a bombardier remotely controls the bomb from the mother plane by watching the television image transmitted from the bomb. In the radar-controlled bomb (ELECTRONICS, p 186 Dec 1946), the bombardier centers the forward scanning radar carried by the bomb on the target before the bomb is released; thereafter the bomb automatically homes on the target as tracked by its own radar.



Self propelled missiles that can be launched either from a ship or an airplane were developed. This one is powered by four rockets at take off and by jet propulsion while in flight. A flare mounted on one wingtip enables the radio control operator at the launching position to follow the missile in flight. A proximity fuze detonates the missile when it approaches the target

Acquisition operates through the *guidance* function to supply movement to the aerodynamic controls of the missile or aircraft. Guidance is performed by usual electronic autopilots as used in commercial and military airplanes to relieve pilots of purely routine functions and the need to exert large controlling forces. The signals developed by the acquisition function and its associated computers control the guidance mechanism. These functions can be performed by combinations of familiar electronic circuits adapted to the tactical requirements.[2]

Means of Control

Authority for guidance can be placed at several points. In the *preset* system, the parameters of the trajectory to the target are set at the time of launching by aiming the missile. An elaboration provides navigation whereby coordinates are established either by the earth's magnetic field, as in the V-1 which carried a compass to keep it on its initial course, or by such radio techniques as loran. The trajectory can be modified by *external* command as has been done in radio-controlled aircrafts used in gunnery practice (ELECTRONICS, p 300 Dec 1945) and in drones (ELECTRONICS, p 262 Feb 1946). In the Azon and Razon bombs, command of the fall is performed by radio control of the fins by the bombardier who observes the flight of the bomb, made visible at night by a tail flare.[3] The missile can provide its own target tracking signal, in which case command is by *homing* as in bombs that fall toward heat-radiating targets or targets located by the bombs' radars. In the case of command from beyond the missile or aircraft the data is transmitted to it by telemetering.

Development of Autopilots

The assault drone, used to obtain samples of radioactive gases at the Bikini[4] atomic bomb tests (ELECTRONICS, p 294 May 1946, also p 330 April 1946), grew out of the radio-

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for their new Broadcast Stations

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MEN WHO KNOW news pick the "big news in radio"—FM by Federal. From New York to Nebraska—from Wisconsin to Kentucky—these eighteen newspapers in eleven states are going on the air with new FM broadcasting stations. And—like so many major radio stations from coast to coast—they have *all* selected Federal equipment.

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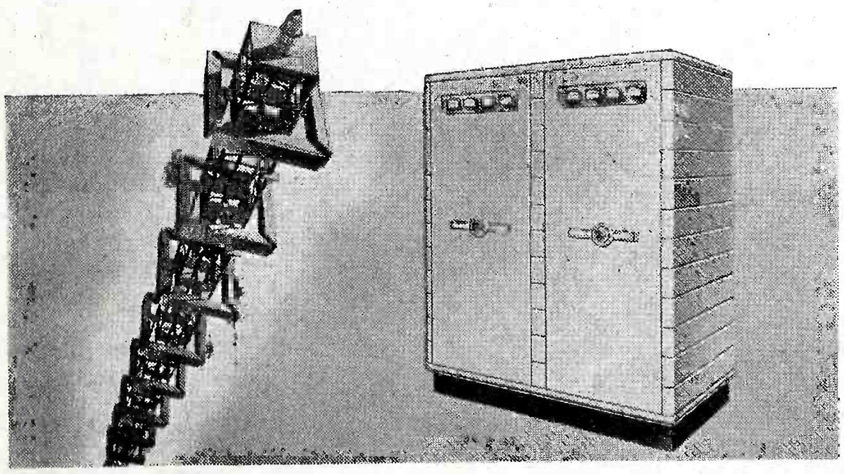

Federal's **SQUARE-LOOP ANTENNA** gives added effective radiation strength—up to 8 times that of the rated transmitter output.

The **"FREQUEMATIC" MODULATOR** is an exclusive feature of every Federal FM transmitter—assuring greater center-frequency stability, simplicity of operation and longer life.

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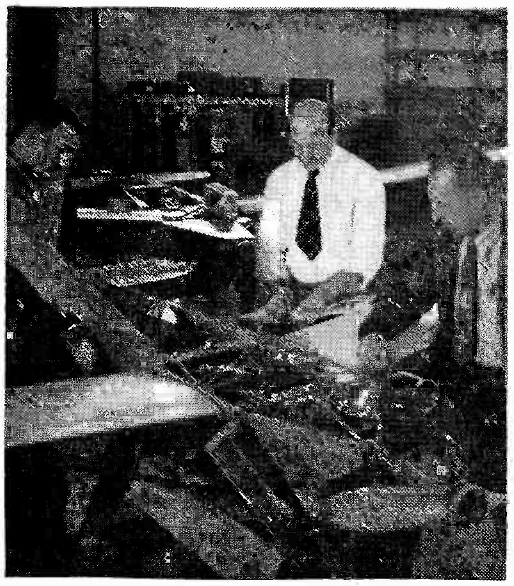
Newark 1, New Jersey

controlled target drone. Guidance from the ground or mother craft can be provided for these on the basis of information presented by television (ELECTRONICS, p 332 April 1946, also p 298 May 1946) or by radar. Command type of guidance is relayed to the drone by telemetering usually from the operator's controls.

Visibility, especially in overcast or at night, is an essential prerequisite to pilotless control. In the gravity-propelled Bat, a radar in the nose provides the visibility necessary to locate a target (detection). The radar scanner tracks the target (acquisition). The error signal from the scanner actuates the aerodynamic control surfaces (guidance of the homing type). Radio proximity fuzes (ELECTRONICS, p 110 Nov 1945, also p 226 and p 228 Jan 1946), developed for bombs, rockets,[5] and antiaircraft[6] munitions and used to detonate the radio-controlled, rocket-propelled missile (ELECTRONICS, p 206 March 1946) designed to attack the Kamikaze planes, afford visibility of the target to the missile.

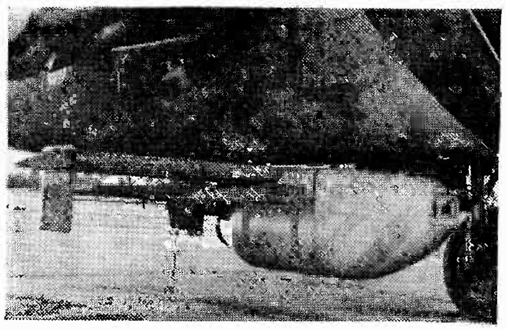


Drone target planes, such as this one for which some improvements are being planned, served as the proving ground for development of remotely controlled aircraft. Circuits used to control target drones were adapted to guide Weary Willies, warweary B-17's loaded with ten tons of explosive, which were flown by control from mother planes in formation with conventionally manned planes until within sight of the target. The Weary Willies then proceeded alone in power dives into the target

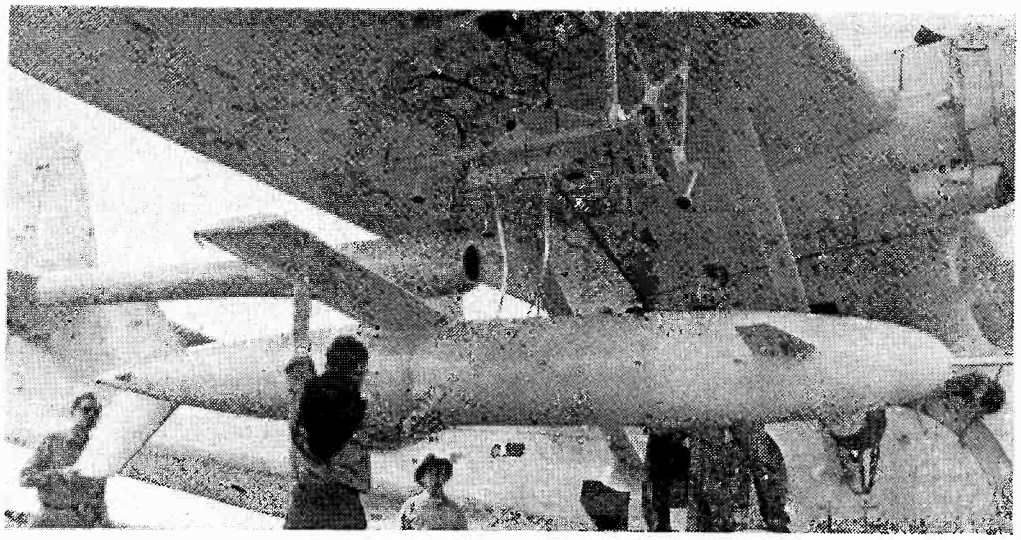
Performance of individual circuits necessary to provide the functions outlined above are generally similar to those developed by the electronic industry for other purposes. The requirements for use in guiding missiles include operation at extremes of temperature and at high altitudes and high accelerations. Transmission and reception of electromagnetic energy (radio and heat waves in particular) present problems of antennas. Due to high velocities of these airborne vehicles, external antennas are prohibited. The antennas can be inside the structures and provided with electromagnetic windows and lenses, or radiation can be through holes in the surface, such as the slot antenna.

Another possibility is to have portions of the missile function as the antenna.

The ultimate accuracy with which the vehicle can track its target depends on noise. The noise from beyond our atmosphere, especially from the sun (ELECTRONICS, p 200 Aug 1946, also p 290 June 1946), may render missiles blind in certain directions. (The Germans had developed an antiaircraft rocket that homed on heat from an airplane's exhaust, but it frequently attempted to home on the sun.) Other sources of noise are scattered and reflected radiation due to yaw and pitch of the target and the missile, and perturbation of the plane of polarization produced by random reflections. To determine the magnitudes of these noises, propagation studies are being made, both of the transmission of the ionized layer to radiation from beyond the earth[7,8] and of its reflective properties (ELECTRONICS, p 264 August 1946, also p 262 July 1946). Related to the problem of noise is that of effective target area for the type of detection used, and the problems of generating high powers and detecting weak powers. There are also limitations presented by the atmosphere such as resonance absorption of certain frequencies and the bending of radio waves by temperature and humidity gradients in the atmosphere that are not fully understood. The reliability with which pilotless vehicles can be controlled in flight thus depends on many factors, but tests (ELECTRONICS, p 296 May 1946) show that the problems are not insolvable.



Glide bombs and glide torpedoes are carried by long range bombers to target areas, but not to within range of target defenses, and released. The missiles travel at between 200 and 300 miles an hour in gliding toward the target, falling one foot for every six feet traveled forward. This glide bomb homes on the target by television. An air frame consisting of wings, control surfaces, and a homing head suitable for the type of target being attacked is attached to conventional bombs or torpedoes



To extend the accurate range from which a plane can launch its bomb load toward a target, rocket driven bombs are used. In this rocket driven bomb (the rocket engine is above the body of the bomb), a compass in the nose provides directional sense. The rudder at the tail and the elevators near the nose are controlled by individual servoes from a gyro control. Air, fuel, and explosives are carried in the main body

(1) Piore, E. R. and R. M. Page, Elec-

(continued on p 192)

It may look good on paper . . . and perform superbly under regulated laboratory voltages, BUT . . . when it encounters the *unstable* voltages that are available to your customers, what happens—

—to costly filaments and tubes?
—to precision parts?
—to sensitive, balanced circuits?
—to over-all efficiency?
—to customer good-will?

The operating voltage you specify will never be consistently available unless you make provision for it. That can be done most economically and satisfactorily by including an automatic, self-protecting SOLA Constant Voltage Transformer as a "built-in" component of your equipment.

There are many standard models in SOLA Constant Voltage Transformers that have been specifically designed for built in use. They are being successfully used today by many manufacturers of electrically energized equipment who have *guaranteed* the availability of constant rated voltage. May we make a recommendation for your equipment?

Write for Bulletin DCV-102
. . Here is the answer to unstable voltage problems.

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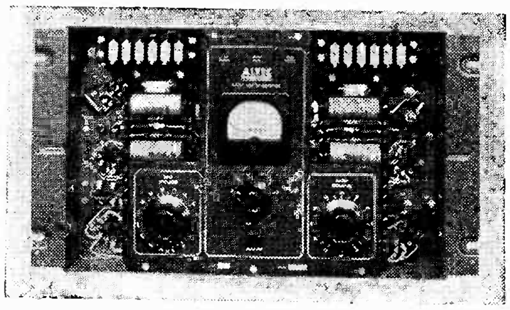
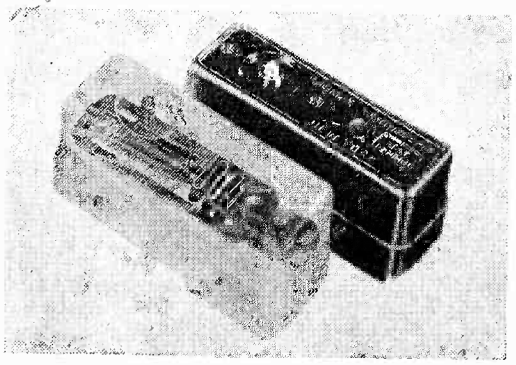


output beyond this point. A meter having a 100 percent point and calibrated in DB LIMITING permits the operator at all times to know the amount of limiting taking place. When desired a remote meter can be connected. Provisions are also made so that the NAB-orthacoustic preemphasis equalization which is a built-in feature can be utilized since the limiting is controlled from the preequalized voltage. With proper balancing the thump when limiting, will be 50 db down from the signal level. Gain at 1000 cycles with the equalizer out is 68 db; with the equalizer in, it is 60 db. Hum and noise with the equalizer out is -45 db; with the equalizer in it is -52 db. Frequency response with the equalizer out is ± 1 db 20 to 20,000 cycles. Normal limiting threshold is $+$ 17.2 db. The attack time is 0 to 0.0002 second and the release time is normal at 0.5 second.

Snap-Action Switch (6)

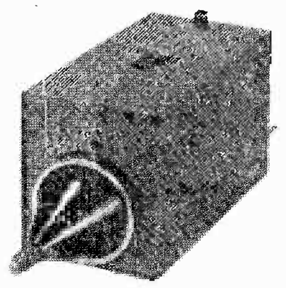
UNIMAX SWITCH CORP., a Subsidiary of The W. L. Maxson Corporation, 460 West 34th St., New York 1, N. Y. The Unimax moving member of heat-treated beryllium copper, with tongue ribbed for maximum



stability, gains a uniform characteristic from the folded flat spring section which exerts high contact pressure and produces instant traverse. The nonrotatable actuator button assures an application of force to the same spot on the tongue throughout life of the switch. Contacts are silver, laminated on copper; the moving contact has a low mass for minimum contact bounce. For convenience in production assemblies, one mounting hole is elongated. Overall dimensions of the molded phenolic case are $1\frac{15}{16}$ x $\frac{11}{16}$ x $\frac{13}{16}$ inch. Electrical ratings: 15 amp, 125 volts; 5 amp, 250 volts; $\frac{1}{2}$ hp, 115 to 460 volts, 60 cycles; all units are spdt.

VHF-UHF Load Resistor (7)

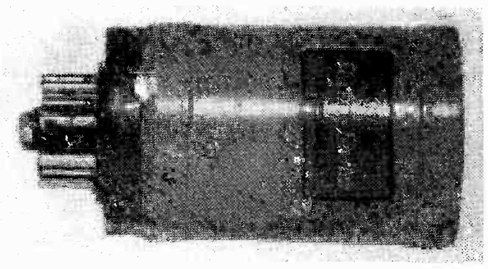
BIRD ELECTRONIC CORP., 1800 E. 38 St., Cleveland 14, Ohio. The model 69 Termaline resistor is the latest development in low vswr coaxial loads. For laboratory and production tests it offers a constant re-



sistance of 51.5 ohms through a frequency range from d-c to well over 1,000 mc. Without auxiliary cooling, it will dissipate 300 watts; connected to tap water supply, (through hose stems at rear of unit), it will handle 1 kw with ease. Flow rate of $\frac{1}{2}$ gallon of water a minute is satisfactory. At frequencies below 100 mc, the r-f resistance is within 2 percent of the d-c resistance and reactance component is very small. The d-c resistance is held to ± 5 percent. Above 100 mc typical voltage standing wave ratios for a 51.5-ohm d-c resistor lie between 1.02 and 1.04. In addition to the N connector shown, the unit can be furnished with larger connectors.

A-C Relay (8)

ELECTRO-SWITCH AND CONTROLS CO., Box 453, Culver City, Calif. Originally designed for 400-cycle aircraft inverter control, the relay illustrated operates satisfactorily in the frequency range 10 to 10,000



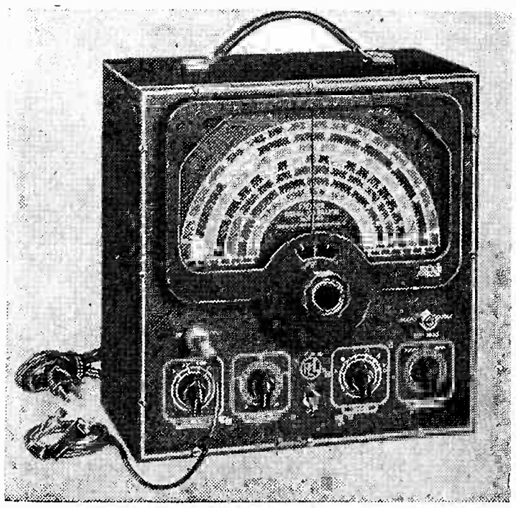
cycles. It is hermetically sealed, will operate in an ambient temperature in excess of 250 degrees F, and is said to contain a new type of rectifier. It is available in ratings up to 10 amperes at 120 volts a-c or 24 volts d-c with contact assemblies up to 3pdt in the octal base type or with screw terminals.

Insulation Resistance Meter (9)

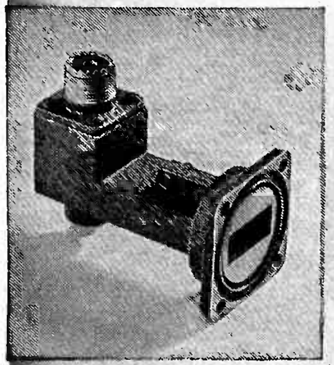
ASSOCIATED RESEARCH, Inc., 231 South Green St., Chicago 7, Ill. The Model 261 Vibrotest is a self-contained portable testing meter that measures resistance up to 50,000 megohms on a scale that is centered at 1,200 megohms. Tests are made at 500 volts, provided from a pair of dry cells and a vibrator circuit, so that no cranking is necessary. Accuracy is maintained by a voltage regulator in the measuring circuit. Housed in a weatherproof steel case, the portable unit weighs $17\frac{1}{2}$ pounds.

Signal Generator (10)

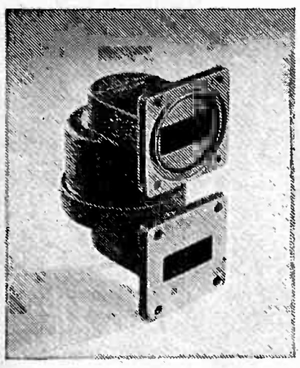
PREMIER ELECTRONIC LABORATORIES, 382 Lafayette St., New York 3, N. Y. A new precision tuning signal generator Model No. 570 is specially designed for f-m and television alignment. Frequency range covered is from 75 kc to 50 mc on fundamentals and up to 150 mc on the



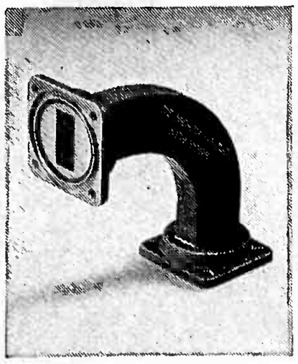
EVERY DE MORNAY-BUDD WAVE GUIDE
is Electrically Tested, Calibrated and Tagged



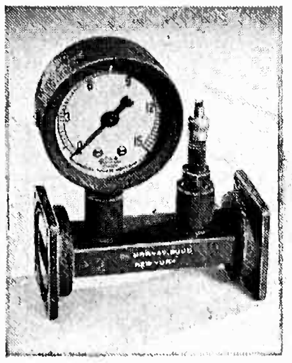
Crystal Mount DB-453



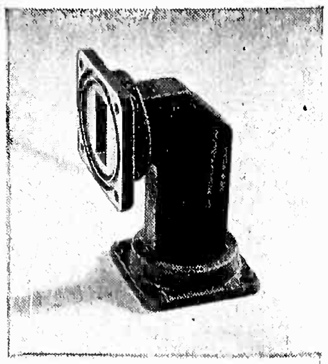
Rotating Joint DB-446



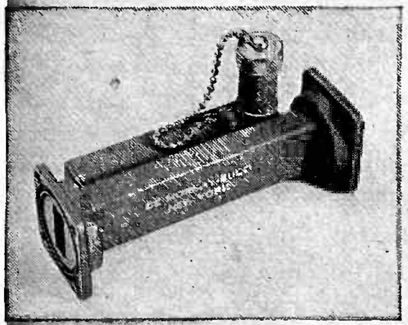
90° Elbow (H Plane) DB-433



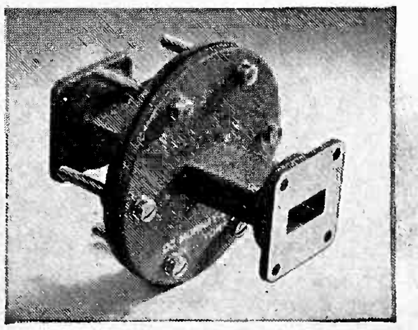
Pressurizing Unit DB-452



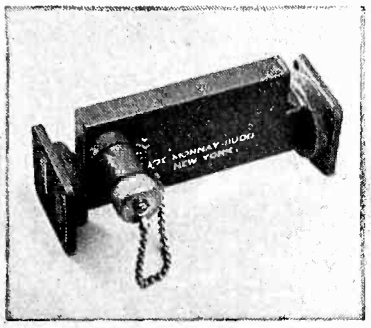
Mitered Elbow (H Plane) DB-439



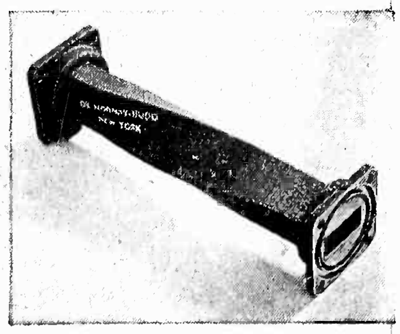
Uni-directional Broad Band Coupler DB-442



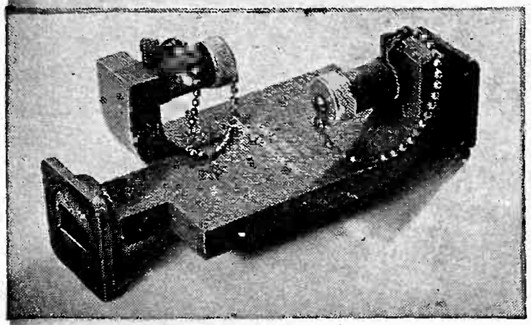
Bulkhead Flange DB-451



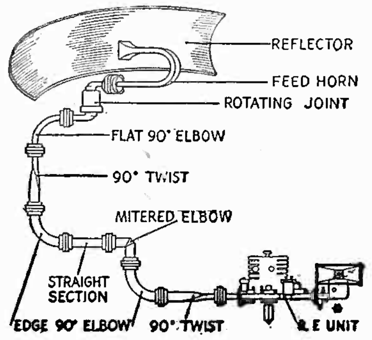
Uni-directional Narrow Band Coupler DB-440



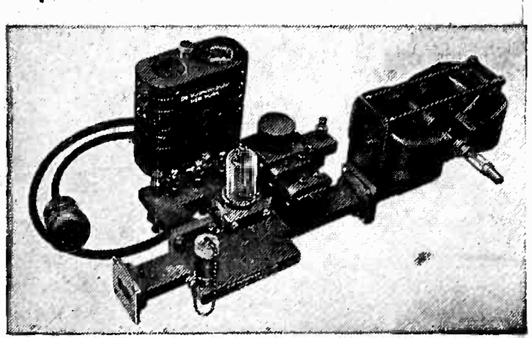
90° Twist DB-435



Bi-directional Narrow Band Coupler DB-441



Typical wave guide assembly illustrating use of De Mornay-Budd components available from standard stocks.



RF Radar Assembly DB-412

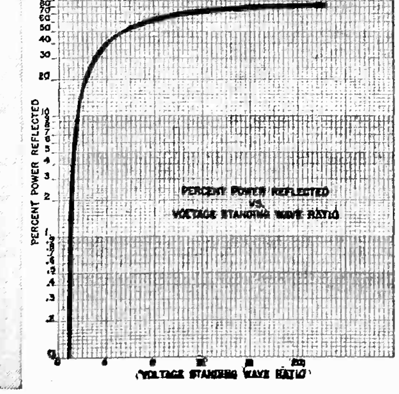
When you use any De Mornay·Budd wave guide assembly, you know exactly how each component will function electrically. You avoid possible losses in operating efficiency through impedance mismatches, or breakdown and arcing caused by a high standing wave ratio. (See chart below.)

De Mornay·Budd wave guides are manufactured from special precision tubing, and to the most stringent mechanical specifications. Rigid inspection and quality control insure optimum performance

NOTE: Write for complete catalog of De Mornay·Budd Standard Components and Standard Bench Test Equipment. Be sure to have a copy in your reference files. Write for it today.

The curve shows the manner in which the reflected power increases with an increase in the voltage standing wave ratio. The curve is calculated from the following equation:

$$\%\ \text{Power Reflected} = \left(\frac{\left(\frac{V_{max}}{V_{min}}\right) - 1}{\left(\frac{V_{max}}{V_{min}}\right) + 1}\right)^2$$



DE MORNAY BUDD

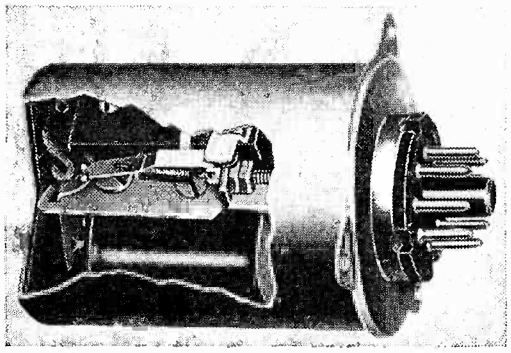
EQUIPMENT FOR 97% OF ALL RADAR SETS

De Mornay-Budd, Inc., 475 Grand Concourse, New York 51, N. Y.

third harmonic. Air trimmers are used on all bands. Calibration is stable and accurate to 0.5 percent up to 1,600 kc and 1 percent on higher frequencies. The buffer stage is modulated by an internal 400-cycle generator providing pure sine wave modulation (less than 5 percent distortion) as well as an audio signal for external testing purposes. The instrument can also be modulated by an external variable audio oscillator.

Sensitive Relay (11)

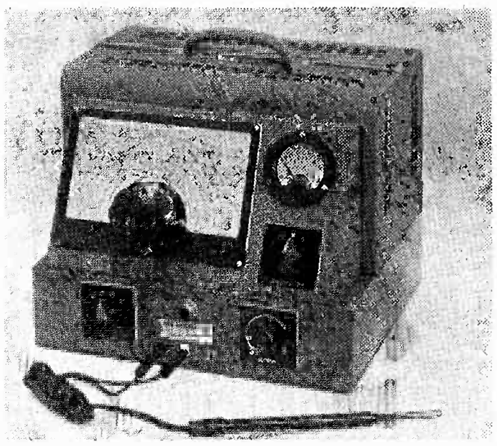
WARD LEONARD ELECTRIC Co., Mount Vernon, N. Y. The new Bulletin 108 sensitive relay is a plug-in type mounted on a standard octal plug base and enclosed in a cylindrical metal can hermetically sealed.



The relay is provided with a normally open single-pole contact having ratings of 2 amperes 24 volts a-c or d-c, 0.75 ampere 125 volts d-c and 2 amperes 125 volts a-c. The a-c ratings are for noninductive loads at commercial frequencies. Average coil consumption is 0.056 watt so that the relays are suitable for current-sensitive applications from 1.3 milliamperes to 0.54 ampere on direct current and are applicable for operation on nominal voltages from 0.1 to 48 volts d-c.

Variable Frequency Stimulator (12)

RAHM INSTRUMENTS, Inc., 12 West Broadway, New York 7, N. Y. A new electrophysical stimulator supplies frequencies in the range of 11.5 to 1,300 cycles per second in either sawtooth or sharp pulse shape. Maximum output of 10 volts is available with continuously variable output adjustable within 2 millivolts. Good frequency stability for line voltages from 95 to 125



volts is obtained by use of a regulated voltage supply for the oscillator section.

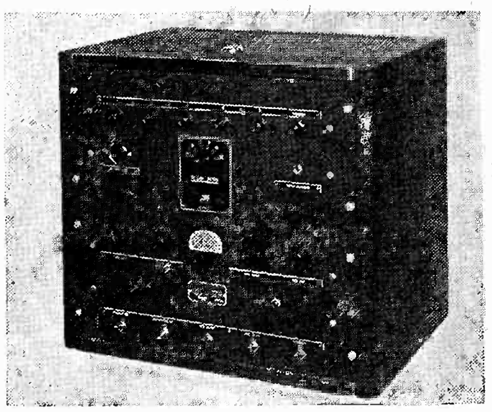
Breakdown Tester (13)

SUPERIOR ELECTRIC Co., 377 Church St., Bristol, Conn. To conform to ASTM specifications, the output voltage of dielectric break-down testers must be increased at a uniform rate. The Hypot Auxiliary has been designed to operate as an intermediary between a 35-kv oil tester and a 115-volt single-phase source. The basic element is a

powerstat variable transformer driven by a synchronous fast starting and stopping motor. Various switching arrangements enable the Hypot Auxiliary to be completely automatic or semiautomatic. Colored signal lights provide effective means of determining the operations of the unit.

Counter Set (14)

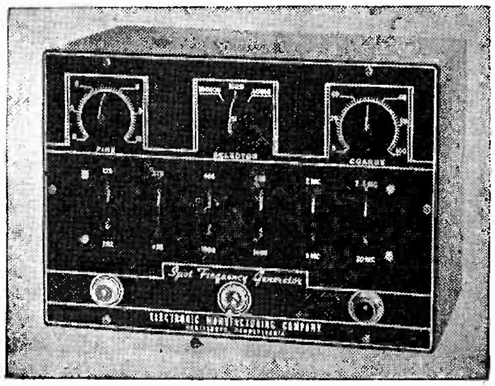
HERBACH AND RADEMAN Co., 517 Ludlow St., Philadelphia 6, Pa. The GL532C high speed counter set consists of a preamplifier, second amplifier, power supplies, including a high voltage supply for a Geiger-Muller tube, and scaling circuits arranged for connection to recorder circuits. The equipment uses 28



tubes and will record a maximum speed of 160 counts a second for radioactive substances at an accuracy of 5 percent using a commercial impulse register. Other arrangements will result in an increased counting speed. Further details are given in a bulletin.

Spot Frequency Generator (15)

ELECTRONIC MFG., Co., 714 Race St., Harrisburg, Pa. The model No. 200 generator provides 12 preset frequencies from 175 kc to 20 mc any of which can be switched to the output jack. Any of the radio fre-



quency signals most useful for broadcast receiver testing can be modulated by a 400-cycle tone furnished in the unit. Good shielding allows the attenuator to be set for an output of less than 1 microvolt.

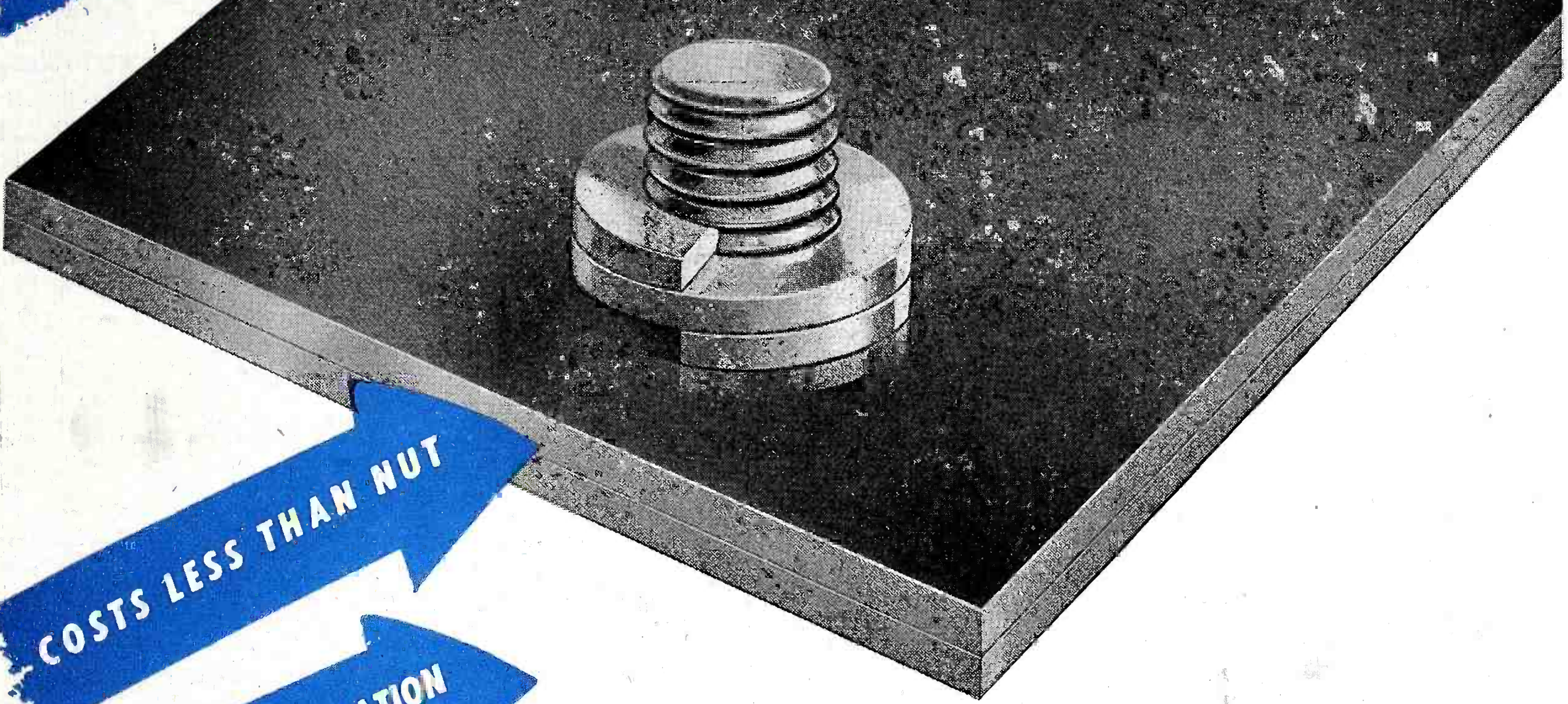
Hermetic Seals (16)

HERMETIC SEAL PRODUCTS Co., 414 Morris Ave., Newark 3, N. J. Hermico-Glass headers possess a matched coefficient of expansion;

(continued on p 218)

SPRING LOCK NUT

REVOLUTIONARY NEW FASTENER



- COSTS LESS THAN NUT
- ELIMINATES ONE OPERATION
- SURE LOCK FOR BOLT
- SPEEDS PRODUCTION
- EASILY ASSEMBLED

CUTS TIME . . . MATERIAL . . . COSTS

Here's one of the greatest advancements ever made in the field of fastening devices. A new and revolutionary fastening device developed in the engineering and research laboratories of Garrett's to meet an urgent post-war need.

It replaces the conventional nut and in one assembly operation assures a positive locking action on the bolt. The Diamond G Spring Nut has all the advantages of a regular nut and is adaptable for use in "hopper-feeders" and various types of power wrenches. Because of precision manufacturing it has greater gripping power on threads of screw or bolt and therefore resists loosening. This new Spring-Nut is priced to offer a tremendous saving over conventional nuts and other fastening devices.

Don't delay . . . get your information on this new development of Garrett's today. Write for complete information and prices on the Diamond G Spring-Nut, or just call your local Garrett office and have the Diamond G man show you how you can save with Spring-Nut on your products.

GEORGE K. GARRETT CO., INC.
1421 CHESTNUT ST., PHILADELPHIA

DIAMOND PRODUCTS

LOCK WASHERS • • FLAT WASHERS • • STAMPINGS • • SPRINGS • • HOSE CLAMPS • • SNAP AND RETAINER RINGS

NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

Spring technical meetings; Eta Kappa Nu awards resumed; Geiger-Muller counter laboratory established; engineer promotions

International Conference on Radio Aids to Navigation

U. S. MANUFACTURERS of electronic equipment for marine navigation will show their products to representatives of 60 countries at an international session sponsored by the State Department in New York City and New London, Connecticut April 28 to May 9.

The purpose of the meetings is to exhibit equipment such as loran and radar, already adopted by this country, and to discuss various technical problems and policies working towards possible standardization of certain radio navigation aids at some later meetings.

These conferences are a return engagement on a larger scale for meetings held in London in May 1946, at which time British equipment was displayed to representatives of the U.S., the Dominion, and European countries.

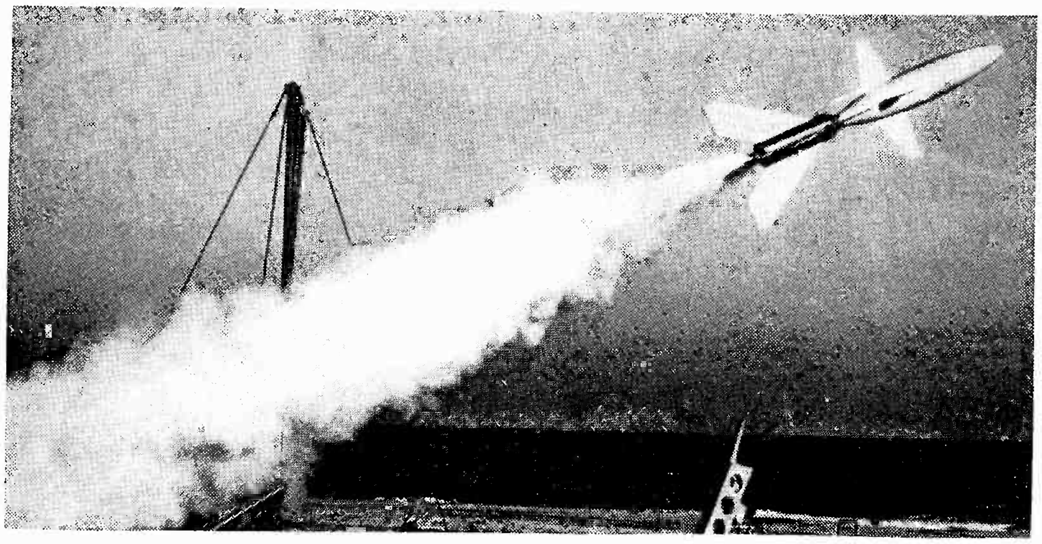
According to present plans, the first week's meetings at Hotel Roosevelt, New York City will be devoted to the presentation of about 30 technical papers, technical discussions, and exhibits of equipment. The group will move to New London for the second week to see actual tests of equipment on three vessels—a coast guard cutter, a maritime service training vessel, and a coast and geodetic survey vessel.

About 250 to 300 delegates and technical advisors are expected to attend the meetings, which are being held just previous to the World Telecommunications Conference starting May 15 at Atlantic City.

Chicago Parts Show

WITH ALL exhibit space assigned and heavy advance registration already in, sponsors of the Radio Parts and Electronic Equipment Show predict record attendance at the Hotel Stevens, Chicago, for this year's show. Monday May 12 will be National Electronic Distributors Association day, with a breakfast for manufacturer guests of NEDA members and a lunch for the sponsoring organizations (RMA, Sales Managers Club Eastern Division, Association of Electronic Parts and Equipment Manufacturers, and NEDA). The exhibition hall will be open on May 13, 14, and 15 for member exhibitors, booth attendants, members of the press, sales representatives, and distributors only. Radio amateurs and the general public will be admitted only on Friday May 16, which is open house day.

MANEUVERABLE ROCKET-POWERED MISSILE



Newest guided missile to be announced is the Tiamat, named after an Assyrian-Babylonian goddess whose emblem was a winged dragon. It is the first to be flown successfully through a predetermined program of maneuvers. Weight is 600 lb, length is 14 ft, and top speed is 600 mph. Instrumentation readings in the rocket are telemetered to the ground over a radio link, and the missile is tracked by radar during flight. Picture shows takeoff from launching platform at NACA Laboratory, Langley Field, Va.

Research Evaluation Committees

THE RECENTLY established Joint Research and Development Board under the direction of Dr. Vannevar Bush has organized a number of technical committees to study existing Army and Navy research projects. The object is to determine means of increasing the effectiveness of the research and development programs and eventually to redistribute some of the work if it is considered advisable.

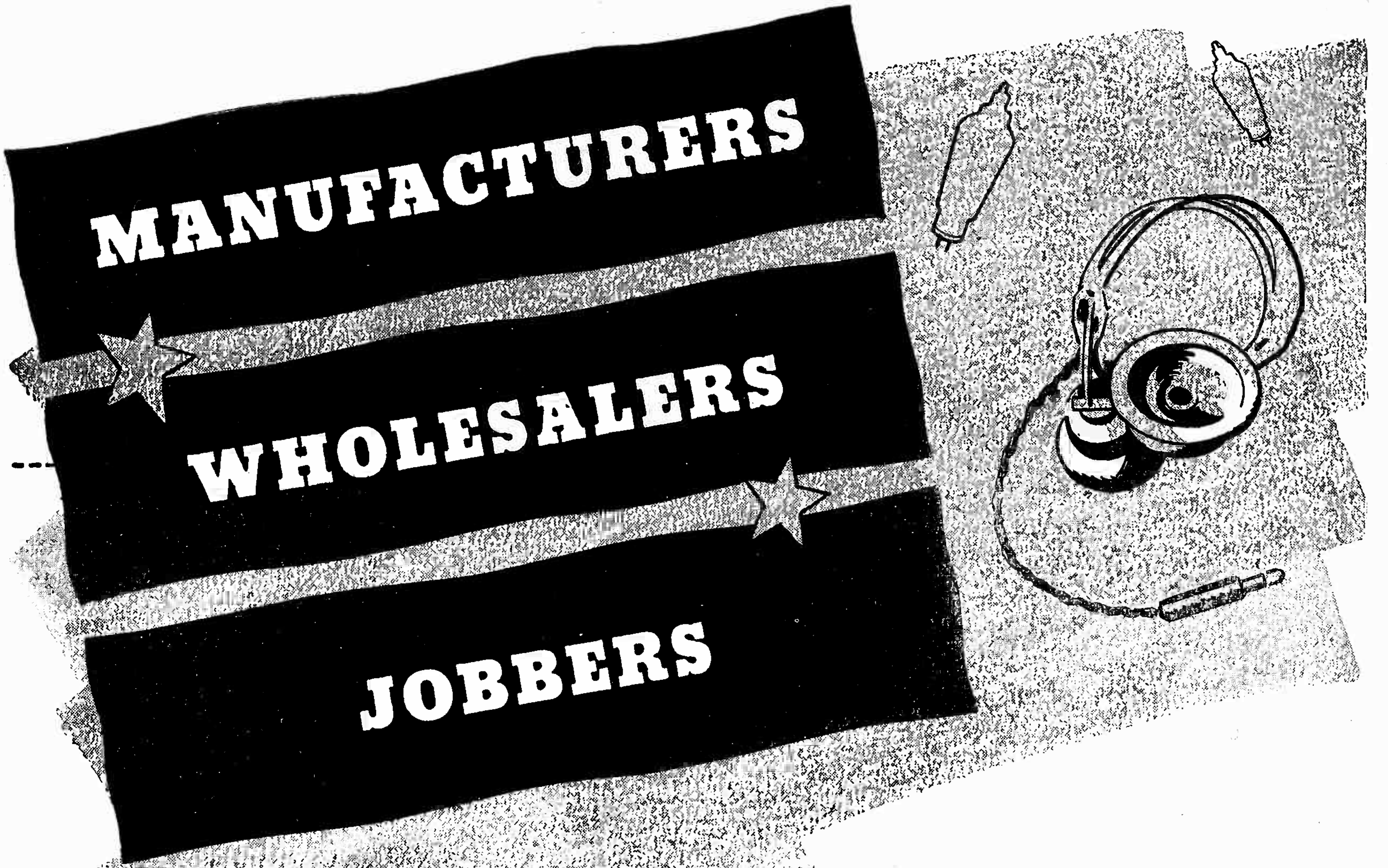
The committees will function first in an advisory capacity. However, it is expected that they will increase in power, and that some military projects may be revaluated.

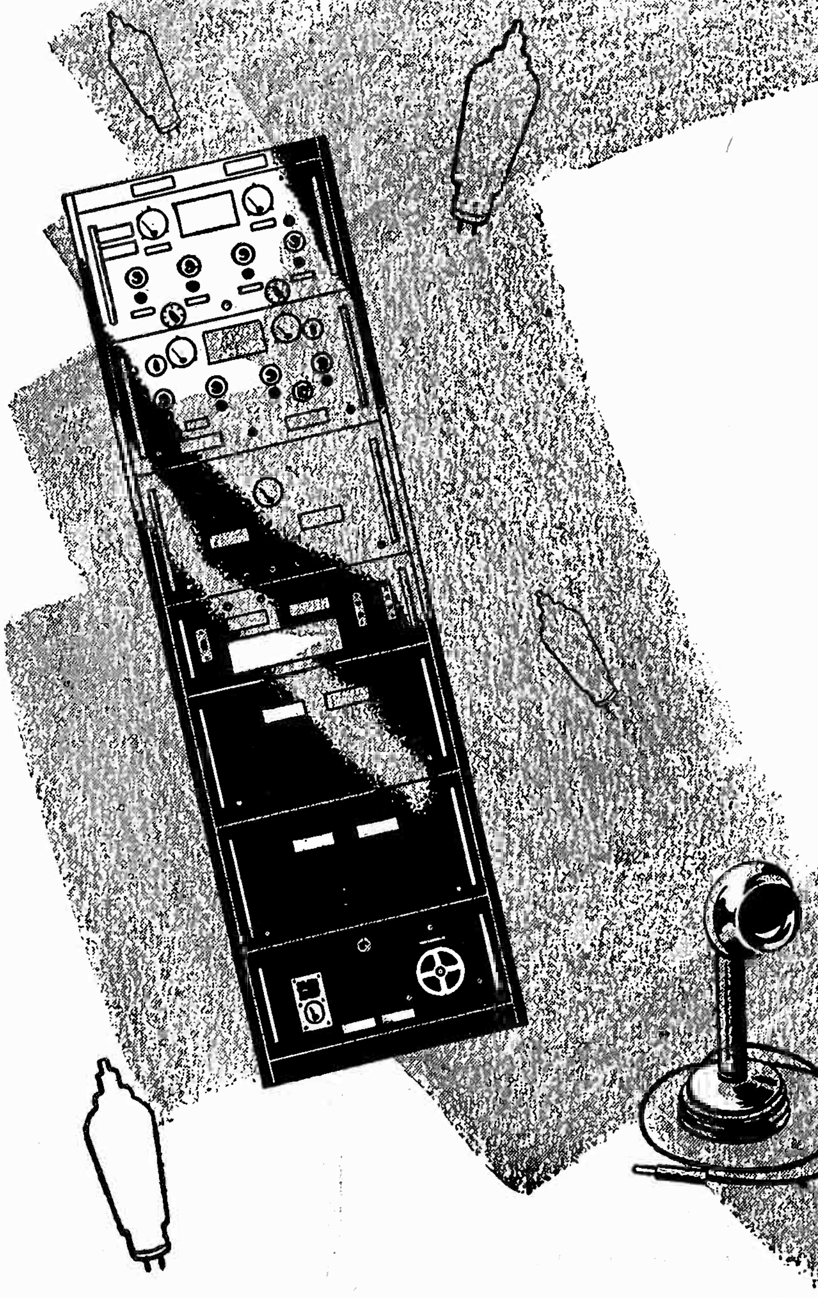
The committee on electronics is headed by Dr. J. A. Stratton, director of the Research Laboratory of Electronics at MIT, and will have such special panels as radar, communications, and countermeasures. Other committee heads are: Atomic Energy—Dr. J. B. Conant, president of Harvard University; Guided Missiles—Dr. Karl T. Compton, president of MIT; Geophysical Sciences—Dr. Roland F. Beers, president, Geotechnical Corporation, Dallas, Texas; Geographical Exploration—Dr. Charles H. Behre, Jr., professor of geology, Columbia University.

Fellowships in Electronics

A NUMBER of graduate and advanced research fellowships are of-

(Continued on p 260)



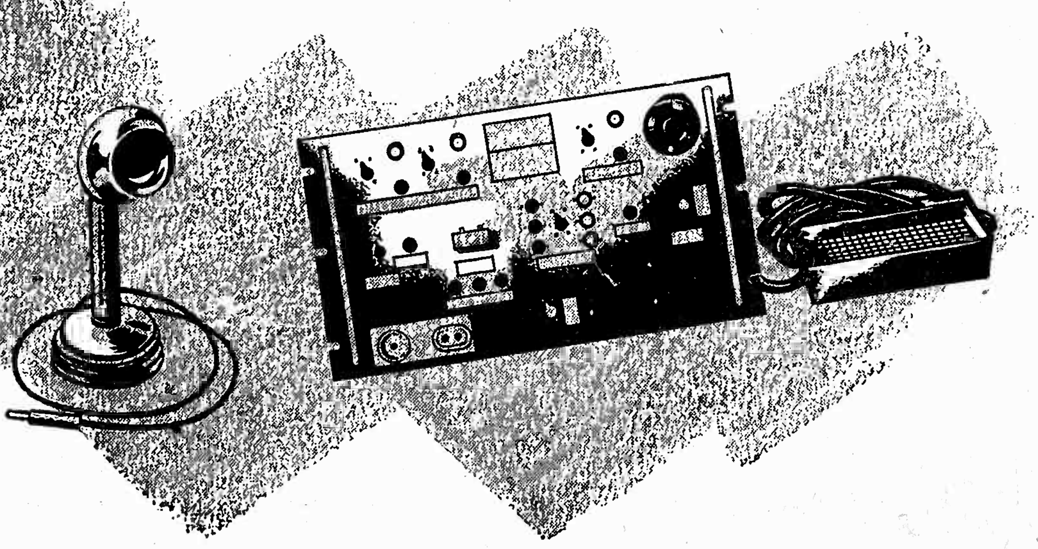


MANUFACTURERS
WHOLESALERS
JOBBERS . . .

to obtain this desirable material get in touch with your WAA approved Distributor!

Much of the huge inventory of electronic tubes and equipment, declared surplus by the armed forces, has been allocated to approved distributors for disposal.

The names and addresses of our distributors are listed here. They are equipped to serve your needs and will know what is immediately available.



TUBES AT WORK
(continued from p 148)

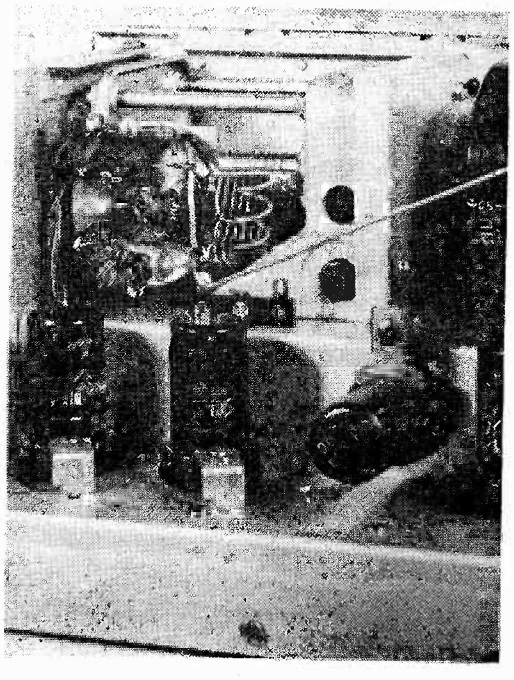
is unchanged. The remaining changes are the inclusion of an audio-frequency modulator and the substitution of the one-mc reference crystal by one of higher frequency of not less than five mc.

For modulated output, the 6SJ7 tube, formerly the r-f oscillator, is utilized. The audio-frequency oscillator components are mounted in the space originally occupied by the r-f components, and the frequency-band switch is used to turn the modulation on and off.

Operation

The method of using the modified instrument is essentially the same as that described in the instruction manual supplied with the standard instrument. A calibration book must be prepared showing the correct dial reading for at least every megacycle in the fundamental range. For this purpose, the use of a substandard frequency meter is required. The harmonic frequencies corresponding to twice, three, four, five and six times those in the fundamental range should be shown in the same book against the appropriate dial readings.

When the instrument is put into use, the oscillator frequency must first be corrected. Determine whether the frequency to be measured lies within the fundamental range or, if not, determine the fundamental frequency harmonically related to it. Next, decide which crystal harmonic is closest to this



Mounting of the acorn tube and components. A 6,200-kc correction crystal is used in this model

IN adjusting itself to its greatly expanded postwar volume Formica has arranged and installed an entirely new department for the production of tubing, much more spacious, with modern high production machinery arranged for the most efficient straight line output.

That means beginning *now* we can take care very promptly of your tubing orders, no matter how large. You can also be sure of uniformity and high quality.

Electrical characteristics of Formica tubing have been much improved by recent developments in resinoids and by production techniques that have been affected by knowledge gained by the many special problems the Formica engineering department was called upon to solve during the war.

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fundamental frequency and set the dial to the reading appropriate to it; then, with the switch at CHECK, a beat note should be heard. Adjust the correcting capacitor C_2 to zero beat and switch to OPERATE.

To determine the frequency of a transmitter, rotate the dial until zero beat with the signal to be measured is obtained; read the dial, and convert it to a frequency by interpolating between the two nearest readings in the calibration book, multiplying by the harmonic order if appropriate.

To tune a receiver, determine the correct dial setting for the frequency meter by interpolation between the two nearest calibration book readings, adjust the dial to the reading so obtained, and the appropriate fundamental and harmonic frequencies will be available at the antenna terminal. If the receiver has no c-w oscillator, the switch on the instrument previously used for frequency-band selection is set at LOW to obtain a modulated signal.

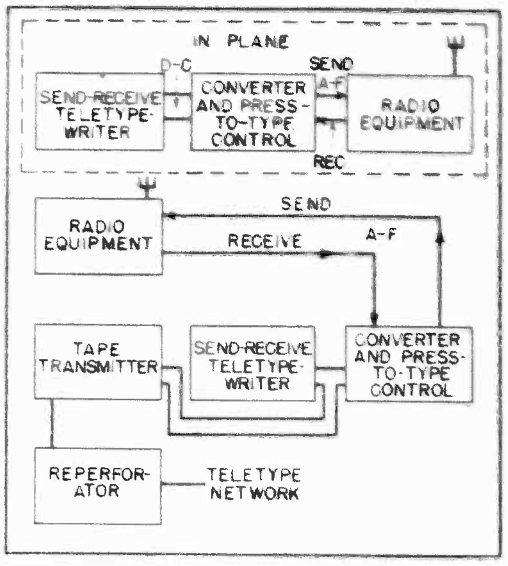
Two-Way Teletype In Air

TELETYPE METHODS of communication can be extended to aircraft in flight by use of equipment developed by Teletype Corporation engineers and Bell Telephone Laboratories. Radio-telephone facilities provided for plane to ground communication are used without modification.

For interconnecting a teletype machine and existing press-to-talk radio telephone equipment, a converter is used. This translates the electrical conditions set up by the teletypewriter keyboard into signals suitable for transmission over the radio telephone channel. When receiving, it translates the signals from the radio channel into signals suitable for operating a teletypewriter.

The unit also automatically conditions the radio equipment for transmission when the first teletype character is sent, automatically returns the radio equipment to a receiving condition after the last teletype character is sent and lights indicator lamps to show whether the radio circuit is in the transmitting or receiving condition

The converter unit produces an



Block diagram of teletype system for plane to ground operation

audio-frequency signal which modulates the radio transmitter continuously during teletype transmission. The frequency of the audio signal is varied back and forth between the frequencies of 1,615 cycles and 1,275 cycles in accordance with the teletype character being transmitted. This frequency-shift transmission has an advantage in signal-to-noise ratio over on-off keying of a single tone. Another important characteristic of the frequency-shift method is rapid and accurate compensation for changes in amplitude of the signal received over the radio circuit. For this reason no adjustments need be made during operation.

Approximately five seconds after the automatic transmission is stopped a red indicator lamp is turned off to show that the control circuits have restored the radio equipment to a receiving condition. Additional control circuits in the converter then place an electrical holding condition on the teletype unit so that it will not be operated falsely by noise received on the radio circuit in the absence of a signal.

At the beginning of each transmission a short preparatory signal is transmitted to release the holding condition which exists at all teletypewriters when no transmission or reception is taking place. This preparatory signal is supplied automatically when transmission is from perforated tape. When transmission is from the teletype keyboard a few nonprinting teletype characters are first transmitted.

After transmission from the

sending station has ceased, the radio teletype circuit goes into the idle or waiting condition, and then when another station on the network begins transmission, it is actuated to the receiving condition, as indicated by illumination of a green indicator on the converter-control unit.

Messages may be transmitted easily and accurately by personnel such as the crew chief or plane hostess who are not experienced in radio operation.

By connecting a reperforator in the plane-ground communciation circuit at the ground station, passenger message traffic may be retransmitted over commercial telegraph circuits without the necessity for retyping. Similarly a reperforator associated with the commercial land line circuit would provide messages in perforated tape form for transmission to the plane at such times as do not interfere with communications necessary to the operation of the plane.

Measuring High Potentials

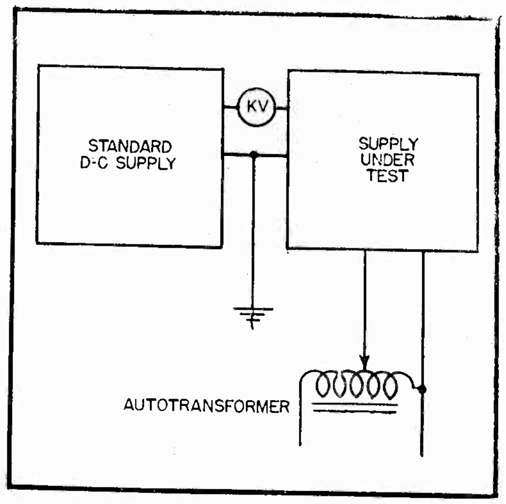
By Morton R. Whitman
Electronic Engineer
Thordarson Electric
Chicago, Illinois

A technique for measuring high d-c potentials has been effectively employed in this laboratory. Where a laboratory already possesses a continuously variable high-voltage d-c supply, no additional investment in cumbersome and expensive strings of wire-wound resistors is required.

As may seen from the diagram, the method uses a second high-voltage supply together with the one to be measured in a potentiometer circuit. The advantage of this technique is that at balance no measuring current drain is imposed on the test circuit. This means that supplies having a large effective internal impedance can be readily measured without regard to the consequent regulation.

As an illustration, take the case of a 30-kv supply with load current of 200 microamperes. The equivalent load resistance would be 150 megohms—an awkward value for a meter multiplier. This setup is additionally useful for measuring small increments in large voltages.

The meter should be of high



Simple circuit for measuring high potentials without consuming current from the supply under test

range, preferably 5 kilovolts. This is desirable since the supplies must be taken in alternate steps up to full value and surges due to gross movements of controls or transients may produce excessive voltages across the meter.

The procedure is to alternately raise each supply in sufficiently small steps so that the meter is not overloaded. When the test supply is at rated voltage, final adjustments should be made for zero deflection of the meter. At this point the voltage of both supplies is exactly equal.

Broadcast Carrier System

By F. R. Brewster

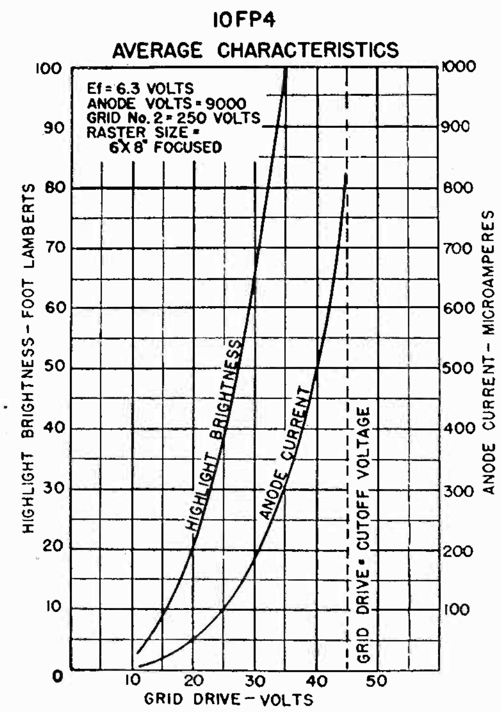
McGraw-Hill News Bureau
London, England

Over 600,000 homes in Great Britain listen to broadcast relay companies, served by some 300 exchanges in towns with an aggregate population of between six and seven millions. Surveys have shown that, where such a system is available, one in every three householders chooses this form of listening; in some communities the density of subscribers is as high as 80 percent.

The original broadcast relay services carried a single program (received from the BBC by landline wherever possible) to subscribers at audio frequencies on a single pair of wires. Later, a second program was generally made available by adding a second pair of wires. The problem confronting the relay industry was how to increase the number of programs available while keeping to the absolute minimum the number of wires linking each subscriber to the network.

Carrier-frequency transmission

Specifications of the Rauland Visitron 10FP4/R6025	
Heater Voltage	6.3 A.C. or D.C.
Focusing Method	Electromagnetic
Deflection	Electromagnetic
Deflection Angle	50 Degrees
Screen	Phosphor P4 Aluminized Reflector
Bulb Diameter (Max.)	10⅝″ at screen end
Length	17⅝″ ± ⅜″
Base	Small Shell Duodecal 7 Pin
Anode Terminal	Cavity
Anode Volts (Max.)	13,000
Anode Volts (Operating)	9,000
External Coating (Optional): 500 mmf.	

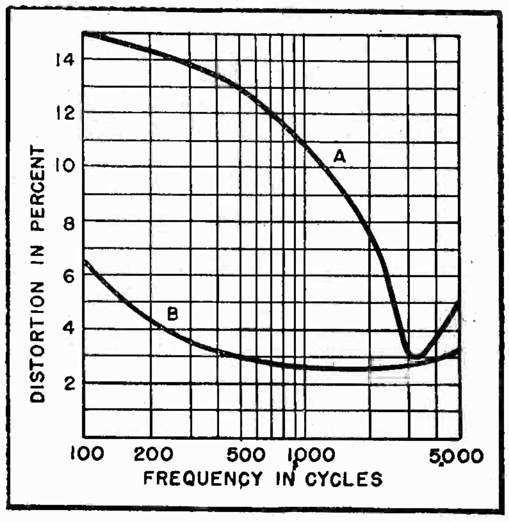


· WRITE FOR INTERESTING BULLETIN ·

RADIO · RADAR · SOUND · **Rauland** COMMUNICATIONS · TELEVISION

Electroneering is our business

THE RAULAND CORPORATION · CHICAGO 41, ILLINOIS appeared to offer advantages in solving this problem and the British Thomson-Houston Company has developed carrier-frequency equipment to relay six programs. This triples the selection now open to subscribers and reduces from four to two the number of wires needed to link them to the broadcast relay center. Provision of six channels accommodates three BBC programs and the sound accompaniment to BBC television, with two spare channels for foreign



Curve *A* is an a-f distortion curve for a typical British broadcast receiver. Curve *B* shows the response of the carrier-frequency system

broadcasts and future developments in the home entertainment field.

Technical Details

The most efficient transmission line has been found to be two insulated copper conductors of 0.048-inch diameter, spaced two inches apart. Radiation from the line is negligible and allows selection of the carrier frequencies and frequency-spacings to give high fidelity reproduction without reference to any international conference.

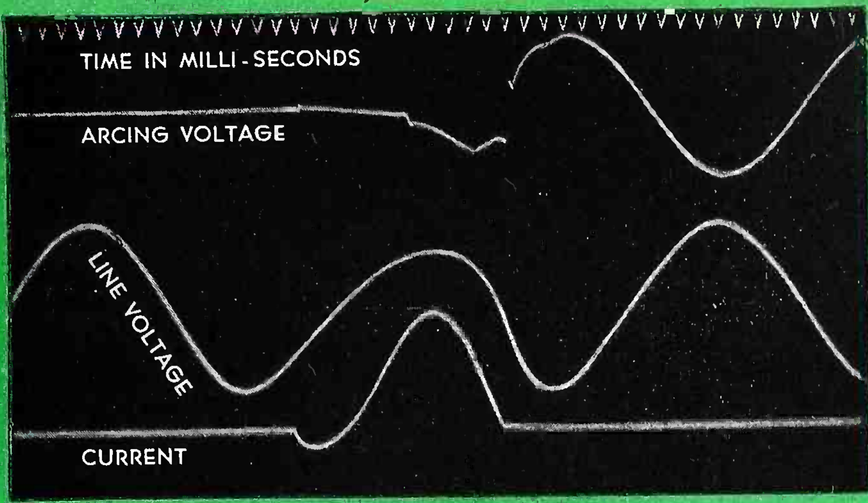
Broadcast programs, whether received by landline from the BBC or through the ether, are fed into frequency-modulation equipment where the signal modulates the carrier frequency of the channel designated for transmission of the program. The resultant is amplified and piped into the distributing network. The carrier frequencies are generated by a crystal-controlled oscillator.

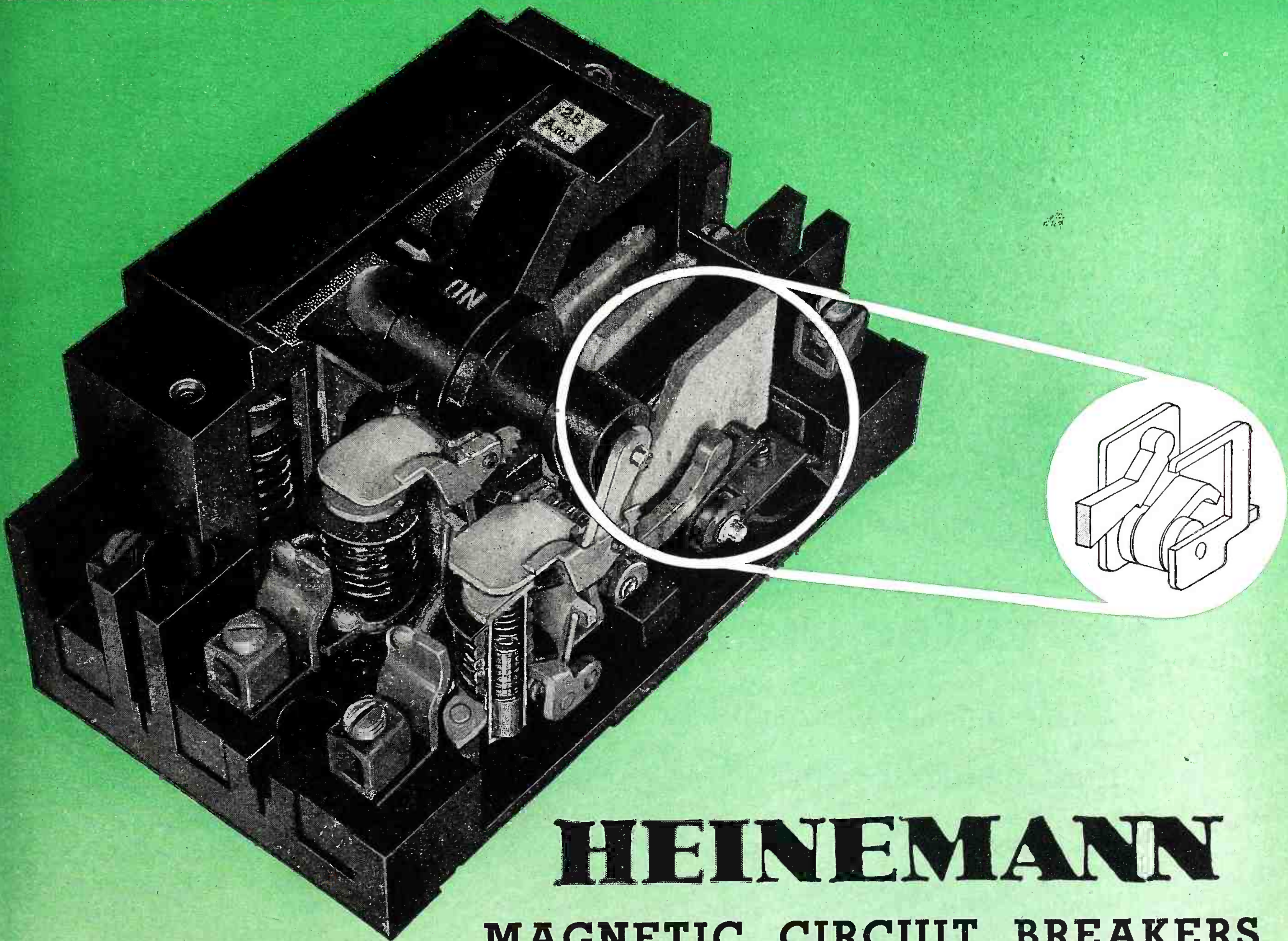
Comparative performance of the average broadcast receiver with the multi - broadcast reproducer is shown by the accompanying graphs.

Ever see a Picture of a Short Circuit?

Oscillogram taken on a 50 ampere breaker showing short circuit with 6450 amperes rms flowing through the breaker which interrupted within ½ cycle on 120V AC with a power factor of approximately 60%.

This was the third operation on a circuit having a capacity of approximately 8000 amperes rms.





HEINEMANN

MAGNETIC CIRCUIT BREAKERS Employ High Speed Blowout

EST. HECO 1888

The stationary contact is coiled around an insulated iron core which connects the steel plates forming a U-shaped magnet. On overloads and short circuits the current flowing through the contact creates magnetic lines which force the arc into the arcing chamber and blow it out. As the value of the current to be interrupted increases, the quenching effect becomes greater due to the intensified magnetic blowout field.

HEINEMANN ELECTRIC COMPANY

Established 1888

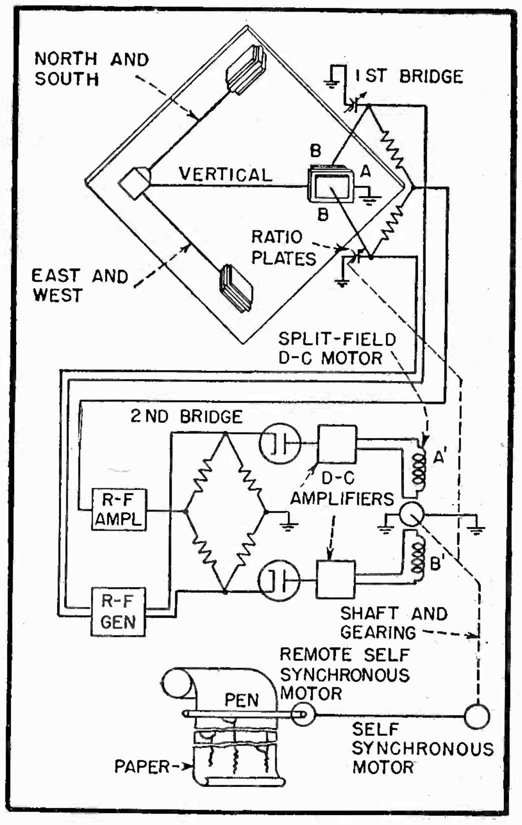
97 PLUM STREET TRENTON, N. J.

INDUSTRIAL CONTROL
(continued from p 150)

oil companies to locate new oil deposits, and that branch concerned with the analysis and study of earthquakes and related phenomena.

The prospecting type of seismographs have long used electronics but it is only within the last year or so that electronic seismographs have been made available to colleges and other institutions interested in seismic research.

The ancient Chinese devised a



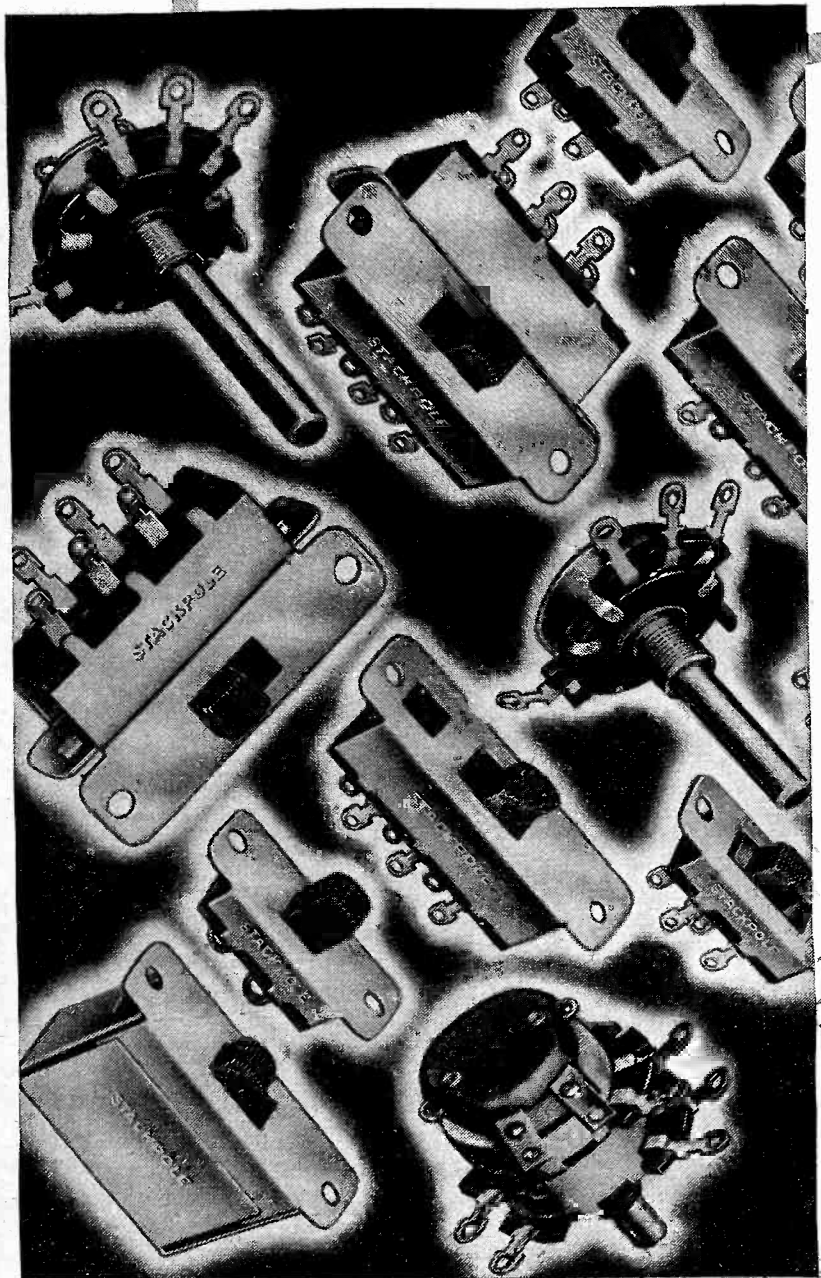
Arrangement of r-f bridges and d-c amplifiers used in the seismograph

dish with a cone imposed in the center. The apex of the cone contained a slight hollow upon which a comparatively large ball rested. When an earthquake occurred, the ball was shaken from the cone into the dish and the gyrations therein were observed.

Many years later, the swinging of a chandelier in an Italian church enabled Galileo to give us the pendulum. The pendulum as used in seismology acts simply as an inertia mass when earth motion causes its support to move. To capture the difference in motion between the inertia mass and components of the support and then record it is the object of all seismographs. The motion to be recorded from a distant earthquake is frequently on the order of three and four places to the right of the decimal point in fractions of an inch. Moreover, the least friction between the pendulum and its related components will have

ECONOMICAL SWITCHES

LINE **SLIDE** **ROTARY ACTION**



. . . for almost any appliance or instrument

Chances are Stackpole has the switch you need—at a price in keeping with your production budget. Eighteen standard types include 1-, 2-, 3- and 4-pole and 3-position switches, with or without detent, spring return, covers and other optional features. Special types and adaptations can be produced economically for large quantity users. They're fully dependable. They add greatly to the sales appeal and efficiency of any electrical product.

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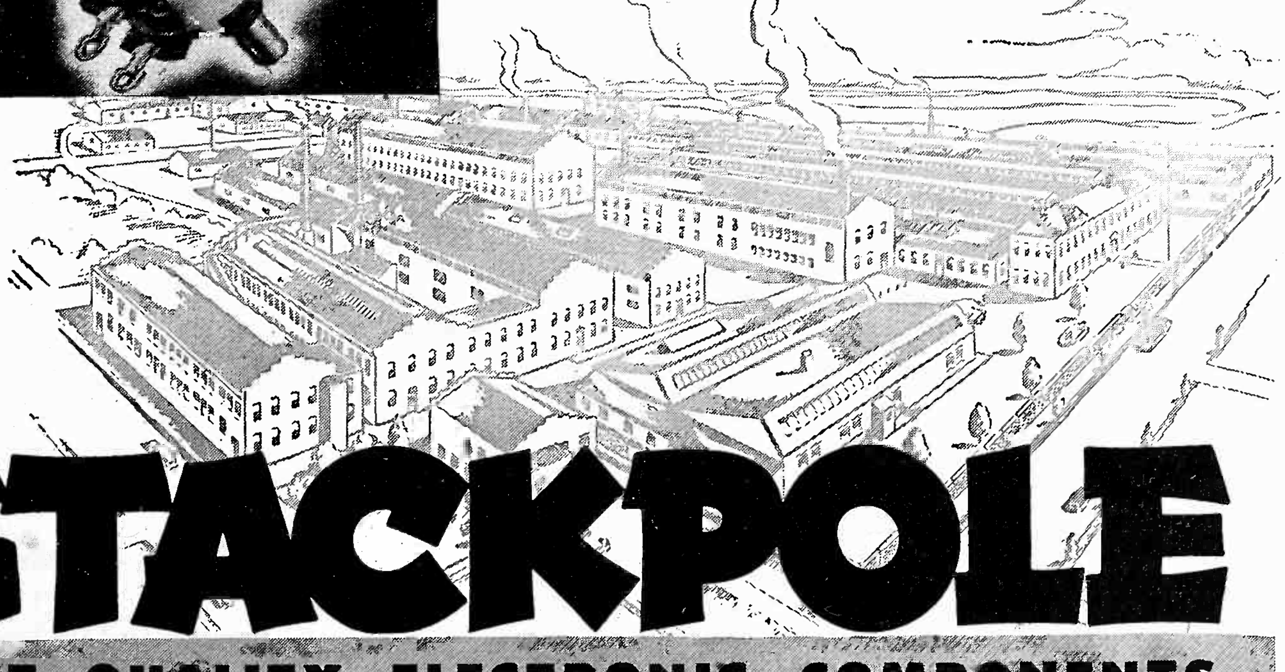
Write for Catalog RC-6 including Stackpole Switches, Fixed and Variable Resistors and Iron Cores.



STACKPOLE

FIRST QUALITY ELECTRONIC COMPONENTS

the same effect as a rat's nest in a grandfather's clock.

For several years, satisfactory seismographs have been in operation which use a photographic method of amplification and recording. In such equipment, a mirror is attached to the pendulum and a light beam strikes the mirror, and in turn is reflected a given distance to photographic paper on a revolving drum. The distance between the mirror and photographic paper determines the amplification. Some types use a transducer at the pendulum and the current generated is passed through a galvanometer which contains the mirror. The principle is the same.

The photographic method, however, has certain features which involve considerable labor and expense, such as the daily changing and developing of records, all of which is done in a dark room. A seismologist never knows the characteristics of a 'quake until it is over and the record developed. Photographic paper and chemicals are expensive when used on a scale necessary to a well conducted station. Moreover, a separate instrument is required for each dimension of motion (North-South, East-West, and vertical).

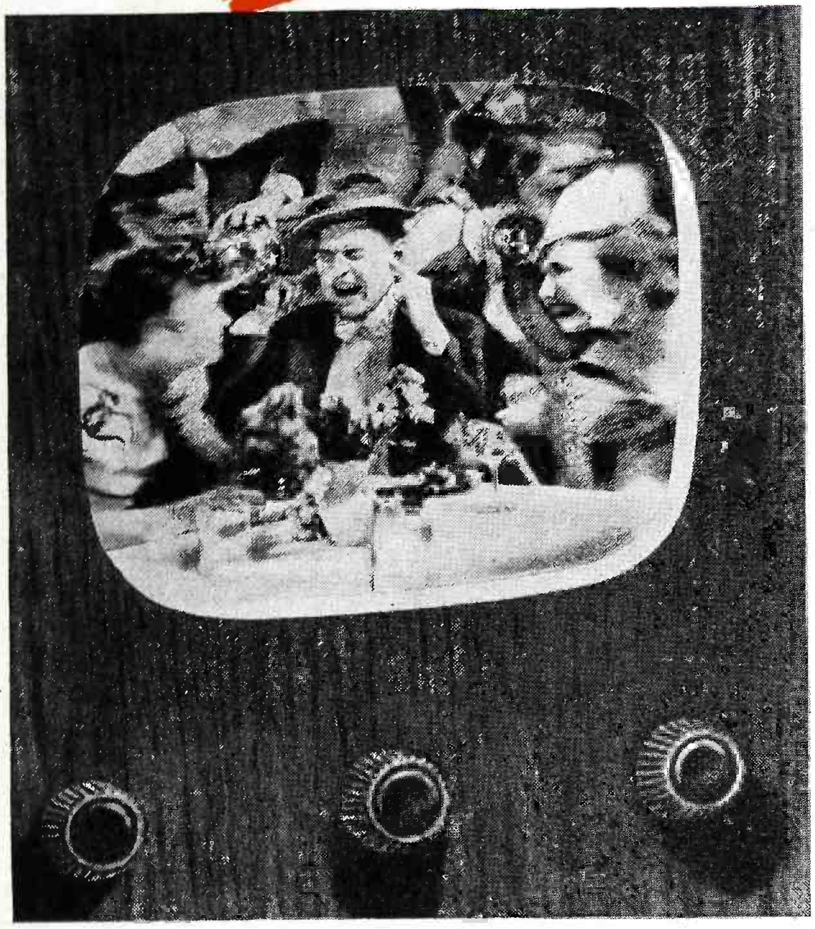
Circuit

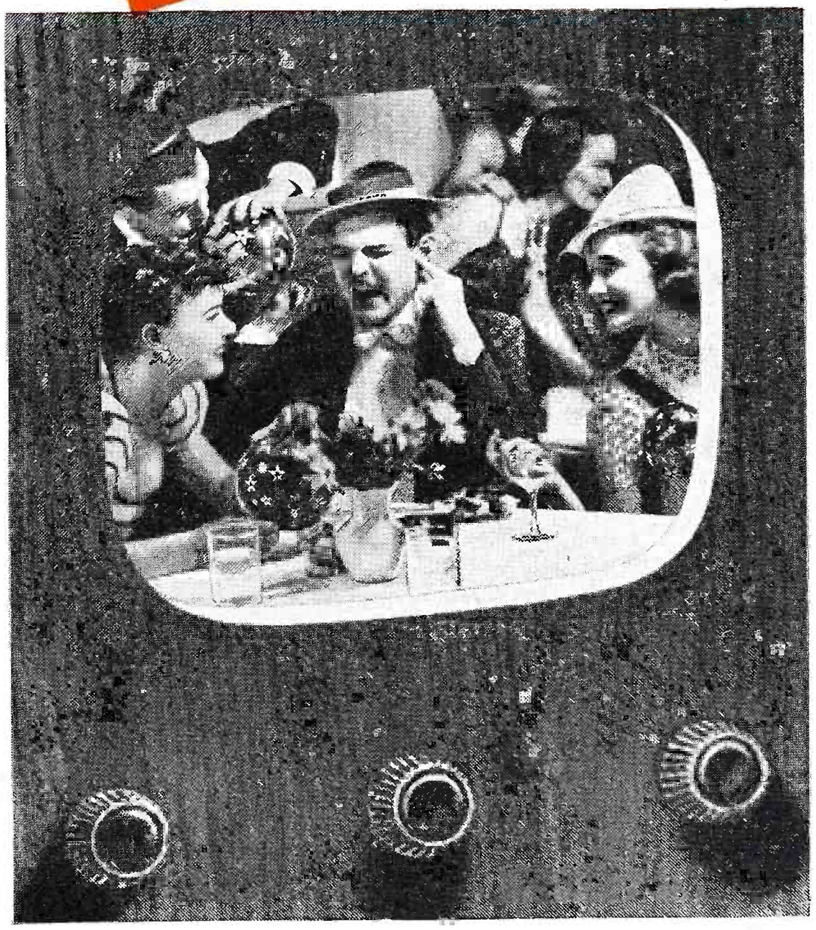
About a year ago, the writer, and Father Daniel Linehan, seismologist at the Jesuit College at Weston, Mass., with Dr. L. Don Leet of Harvard, acting as coach, decided to design an instrument which would take the drudgery out of operating a seismograph station.

The diagram shows a closed cycle servomechanism. At *A* is one of the pendula suspended between two fixed plates *B* that are two legs of a balanced r-f bridge circuit. When earth motion swings the pendulum, it causes an unbalance of this bridge. The unbalanced voltages are amplified and fed into a split-field motor. A variable capacitor which turns with the motor shaft rebalances the bridge.

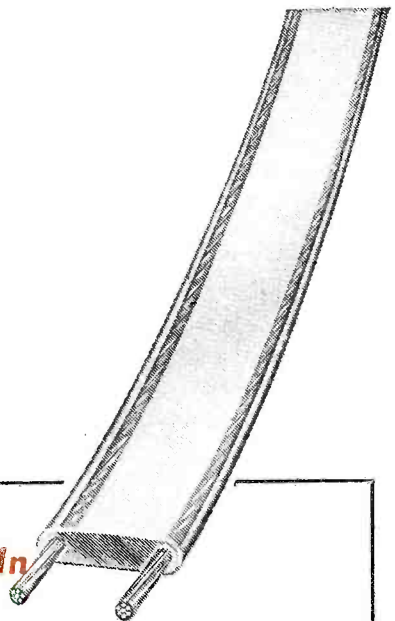
The split-field motor is directly connected to a self-synchronous motor. Leads from this motor connect with a second self-synchronous motor in the recorder which activates the pen. Thus, the recorder can be placed any distance from the pendula. The three pendula (N-S,

CONFUSING? OR **AMUSING?**





Lead-In Lines Play an Important Part in Television Reception



The effects of attenuation and impedance mismatch on FM and Television reception are minimized by Anaconda Type ATV* lead-in lines.

The satin-smooth polyethylene insulation of Type ATV line sheds water readily, thus avoiding subsequent impedance discontinuities. This material also has exceptionally high resistance to corrosion. Count on Anaconda to solve your high-frequency transmission problems—with anything from a new-type lead-in line to the latest development in coaxial cables. 47130

**An Anaconda Trade-Mark*

A Type ATV Lead-In for Every Need

Anaconda offers a complete selection of Type ATV lead-in lines for 75, 125, 150 and 300 ohms impedance unshielded and 150 ohms shielded. For an electrical and physical characteristics bulletin, write to Anaconda Wire and Cable Company, 25 Broadway, New York 4, N. Y.

ANACONDA from mine to consumer

ANACONDA WIRE AND CABLE COMPANY

E-W, and vertical) are on a single base but each pendulum has a separate servomechanism, all of which feed into a single recorder.

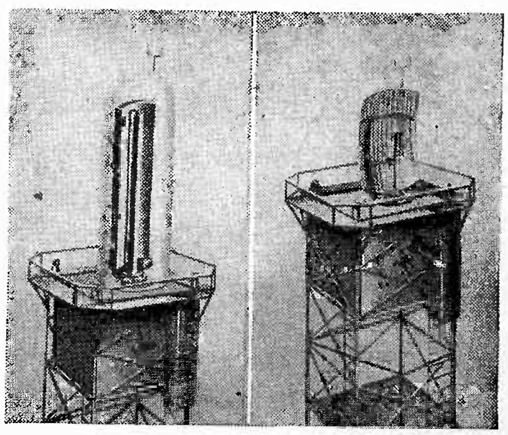
All three pens record on a single paper tape and thus three dimensional motion is recorded simultaneously. Earthquakes can thus be observed in action.

No dark room is required and the recorder carries sufficient paper of the inexpensive adding machine quality and ink to operate nearly a week without attention. The recorder carries an alarm which gives warning with bell or buzzer when a major quake is being recorded. Time is indicated on the record every minute and hour by a built-in spring-wound precision clock, which has an error of approximately six seconds per week. This is important because time is the fourth dimension of seismology.

Improved GCA for Navy

TWO NEW devices have been added to the Navy's Ground Control Approach system to give the radar controller an accuracy never before achieved in directing plane movements. The first of these devices is a separate identification indicator which flashes on a compass rose above the search scope the bearing of any plane communicating with the tower on voice radio. This beam identifies each plane in its exact position with relation to the airport, eliminating confusion between indications of planes in the vicinity as they appear on the radar scope.

The second device is a radar height-finding antenna, indications



Height-finder antenna (left) and search antenna used in new GCA for covering distances up to 30 miles at altitudes up to 12,000 feet

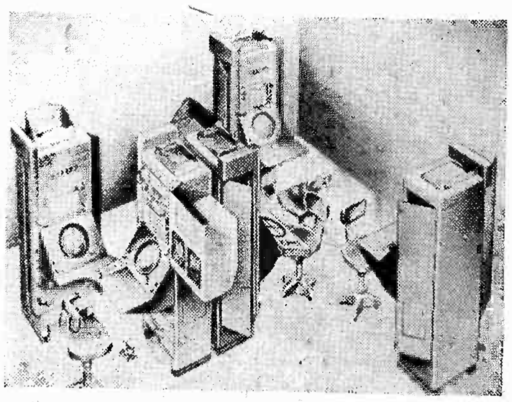
of which appear on an adjacent scope similar to the control scope. The zone air controller can point the antenna in any direction and read off the exact altitude of the plane on the height-measuring scope.

Navy experiments indicate that planes can be orbited about the field and fed into the landing path at a rapid rate so that the transition from the airways to the ground will be accomplished smoothly and without stacking of aircraft waiting to land. The first set will be installed at the Naval Air Station, Quonset Point, R. I., where special techniques will be evolved for a high rate of instrument landings. This will be the first permanent fixed operational installation of GCA.

This newest Navy set, designated AN/FPN-1 (XN-2) and built by Bendix Radio Division, will give the tower controller a radar picture of all planes within a radius of 30 miles and at all altitudes up to 12,000 ft. The installation will eliminate the necessity for a visual tower controller except for controlling the movements of taxiing planes.

Operation

The zone controller, who has before him the all-around search scope, the altitude finder, and identification beam will find the position and altitude of each individual plane. By means of voice radio, he will direct the planes into the landing path, while at the same time keeping an accurate check on their position and altitude. If the pilot does not follow the orders of the controller either in his flight pattern or altitude level, the controller will be able to correct his errors immediately, thus preventing collisions with buildings, radio



Control tower subdeck of new Navy GCA installation requiring only four operators, one for each chair

towers or other aircraft. Once the controller has the plane heading toward the runway, he turns over the control of the aircraft to the landing path controller, who, by means of his precision radar scope, is able to direct the plane in its final approach to a safe landing on the runway.

The approach system is a precise radar system covering a 20-degree azimuth sector and a 7-degree sector in elevation. These sectors are displayed as expanded views each on 12-inch cathode-ray tubes. When an approaching aircraft has been directed to a distance of six nautical miles from the airfied and into this sector, control of its altitude and azimuth is taken over by the two precision operators. By very accurate means each operator continuously bisects with a cross-hair device the radar indication of the aircraft. This tracking operation is translated into direct indication in feet relative to the correct glide path by an electromechanical device and appears upon a third cathode-ray display. Final direction of the aircraft is accomplished from this accurate data rather than from the original azimuth and elevation cathode-ray display tubes, because information accurate to a matter of a few feet is essential.

Thirteen Navy mobile GCA stations using wartime equipment are now in operation, at the Marine Corps Air Station in El Toro, Calif. and at the following Naval Air Stations: Charlestown, R. I., Corpus Christi, Texas; Jacksonville, Florida; Miramar, Calif.; New York, N. Y.; Oakland, Calif.; Oceana, Virginia Beach, Va.; Olathe, Kansas; Patuxent River, Md.; Saufley Field, Florida; Seattle, Wash.; Whidbey Island, Wash.

16,000 Tubes Work for One Railroad

THE PENNSYLVANIA Railroad used 15,994 electronic tubes last year, more than 100 different kinds. The earliest use, prior to 1920, was a rectifier to convert a-c to d-c for charging storage batteries. Since that time, their use has expanded, and today they are used in such service as telephone repeaters—for long distance phone service, loud-

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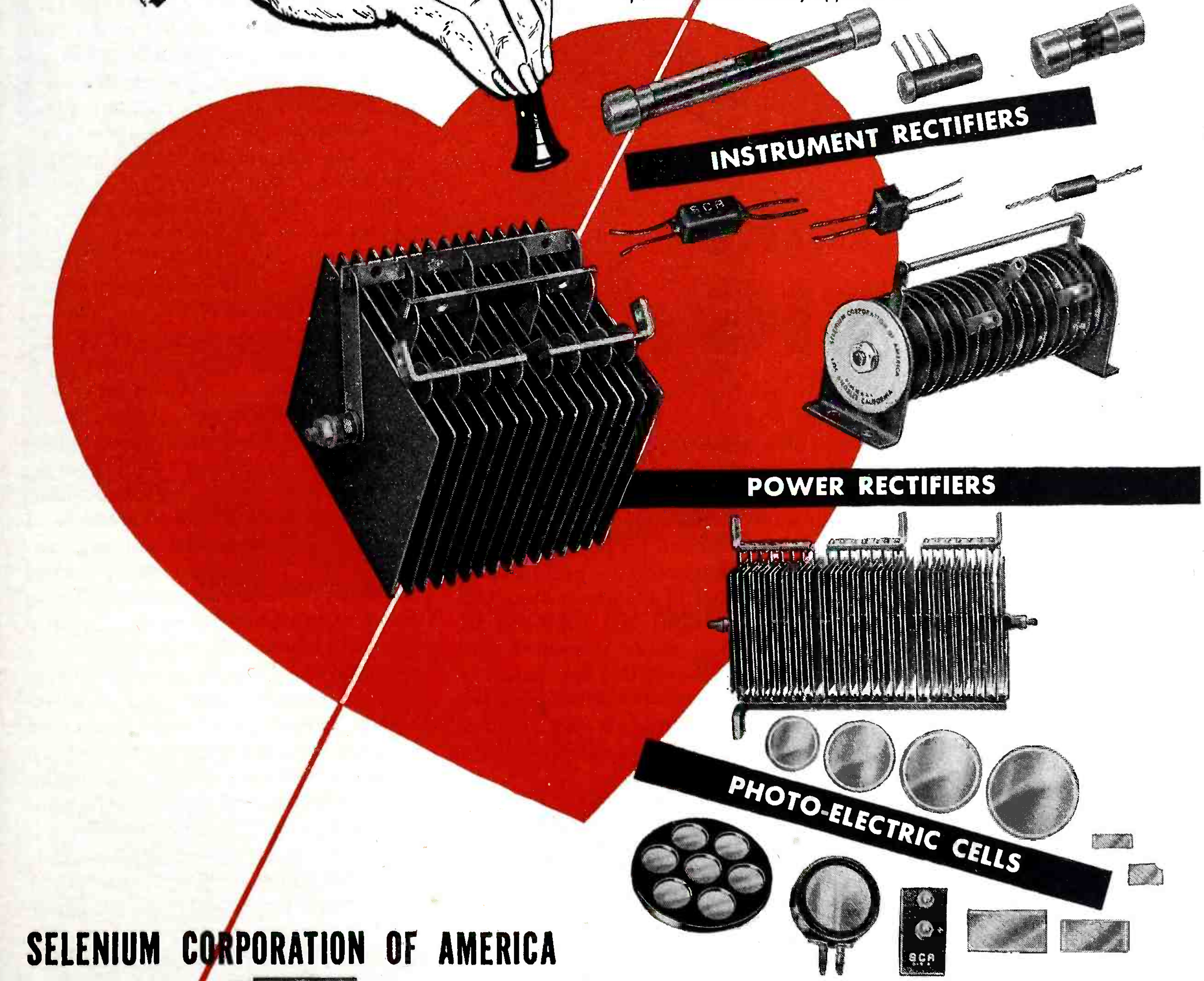
... A STURDY heart

SCA Rectifiers are the heart of the power circuits: ENGINEERED FOR ENGINEERS, Selenium Rectifiers are rapidly becoming standard for all industry.

Selenium Corporation of America meets exacting specifications of modern electronic developments in manufacturing a broad line of Selenium Power and Instrument Rectifiers, Self generating Photo-Electric Cells and allied scientific products.

Selenium Corporation of America's engineering and manufacturing experience can be called upon for the development and production of special rectifiers for any applications.



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CHECK THESE OUTSTANDING FEATURES:

- Unlimited life—no moving parts.
- Permanent characteristics.
- Adaptability to all types of circuits and loads.
- Immunity to atmospheric changes.
- High efficiency per unit weight.
- From 1 volt to 50,000 volts rms.
- From 10 micro-amperes to 10,000 amperes.
- Economical—simple to install—no maintenance cost.
- Hermetically sealed units available.

46-H

speaker systems for yard service, train announcing and paging in stations, wreck train service, carrier telephone and teletypewriter service, charging equipment for communication power plants, train telephone service, recording devices for recording telephone conversations and conferences, test equipment for testing telephone and teletypewriter circuits, and inter-office communication systems.

The first important application of electronic tubes on P.R.R. locomotives and cars was in the amplifiers of the train control and cab-signal system with the original and experimental installation made in 1923. This use has expanded to the point where several thousand tubes are now in service. During the early and middle thirties, radio broadcast reception for entertainment purposes was provided on a number of trains, followed sometime later with public address systems on a few trains for announcements.

Recent use of electronic tubes and devices on railway vehicles is in the trainphone system for telephone communication between locomotives, cabin cars and wayside offices. In this system, over twelve thousand tubes are now in daily use.

In the signal department, photo tubes are employed for supplementary protection at remote interlocked switch to detect presence of train on track circuit, and as drawbridge aligners. There is a proposed use of detecting presence of a train on hand-operated crossover in automatic territory.

Rectifier tubes are found charging storage batteries and on pulsating or half-wave d-c track circuits.

Other tube types are used on high-frequency circuits superimposed on existing line wires for control of check locking between adjacent block stations and on existing line wires for C.T.C. control. At locations where 100-cycle a-c power is not available they convert 60-cycle power to 100-cycle power.

Motor Control for Polio Patients

To COMBAT polio after effects, Respir-Aid, Inc. of Toledo makes a bed mounted on a motor-driven frame which is driven by G-E Thy-

See for yourself how new developments can give you better electrical insulation

● Varflex Corporation wants every manufacturer of electrical equipment to have one of these new folders. Each one contains actual working samples of 20 different types of sleeving and tubing, including *Varglas Silicone,* which was developed during the war to meet temperature variations from −85° F. to 500° F.

Write for this folder containing test samples today.

Varflex Corporation, 308 N. Jay St., Rome, N. Y.

Please send me your FREE folder containing 20 different types of electrical insulation. I am particularly interested in samples suitable for..............................

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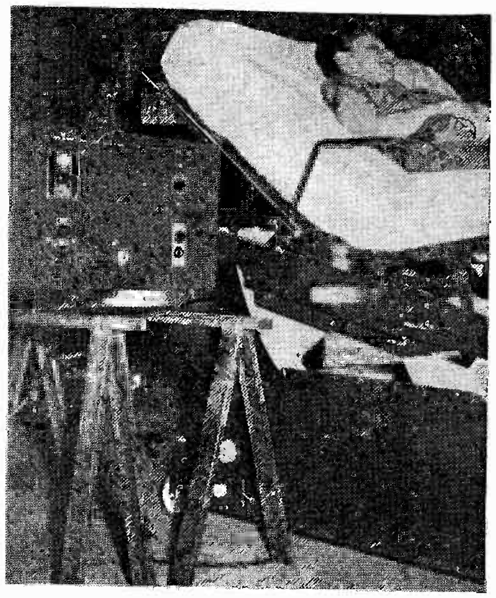
Varflex CORPORATION

Makers of Electrical Insulating Tubing and Sleeving

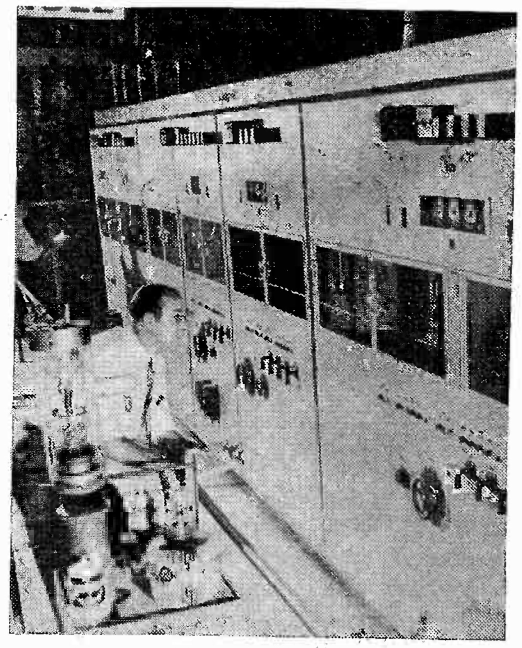


Breathing of polio victims is aided by this oscillating bed driven by a G-E Thy-mo-trol-controlled motor

mo-trol drive to see-saw in rhythm with the patient's normal breathing. By turning a small knob which controls the speed of the driving motor, an attendant can regulate the speed. A small a-c motor regulates the arc of travel of the bed's motion.

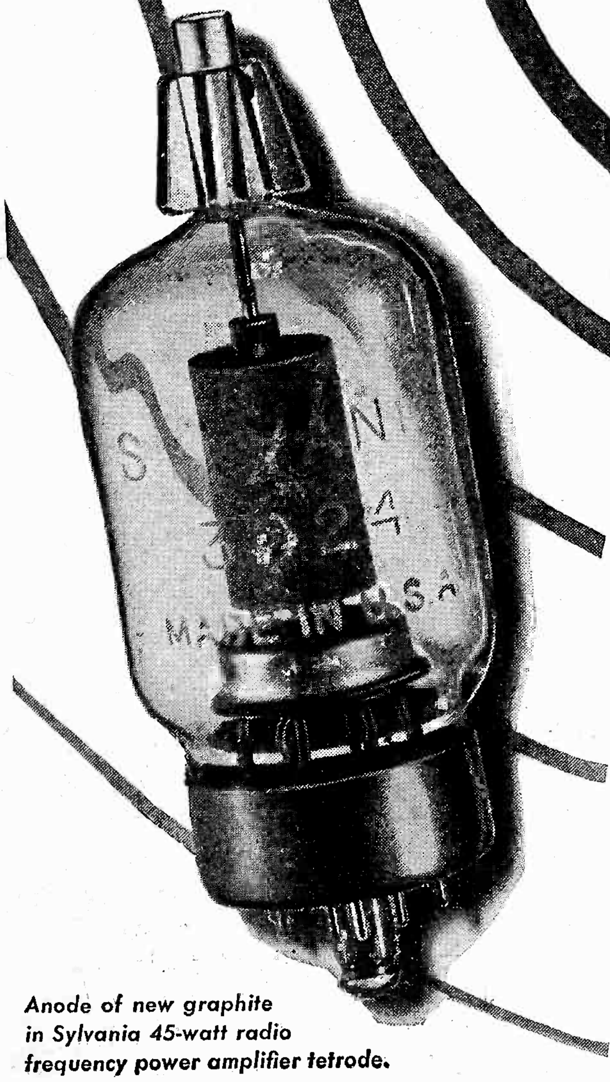
The bed aids the patient in breathing and need not be limited to polio victims, since it has many other uses in treating respiratory and circulatory diseases. The patient may sleep in any position without losing the effectiveness of the treatment. Neither the bed nor the motion restricts usual care or treatment of the patient in any way.

TUBE TESTER



Water-cooled and force-air-cooled tubes up to 500-kw rating can be tested in this tube performance analyzing equipment built at General Electric tube engineering laboratory

NOW... A NEW GRAPHITE FOR ELECTRONIC TUBES



Anode of new graphite in Sylvania 45-watt radio frequency power amplifier tetrode.

HERE is a new grade of graphite that makes possible the design of greatly improved and more economical power tubes.

This graphite, developed as a result of wartime needs, is *stronger than ever before.* It has *finer grain structure.* And it is the *purest graphite* ever produced for this purpose.

Sylvania Electric Products, Inc., is taking advantage of this "National" graphite in the first of a new line of transmitting tubes currently being announced.

This new "National" graphite offers you many advantages. It has no melting point and does not distort at highest temperatures. It has high *thermal emissivity,* thus permitting heavy overloads of the anode and providing a welcome reserve of plate dissipation. Also it has unmatched thermal conductivity.

Write for complete details. Address National Carbon Company, Inc., Department E.

The word "National" is a registered trade-mark of

NATIONAL CARBON COMPANY, INC.

30 East 42nd Street, New York 17, N. Y.

Unit of Union Carbide and Carbon Corporation

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Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

• *"There is a design trend toward the use of graphite for some tube applications where the greatest economy is desirable and at the same time allowing greater capability of tubes both mechanically and electrically."* . . . H. W. Parker, of Sylvania Electric Products, Inc., in *Radio News,* October, 1946.

ELECTRON ART

(continued from p 154)

tronics and High Speed Airborne Vehicles, paper presented at the American Association for the Advancement of Science convention in Boston, Dec. 1946. A survey of the terminology and problems of guided missiles.

(2) Ackerman, Sam L., and George Rappaport, Radio Control Systems for Guided Missiles, ELECTRONICS, p 86 Dec 1946.

(3) Selvidge, Harner, Guided Missiles in World War II, *Proc Radio Club of Am*, Oct 1946. Types of Allied and German guided missiles developed recently.

(4) Fink, Donald G., Electronics at Bikini, ELECTRONICS, p 84 Nov 1946.

(5) Huntoon, R. D., and B. J. Miller, Generator-Powered Proximity Fuze, ELECTRONICS, p 98 Dec 1945.

(6) Selvidge, Harner, Proximity Fuzes for Artillery, ELECTRONICS, p 104 Feb 1946.

(7) Mofenson, Jack, Radar Echoes from the Moon, ELECTRONICS, p 92 April 1946.

(8) Sulzer, G. P., Ionosphere Measuring Equipment, ELECTRONICS, p 137 July 1946.

AIEE Winter Meeting— A Technical Summary

EXPANSION OF INDUSTRIAL USES of the many forms of electrical power was reflected in the size and scope of the Winter Meeting of the American Institute of Electrical Engineers held in New York City from January 27 to 31. Technical program was the largest held by the Institute; over 160 formal papers were presented before a total registration of 3,629, some thousand over the previous record attendance. Subjects of papers ranged from a description of new New York City subway cars that have individual amplifiers and loudspeakers so that trainmen can announce the next station stop, to a statistical analysis of the chances that a radar echo will be recognized as an echo and not as noise.

Awards

Dr. Lee de Forest was awarded the 1946 Edison Medal for his pioneering achievements in radio and invention of the grid-controlled vacuum tube because of its profound technical and social consequences. Dr. de Forest holds over 300 patents in fields of radio telegraphy and telephony, sound for motion pictures, facsimile, television, and radio therapy.

The John Fritz Medal, awarded annually by the Am Inst of Elect Engrs, the Am Inst of Min and Met Engrs, the Am Soc of Civil Engrs, and the Am Soc of Mech Engrs, for scientific and industrial achievements in the production and utilization of electrical energy was presented to Dr. Lewis W. Cubb, Director of the Westinghouse Lab-

NOW you can get Sylvania quality in **transmitting** tubes too!

SYLVANIA INTRODUCES THE TYPE 3D24

BEAM POWER TETRODE WITH ELECTRONIC GRAPHITE ANODE

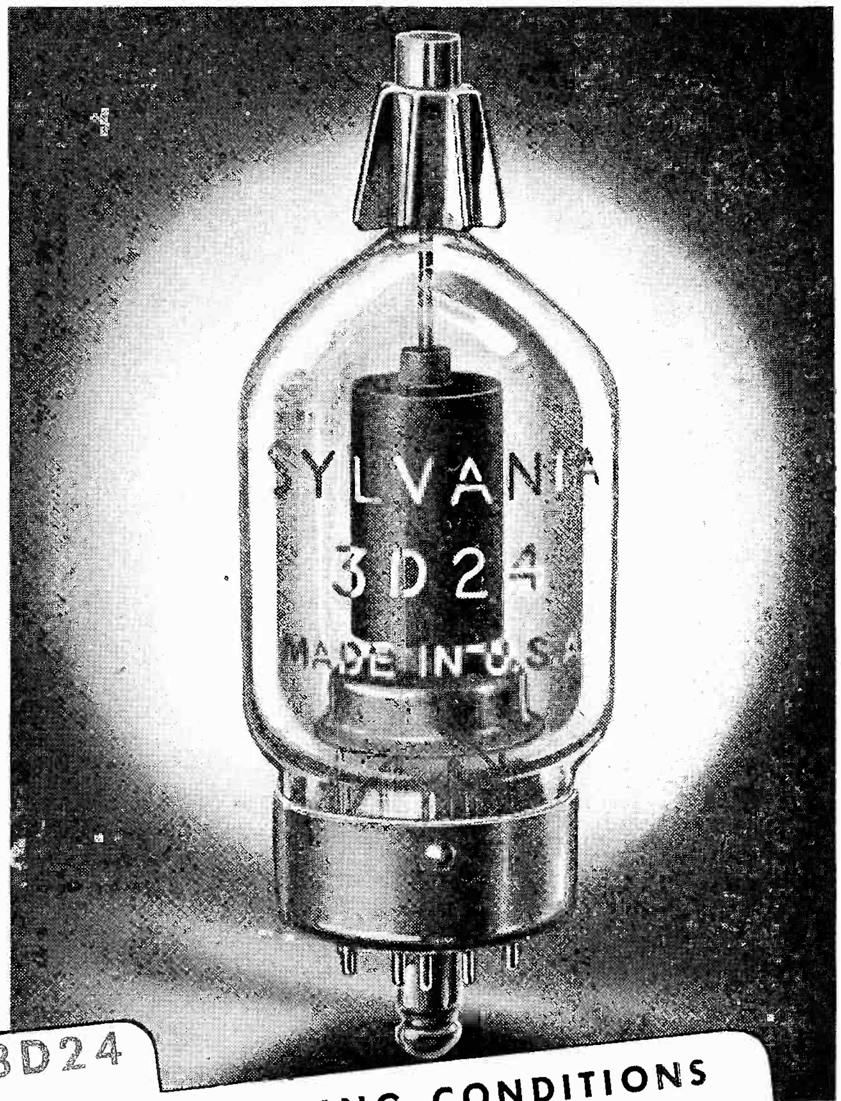
First of Sylvania's new line of transmitting tubes, the 3D24 is a four-electrode amplifier and oscillator with 45 watt anode dissipation. An outstanding development is the electronic graphite anode, which allows high plate dissipation for small area and maintains constant inter-element relationship and uniform anode characteristics.

The 3D24 may be used at full input up to 125 Mc — maximum permissible frequency will be announced later upon completion of tests.

OTHER FEATURES INCLUDE:

1. **Lock-In base.** Short leads, no soldered joints.
2. **Top cap** providing for short path, greater cooling by radiation and convection, resulting in a cooler seal.
3. **Thoriated tungsten filament,** giving high power output per watt of filament power.
4. **Vertical bar grids.** #1 grid supplied with two leads for better high frequency performance. #2 grid provided with heat-reflecting shield for greater dissipation, low grid-plate capacity.
5. **Low interelectrode capacity.** No neutralizing needed with proper circuit arrangement.
6. **Hard glass envelope.** Permits high power for small size.

The 3D24, a product of the Electronics Division of Sylvania, has interesting potentialities in amateur, police, mobile and marine radio.



MECHANICAL SPECIFICATIONS

Type of cooling	Air—radiation and convection
Mounting position	Vertical, base down or up
Length overall	4.3 inches max.
Seated height	3.769 inches
Diameter	1½ inches
Net weight	1.3 ounces

ELECTRICAL CHARACTERISTICS

Filament Voltage	6.3 volts
Filament Current	3.0 amperes
Amplification Factor	50
Direct Interelectrode Capacitances	
Grid-Plate	0.2 $\mu\mu$f max.
Input	6.5 $\mu\mu$f
Output	2.4 $\mu\mu$f

3D24

TYPICAL OPERATING CONDITIONS

R. F. Power Amplifier and Oscillator—Class C Telegraphy

Characteristic	C.C.S.	C.C.S.
D. C. Plate Voltage	1500 volts	2000 volts
D. C. Control Grid Voltage	–300 volts	–300 volts
D. C. Screen Grid Voltage	375 volts	375 volts
D. C. Plate Current	90 ma	90 ma
D. C. Control Grid Current	10 ma	10 ma
D. C. Screen Grid Current	22 ma	20 ma
Peak R. F. Grid Input Voltage	400 volts approx.	400 volts approx.
Full Driving Power	4.0 watts approx.	4.0 watts approx.
Plate Power Output	105 watts	140 watts

Direct inquiries to Radio Tube Division, Emporium, Pa.

SYLVANIA ELECTRIC

MAKERS OF ELECTRONIC DEVICES; RADIO TUBES; CATHODE RAY TUBES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS oratories. Dr. Cubb helped organize KDKA, holds over 150 patents including one on a position-finding technique (patented about 15 years ago) that is similar to loran, invented a chronograph using microwaves for measuring the velocity of projectiles, and assisted in development of methods for separating uranium isotopes.

Dr. Vannevar Bush, Chairman of the newly created Joint Research and Development Board of the Army and Navy received the Hoover Medal for 1946 in recognition of his outstanding public service. Dr. Bush was Director of the recent Office of Scientific Research and Development, is President of Carnegie Institute of Washington, and a member of the National Advisory Committee for Aeronautics. The annual award is made by the same engineering societies that make the John Fritz award.

Among the equipment seen on tours by members attending the meeting were an RCA Labs computer capable of solving ten equations simultaneously, synthetic crystals and radar developments at Bell Telephone Labs, and the television equipment used by CBS.

Joint Meetings

Conferences were held jointly with the American Mathematical Society, and the recently formed American Society for Quality Control. Quality control, utilizing techniques of gaging and testing, has become a primary factor in industrial production of uniform goods with minimum wastage.

At the joint conference on applied mathematics, Dr. Michel G. Malti of Cornell University, as chairman, commented on the welcome growing interest of mathematicians in scientific and engineering problems. Dr. John von Neuman of Princeton University, in discussing applications of high-speed computers, pointed out that in either an analogy computer, which converts quantities of the problem into directly analogous physical parameters that can readily be controlled (like electrical potentials) to obtain the solution, or the digital computer, in which an approximate numerical solution (such as graphical integration) is substituted for the actual problem,

PRODUCTIVE LIGHTING IS *Controlled* BY EACH USER . . . FOR EACH OCCASION

Trained eyes and hands have an ally in the Dazor *Floating* Lamp, whether they're teamed in the first-aid room, at a high-speed machine or across an executive desk. By *floating* the light to the best position for seeing, the user completely controls intensity and position. And a finger-tip touch *changes* either, each time the job requirements change.

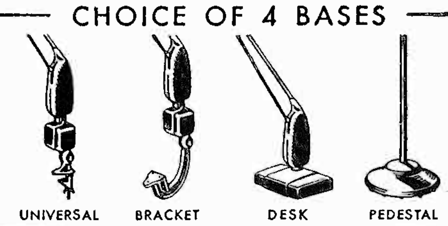
If you are accustomed to stationary lighting, or a lamp of restricted motion, the free movement of light in *all planes* will intrigue you. Dazor alone has the patented *Floating* Arm and its device for holding the reflector firmly, without locking or manual tightening.

But more important than the *how* is the *why* of Dazor illumination. Employees who enjoy this comfortable, glareless lighting see fine details more clearly on machining, assembly, inspection, drafting and other exacting operations. As errors and hazards decline, there is a rise in morale. Special skills come to the front and productivity shows a gain.

Phone Your Dazor Distributor for typical applications by other users or an on-the-spot demonstration. For the name of this nearby lighting authority, if unknown to you, write to Dazor Manufacturing Corp., 4481-87 Duncan Ave., St. Louis 10, Mo. *In Canada* address inquiries to Amalgamated Electric Corporation Limited, Toronto 6, Ontario.

MOVES FREELY INTO ANY POSITION AND STAYS PUT — *WITHOUT LOCKING*

CHOICE OF 4 BASES



DAZOR FLOATING LAMPS

FLUORESCENT and INCANDESCENT

there is an inherent error. This error is the random noise in the analogy computer or the inability of the digital computer to carry numbers to their full places. The digital technique is intrinsically the better method of keeping the error small.

The one great difficulty of high-speed computers, said Dr. von Neumann, is the planning of the work to be done by the machine in solving problems. Next to this difficulty come those of getting data from physical measurements on which computers can operate, and of obtaining meaningful (humanly intelligible) answers (tables of numbers) from computers. One such problem, involving motion of a torpedo launched into the water at a low angle, suitable for high-speed computers was outlined by Dr. Garrett Birkhoff of Harvard University.

Probability as applied to electrical engineering was illustrated by Dr. Mark Kac of Cornell University. In the case of interpreting a radar return, if the signal is below noise level, one might either give a false alarm or be found negligent. Assuming noise to be completely random, the dependence of the probability of recognizing a return as a return on passbands of the various amplifiers and on the law of detection can be analyzed and a best design determined. The method of statistical analysis, illustrated by such a problem, can be applied in similar ways to other design considerations.

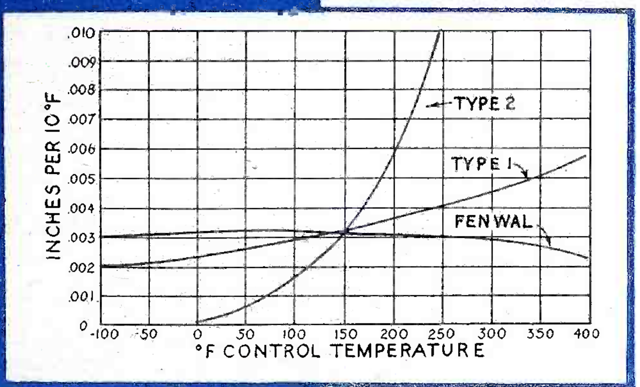
Use of a differential analyser in solving such engineering problems as transient mechanical stress in aircraft landing struts, starting large synchronous motors, nonlinearity effects on range of current transformers, automatic operation of voltage regulators, and trajectories of electrons in vacuum tubes were described by C. Concordia of General Electric Co.

Large-Scale Computers

At a later session six computers in operation or nearing completion were described. Although the popular press has emphasized the speed with which automatic calculating machines can solve complex problems, mathematicians who use these machines emphasized the difficulty

UNIFORMITY OVER WIDE TEMPERATURE RANGE*

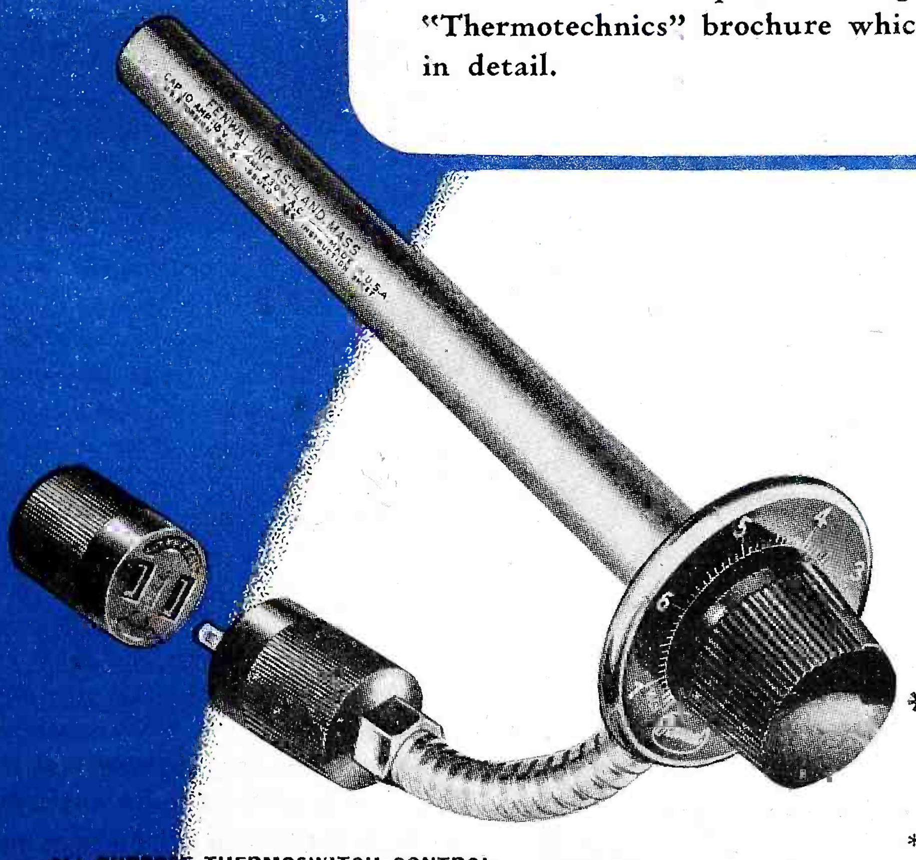
The *useful* operating range of any thermostat is only as wide as its range of uniform response characteristics. The sensitivity of the Fenwal THERMOSWITCH Control is constant throughout its wide range of temperature settings. Careful selection of materials for THERMOSWITCH components on the part of Fenwal engineers insures maintenance of constant ratios of expansion or contraction at temperatures within the operating range — resulting in uniformly excellent control at any set-point. Its ability to function with equal efficiency at any setting within its 500° F. range means that a single THERMOSWITCH Control can be used in a great variety of applications.



CONTACT MOTION PER 10° F.

Chart shows the movement of thermostat electrical contacts per 10° F. change over a wide range of control temperatures. Note the uniform contact movement of the Fenwal unit compared to types 1 and 2 thermostats.

The Fenwal THERMOSWITCH Control has been termed the "ideal" thermostat by leading thermal control engineers because of its many desirable features. Fenwal units, combined with sound thermal engineering practice, are your best insurance of trouble-free temperature regulation and detection. Write for the "Thermotechnics" brochure which describes THERMOSWITCH Controls in detail.



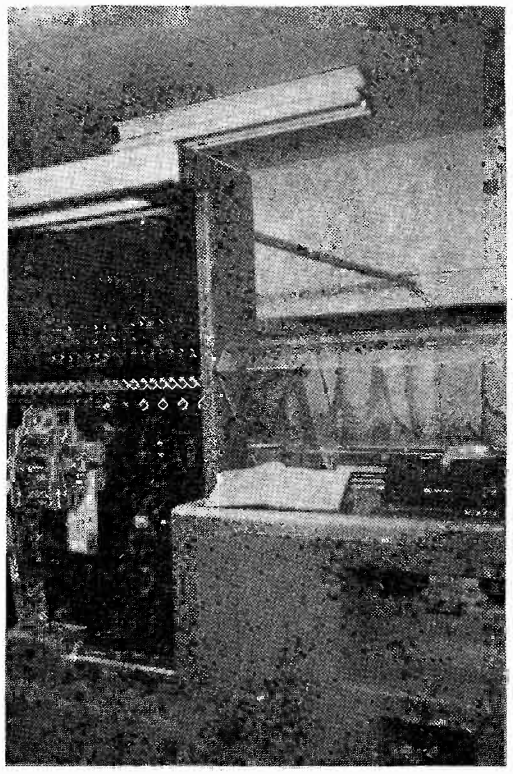
ALL-PURPOSE THERMOSWITCH CONTROL

FOURTEEN FACTS IN FENWAL'S FAVOR

1.—Fast reaction time
2.—Large heat sensitive area small heat storage
3.—Short heat transfer path
4.—Small temperature differential
5.—Built-in temperature anticipation
6.—Enclosed assembly
7.—Minimal vibration effects
8.—Tamper-proof and sealed
9.—Rugged construction
10.—Adjustable over wide temperature range
11.—Minimum size
12.—Directly responsive to radiant heat
* 13.—Uniform sensitivity over adjustable temperature range
14.—Readily installed

*#13 of the "Fourteen Facts in Fenwal's Favor"

of programming them before they are turned on. The computer performs arithmetical operations. The mathematician has to plan the sequence in which the computer performs these operations and the sources from which it draws each number for each operation and what it does with the result after each operation. Planning takes a mathematician who comprehends the mathematical logic behind the solution. One present serious handicap in the utilization of large-scale computers is the lack of adequate mathematicians to plan the work that the computers are to perform.



Portion of Harvard's calculator showing preparation of control tapes

The use at Harvard University of the IBM automatic-sequence controlled calculator was described by H. H. Aiken. The calculator does numerical calculations in a pre-arranged, controlled sequence. It can refer to tables, interpolate, and perform other numerical operations. Problems involving statistics and integrations that it is to solve must be reduced to numerical manipulations. This conversion of the problem into numerical form requires a staff of mathematicians. Once in numerical form the problem is coded for the machine by perforating three groups of eight three-digit numbers on a tape. The first group tells the machine where to obtain numbers, the second group tells it where to put the result, and the third group tells it what trans-

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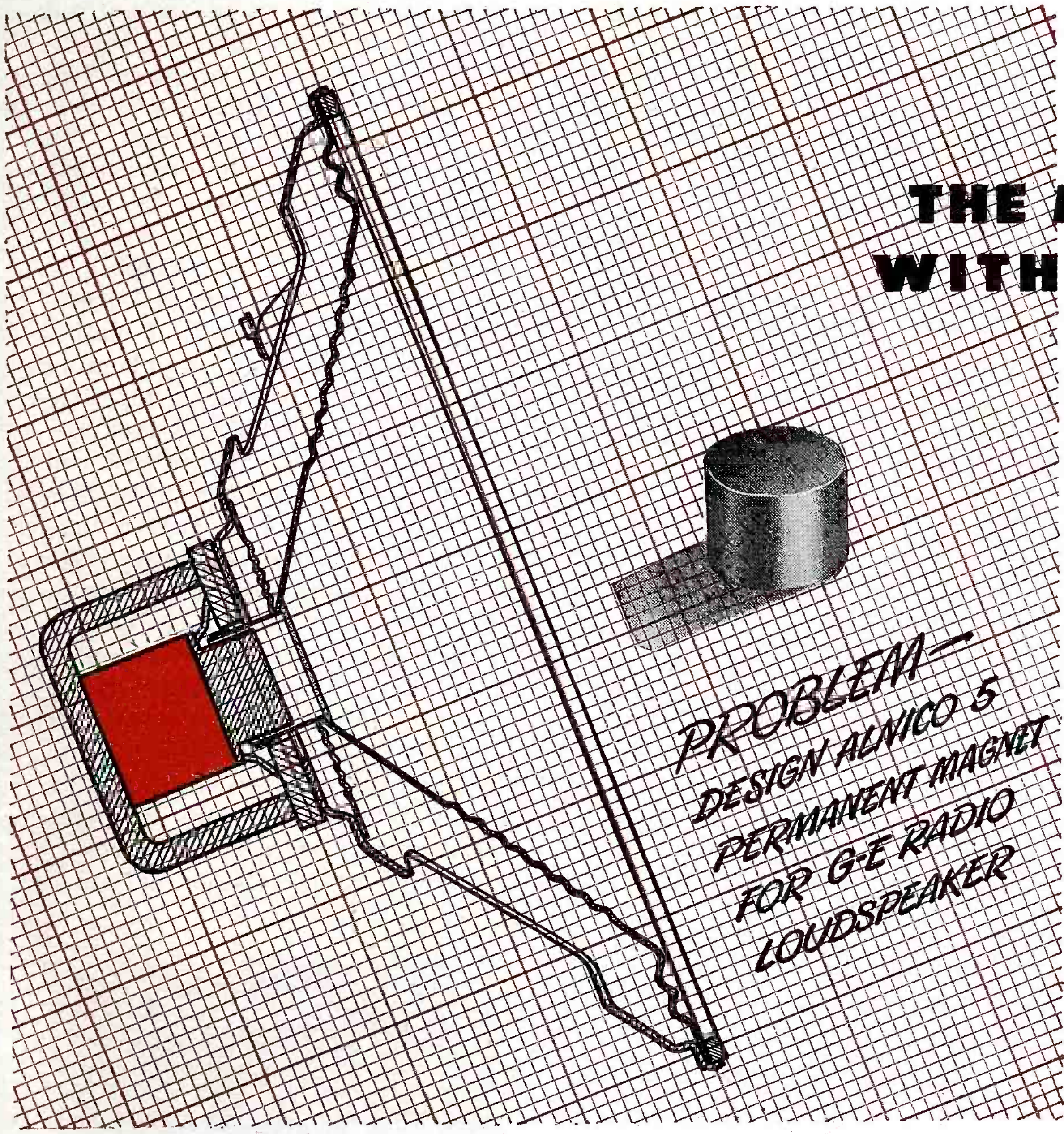
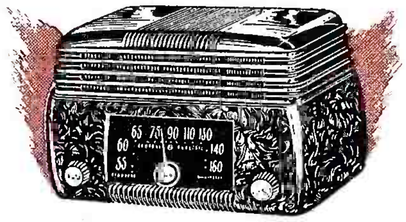


THE MAGNET WITH A VOICE



A voice coil wound on an aluminum base moving in the field of an ALNICO 5 permanent magnet—that's the heart of the modern G-E loudspeaker. Current passing through the coil in the magnetic field causes the coil and attached cone to vibrate in proportion to the applied alternating voltage, thus producing sound waves. ALNICO 5 offers maximum energy with reduced size and weight, minimum losses and increase of sensitivity and power.

General Electric's precise quality control methods used throughout magnet production, plus accurate testing and rigid inspection assure you of receiving magnets of the highest uniform quality for your application.

Greater flexibility of magnet design is possible with the many G-E permanent magnet materials now available. The large group of sintered and cast ALNICO alloys has been augmented by the lightweight, non-metallic mixture, VECTOLITE, and by the ductile permanent magnets, CUNICO, CUNIFE and SILMANAL. From such a wide choice of materials, you may now find a magnet better suited for your application or a material which will make possible new designs heretofore impractical or impossible.

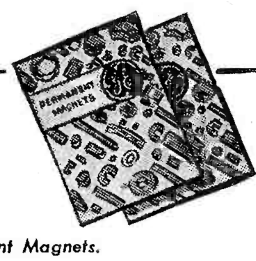
General Electric engineers, backed by research and application experience, have acquired years of "know-how" in selecting the best permanent magnet material and properly designing magnets for thousands of products. These engineers are at your service. *Metallurgy Division, Chemical Dept., General Electric Co., Pittsfield, Mass.*

SEND FOR NEW BULLETINS ON G-E PERMANENT MAGNETS

We shall be glad to send you upon request our new bulletins, CDM-1, "Permanent Magnets," and CDM-2, "Cast and Sintered Alnico, Catalog Supplement," both specifically designed to help you with your permanent magnet problems.

CDM-1 contains information about the characteristics and properties of G-E permanent magnet materials, their application and design. Listed in the catalog supplement, CDM-2, are sintered and cast Alnico permanent magnets available from stock. Proposed R.M.A. standard speaker magnets are included.

For your copies, please fill out the coupon below.



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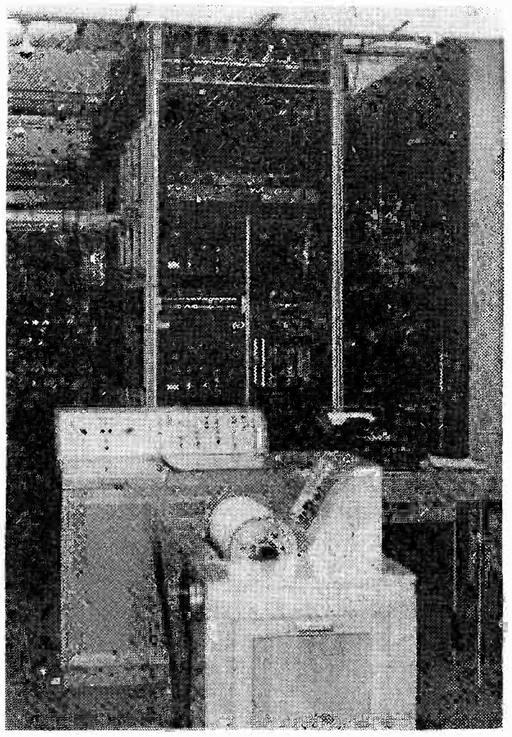
PERMANENT MAGNETS

GENERAL ELECTRIC

CD47-JA3

fer operation to perform on the numbers taken out before putting them back. This sequence constitutes one numerical operation. Subsequent operations are performed from like instructions. The machine carries out instructions faster than they could be made manually (a table of Bessel functions can be printed by the machine faster than pages can be proofread), so several teams of mathematicians are kept at work planning problems and preparing tapes to keep the machine in constant use.

Tapes represent the method and are independent of numerical values used in problems, so once a tape has been prepared for a particular type of problem, that problem, with different values, can be quickly solved. But as the time to prepare the tape is a major portion of the total time to obtain a solution, it is not feasable to solve problems on the calculator unless solutions for many sets of data are required. The machine has been used for such problems as calculation of radar antenna patterns.



MIT's differential analyzer is one of the earlier electronic calculators

The thinking that goes into the design of a computer was presented by Julian Bigelow of Princeton University. From what he said it is evident that computers, far from popular misconception of making possible solutions of problems heretofore insolvable, require mathematicians to think through beforehand all the types of manipulations necessary for solution of

...a metal for inserts that won't work loose from ceramic insulation as temperatures fluctuate.
Mycalex Corp.

...a metal to hold other parts in place under the searing heat of a high-voltage discharge.
General Electric Co.

...a metal that won't develop high surface resistance because of corrosion.
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...a metal whose electrical resistance varies measurably with temperature changes.
The Simmons Co.

...a metal for an armature that vibrates continuously 94,000,000 times a year.
Union Switch and Signal Co.

...a metal that can stand spark erosion without pitting or burning.
Scintilla Magneto Co.

...a metal that will remain non-magnetic during spot-welding.
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THESE ARE TYPICAL METAL SELECTION PROBLEMS THAT WERE SOLVED BY USE OF

MONEL NICKEL INCONEL

	MONEL	"R" MONEL	"K" MONEL	"KR" MONEL	"S" MONEL	NICKEL	"Z" NICKEL	INCONEL
CORROSION RESISTANCE	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
STRENGTH	GOOD	GOOD	HIGH	HIGH	GOOD	GOOD	HIGH	GOOD
TOUGHNESS	GOOD	GOOD	HIGH	GOOD	GOOD	HIGH	HIGH	HIGH
HARDNESS	GOOD	GOOD	GOOD	GOOD	HIGH	FAIR	HIGH	GOOD
MACHINABILITY	GOOD	HIGH	GOOD	HIGH	GOOD	GOOD	GOOD	GOOD
NON-GALLING	NO	NO	NO	NO	HIGH	NO	NO	NO
SPRING PROPERTIES	GOOD	NO	HIGH	NO	NO	GOOD	HIGH	HIGH
ELEC. CONDUCTIVITY	POOR	POOR	POOR	POOR	POOR	GOOD	GOOD	POOR
HEAT RESISTANCE	GOOD	GOOD	GOOD	GOOD	HIGH	GOOD	GOOD	HIGH
HEAT TREATABLE	NO	NO	YES	YES	YES	NO	YES	NO
NON MAGNETIC	NO	NO	YES	YES	YES	NO	NO	YES

Think of the INCO Nickel Alloys first when you need a metal with a hard-to-find combination of properties.

These high-Nickel alloys are Strong... Tough... Hard... Rustless.

They resist High Temperatures... Corrosion... Wear... Fatigue. Their use is insurance for long, trouble-free service.

MORE INFORMATION! Tell us the alloy that interests you, and we'll mail more information. Or, send for "List B-100" which lists over 100 bulletins explaining the properties and applications of the INCO Nickel Alloys.

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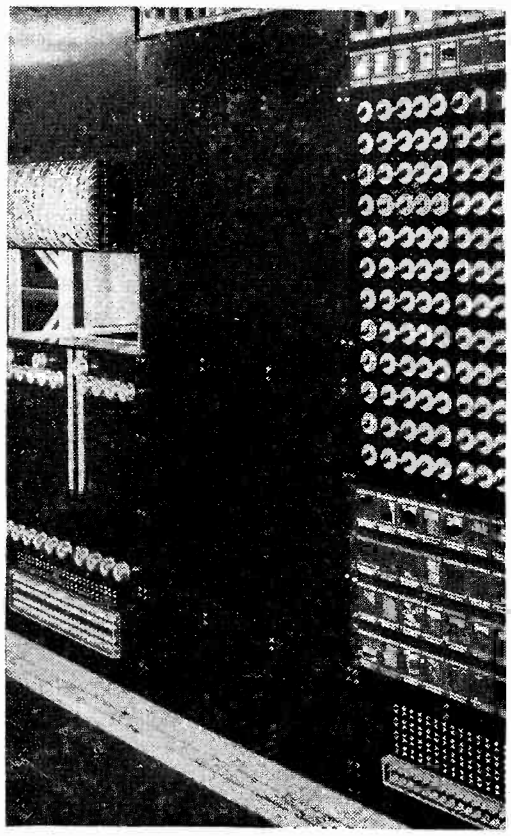
problems for which the computer is to be used. The first consideration is to simplify programming and setting-up of computer problems.

Components of a computing machine are: input, memory, arithmetic manipulator, control, and output. Memory of the Princeton machine will consist of an external unit that records what is to be remembered on a magnetic tape, and an internal unit consisting of an image storage tube modified to meet special requirements of computers. Magnetic tape provides an indefinitely long memory for such quantities as tables of functions to which the machine can refer, while electronic memory provides short time storage for numbers obtained from one arithmetic operation and shortly to be used in another one. Although magnetic tape provides storage of many numbers in very small space, it lacks the desirable feature of being readable instantly at any point. Such an instantly readable memory is needed for high-speed machines.



Universal computers must be adaptable to all types of problems

Although it will take about three years to complete the project, J. W. Forrester of Mass Inst of Tech described an all-electronic computer. The machine is planned to fill needs of pure and applied science, engineering, and statistical studies such as those made by the U. S. Bureau of the Census. Such com-

puters, in addition to being arranged for solution of any problem from data supplied to it, can be simplified for solution of specific problems encountered in industrial processing, in which case the calculator would be built into the industrial control equipment and would serve to control complex operations in accordance with data supplied to it from plant instrumentation.

Among functions to be provided in a computer is that of choice between possible computing programs. For example, the machine should be able to cycle to within a given limit of convergence when handling nonlinearities, and then proceed to the next step in the solution. High speed (50 microsec to multiply two 12-digit numbers) is useful when computing cycles must be frequently repeated. Instead of sequential transmission of numbers to parts of the computer as used in other machines, this machine transmits 40 digits of a number simultaneously over parallel busses (see later about ENIAC). Circuit problem thus introduced is one of precisely gating each train of pulses to the proper unit of the computer. Wide bandwidth is required with low noise, but at the same time circuits are made to pass d-c so that manual programming can be used for locating faults in the machine. The memory is to utilize electronic storage on a dielectric plate.

Reviewing what has been done to provide industry with computers, J. C. McPherson of IBM Corp explained how basic units of business machines controlled by punched cards have been available to engineering computations offices. One such unit is electronic, handling multiplications of one six-digit number by another in 17 microsec.

The ENIAC, described by T. K. Sharpless of the University of Penna as the largest automatic tube tester in constant use, was planned for the specific purpose of preparing ballistic firing tables (ELECTRONICS, p 308 April 1946). A general purpose computer EDVAC, is being developed. It has greater memory facilities, fewer tubes, but does not perform operations quite so fast because it uses time sequence (or division) rather than the spatial division of the ENIAC. Thus, instead of having a multi-

A new principle

FOR THE MEASUREMENT OF D. C. VOLTAGE . . .

SHERRON
D. C. Vacuum Tube Voltmeter-Ammeter

D. C. Current is instantly converted to alternating voltages of a fixed frequency — amplified and metered. With the use of this principle, even the minutest flow of direct current can be read. The extreme sensitivity of this advanced instrument heightens its value. A versatile instrument, Model SE-519 has further application as a megohmmeter with external voltage source.

SPECIFICATIONS

VOLTMETER

Ranges: .015, .05, .15, .5, 1.5, 5, 15, 50, 150, 500, 1500 *volts full scale.*

Input Impedance: 1 *megohm on all ranges with exception of* 1500 *Volt scale, where the impedance is* 3 *megohms. This gives a sensitivity of* 68 *megohms/volt on lowest range.*

MICROAMMETER

Ranges: .015, .05, .15, .5, 1.5, 5, 15, 50, 150, 500 *microamps full scale.*

Voltage Drop: *Maximum* .15 *volts. On lower ranges it drops to* .045 *volts.*

Ohmmeter: *Resistance can be determined by measuring E & I from any external power supply. With* 500 *volts,* 67,000 *megohms give half scale reading on maximum range.*

Power Requirements: 115 *volts,* 60 *cycles,* 175 *watts.*

SHERRON ELECTRONICS CO.
Division of Sherron Metallic Corporation
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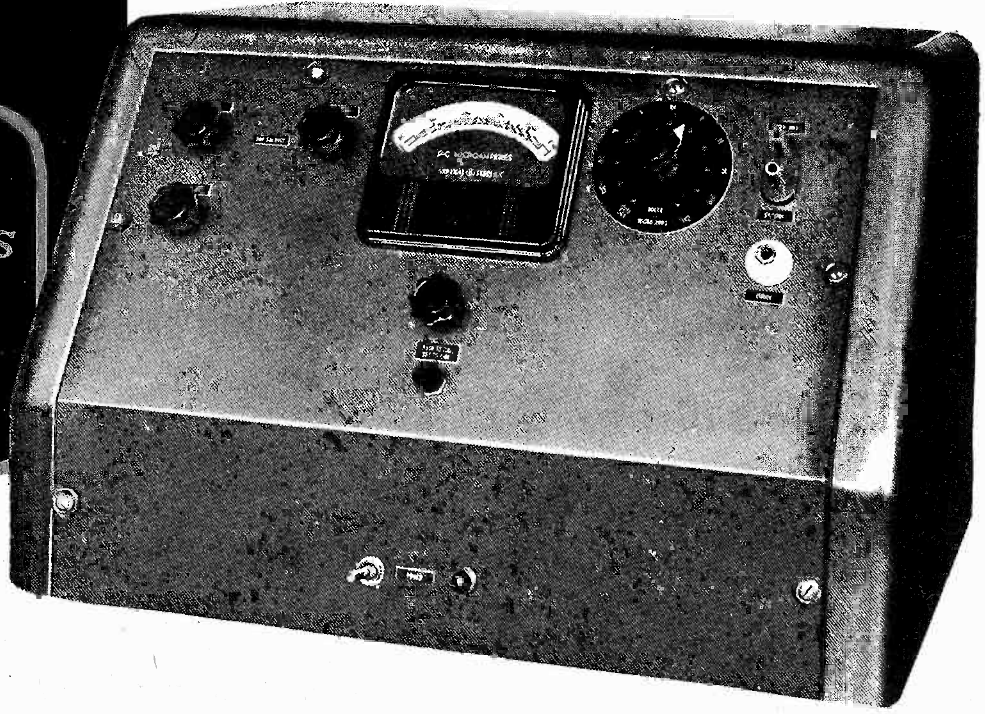
Sherron Electronics
W2XDK



Model SE-519

plicity of circuits through which signals pass in parallel, the EDVAC has a few circuits through which signal pass in tandem. Coding will be by magnetic tape coded at slow speed and run through the electronic calculator at high speed.

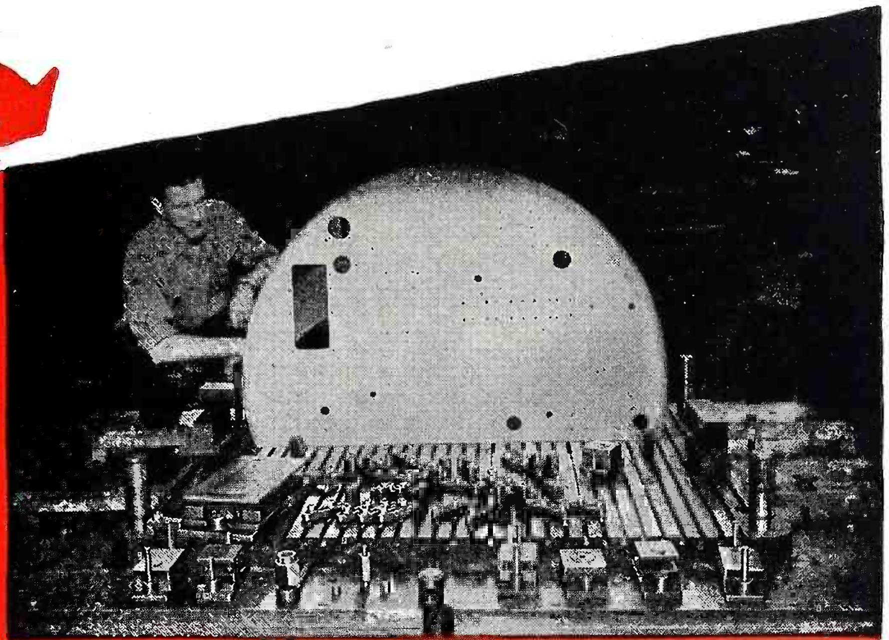
A relay-operated computing machine developed by Bell Tel Labs was described and illustrated by S. B. Williams, consulting engineer. Controlled by a punched tape (perforated by a teletypewriter), the machine adds, subtracts, multiples, divides, and extracts square roots of real or complex numbers and prints results on teletypewriters. Other mathematical operations are performed by combinations of these basic manipulations. Should the computation called for by the control tape not be completed in the allotted time, the machine stops and signals a fault. The serviceman can then see from the fault indication in what part of the machine the calculation has been interrupted and go there and repair the offending relay. Computation then proceeds without loss or repetition.

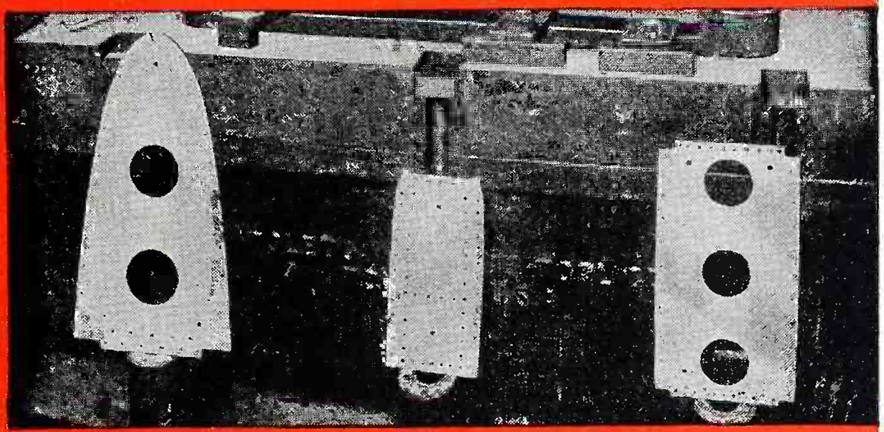
Problem of accuracy of calculations performed by automatic machines was outlined by John Mauchly of the Electronic Control Co. Inaccuracies produced by rounding off in digital machines introduces errors whose magnitudes are difficult to estimate. The machines themselves can be used to determine their truncation errors by, for example, solving the same problem by several methods, which is feasible with machine computers where cost of computation is low.

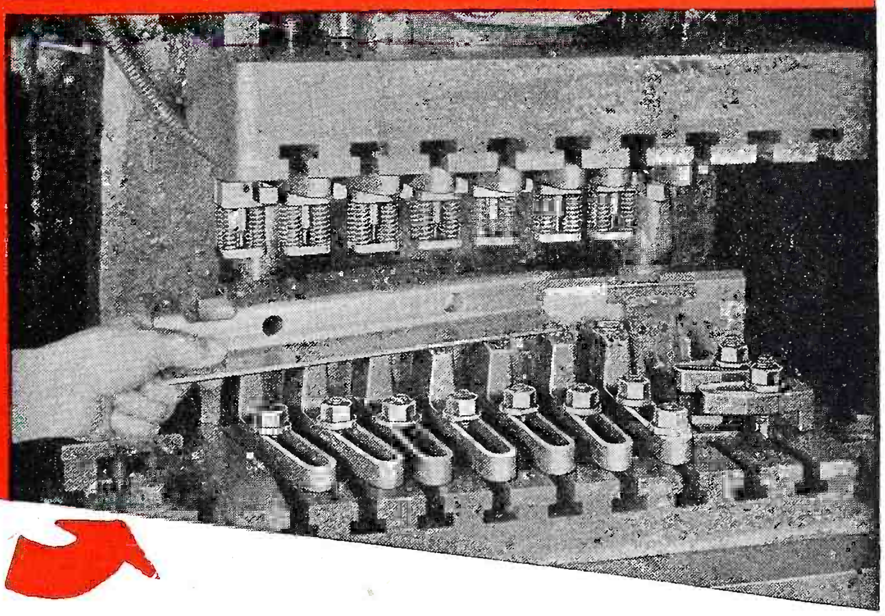
Energy Sources

Beginning a series of conferences to examine systematically possibilities of utilizing all possible sources of electrical energy to their fullest extent, a conference was held by the Committee of Basic Sciences. A brief survey of means of converting other forms of energy into electrical energy was presented in a report prepared jointly by L. W. Matsch of the Armour Research Foundation and Wilbur C. Brown of the U. S. Signal Corps. There are electromagnetic methods, which include such rotating machinery as d-c and a-c generators; there are electrochemical means, which embraces the wide variety of primary and

Some examples of what can be done with Whistler Adjustable Dies. Work in practically any type press.







Re-use same WHISTLER ADJUSTABLE DIES in unlimited combinations

1 To Pierce Holes of any diameter from 1/32″ up.

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Save production time and reduce product costs by having Whistler punch and die units in your tool room.

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Whistler notching dies, group dies and standard units are especially adaptable to combined use in the same set-up. Continued re-use in a variety of arrangements quickly writes off original investment. Reason enough for their expanding popularity with hundreds of America's best known manufacturers.

Now available from stock in a range of diameters up to 3″, shipment can be made the same day your order is received. Special sizes, shapes, notching and group dies are made to order in a few days.

You get production economy plus precision perforating in practically any press with these Whistler dies. Set-ups are easy and fast. No special tools required. Heavy duty series easily pierces 1/4″ steel. All parts interchangeable. Tolerances maintained to .0002″. There are many other advantages. Get in touch with Whistler.

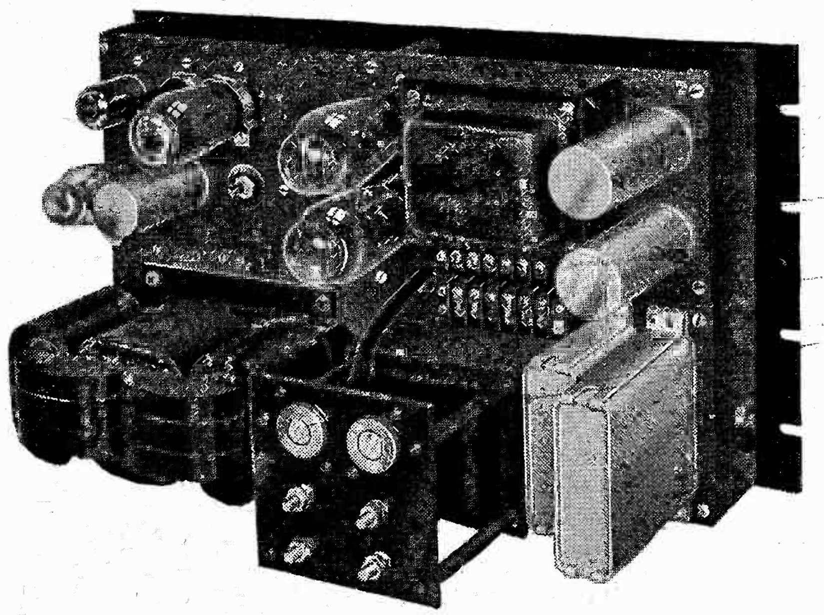
S. B. WHISTLER & SONS, INC.

752-756 MILITARY ROAD BUFFALO 17, NEW YORK secondary (storage) batteries; the electrostatic; the thermo-electric (depending on temperature differences between two junctions of dissimilar metals in a closed circuit); thermomagnetic (in which reluctance of a magnetic circuit is charged by thermal expansion or contraction of elements in that circuit); magnetostrictive (wherein reluctance of a magnetic circuit is changed by mechanical forces); piezo-electric and pyro-electric, production of electric polarity in a crystal, being by pressure in the former and by temperature by the latter; emission, either thermionic or photo-electric; contact (where, when two dissimilar metals are in contact, they become differentially charged; atmospheric (the potential gradients in the atmosphere); and terrestrial (earth currents). All of these phenomena are known, but only the electromagnetic and electrochemical ones have been used extensively for power, while some of the others are not understood.

Emission phenomena, on which the electronic branch of electrical engineering depends, was described by Dr. L. A. DuBridge of Calif Inst of Tech. Dr. Walter G. Cady of Wesleyan University (ELECTRONICS, p 290 Oct. 1946) reviewed piezo-electricity and the related phenomena of pyro-electricity. Possible expansion of the application of electrostatic phenoment was predicted by John G. Trump of Mass Inst of Tech. Nuclear forces released by atomic fission are electrostatic in nature. By means of generators operating in a complete vacuum as insulation instead of gas at high pressure, it may be possible to utilize nuclear energy directly without first converting it into heat as in the steam plants now harnessing the energy from chain reaction piles.

New Electronic Devices and Methods

Electronics is being applied industrially from automotive engine testing to fabrication of desk tops. In a two-part paper, an electronic dynamometer control was described by H. W. Gayek and the application of such dynamometers to automotive testing was explained by E. F. Kubler, both of General Electric Co. The d-c cradle dynamometer can be used conveniently for engine test-



The STABILINE *Electronic* Voltage Regulator

Instantaneous in action with a maximum waveform distortion of 3 percent — this new completely-electronic voltage regulator maintains a stable output . . . within ± .1 volt of nominal for line variations from 95 to 135 volts; within ± .15 volt of nominal for any load current change or load power factor change from lagging .5 to leading .9.

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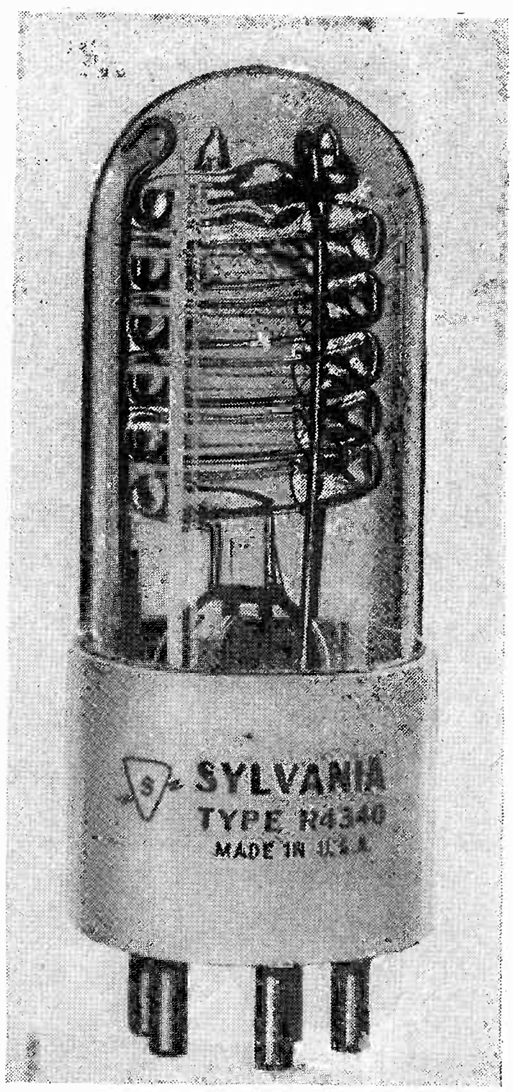
ing because it serves both to start and to drive the motor and to absorb power from it, in which case the dynamometer can return power to the mains by driving a d-c generator that in turn drives an induction generator. Conditions to be met for such operation are that field excitation to both dynamometer and motor be properly adjusted so that the dynamometer absorbs the required power from the motor under test at the test is driven at constant speed.

The fields can be controlled electronically. A tachometer is used as one element of a bridge circuit. Output from the bridge is then indicative of the direction and speed of shaft rotation. This output is used to control a rectifier circuit that in turn controls field excitation of the dynameter through saturable core reactors whose a-c windings are parts of a phase shifting network. Another similar circuit controls the generator motor to keep the generator output at line frequency. Variable arms in the two bridge circuits, which can be ganged for some types of tests, are



Tube has flash duration intermediate between strobatron and photoflash

When mill-ordered ARMCO Electrical Steels are unloaded in your plant you can be sure of this:

The steel is "job-tailored" to your needs — *before* and *during* rolling operations. Metallurgists and mill representatives see that you get the *one right steel* for your products.

For almost 20 years Armco men have called this "Q. C."— Quality Control. Metallurgists who study your requirements specify the analysis of steel, the temper rolling, annealing, and all other operations that affect the qualities of finished sheets and strip. Then mill operators follow through closely with these instructions on your individual routing card.

In recent years, Armco control charts and statistical analyses have further helped assure consistent production of prime electrical steels. They are an added safeguard for the steels that go into your products.

"Quality Controls" like these are one reason why leading manufacturers look first to Armco for special-purpose sheet steels.

Back of it all are the research and experience that contribute to a higher "Q. C." at our end and better quality at yours. The American Rolling Mill Company, 4231 Curtis St., Middletown, Ohio.

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We urge you to collect every pound of iron and steel scrap, including unused and obsolete equipment. Speed it to the steel industry through your regular channels. Present high production cannot be maintained unless more scrap is shipped to the mills promptly. The situation is critical; so act today.

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charge tubes can be fired by a trigger tube actuated by a camera shutter synchronizer, and the others by phototubes observing the flash of the primary tube and operating trigger tubes associated with the other discharge tubes. These secondary discharge tubes flash within two microseconds of the primary tube.

The beam traveling-wave tube, used as a wideband amplifier for microwaves (ELECTRONICS, p 90 Nov 1946) was described by J. R. Pierce of Bell Tel Labs.

Edge gluing of boards to form panels and cores for furniture was described by J. M. Crage of Raytheon Mfg Co. Dielectric heating is readily applicable as glue and board form parallel field paths instead of series (laminated) paths as in forming plywood. With glue and board parallel, the higher dielectric loss of the glue causes it to absorb most of the h-f power. Whereas using dielectric heating in plywood fabrication is expensive because heat is delivered to the wood as well as to the glue, it is both inexpensive and fast in fabricating edge-glued panels.

With 5 kw, and 250 lb per sq in. edgewise pressure holding the boards, the glue has set sufficiently for the panel to be run through the planer after 30 sec of dielectric heating. Minimum heating time is limited by flash point of the wood; size of panel that can be handled is limited by appearance of standing waves on the applicator plates (heating electrodes). Only control beside power pushbuttons for turning the equipment on and for applying r-f power to the applicator plates, is a wheel control for a variable inductor in series with the load to match it at different moisture contents or for different sizes or thicknesses of boards. In the production setup, glue is automatically applied to one edge of each board, the boards manually loaded between applicator plates, and pressure applied through pneumatic cylinders when the r-f is turned on.

High-frequency welding, especially as applied to vacuum tube assembly, was described at considerable length by William Parker of the Victor Division of RCA. By means of h-f (250—400 kc) local induction heating, one can produce

welds. The technique is advantageous because there is no wear on electrodes, no work contamination, the process is readily controlled, there is little mechanical deformation of the work, and because of the energy concentration and short heating time, little power is required. A complete weld can be formed simultaneously by proper shaping of the applicator coils.

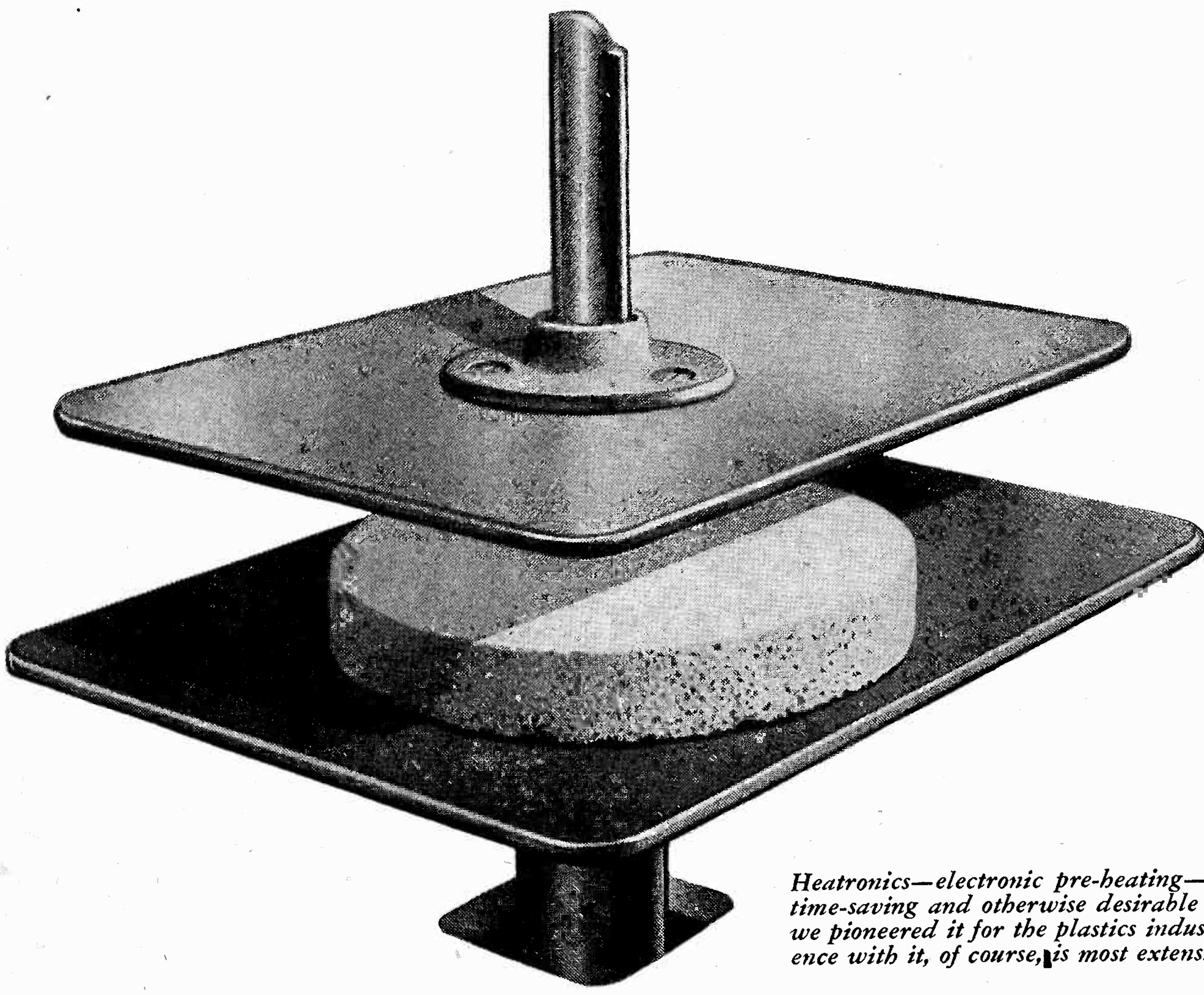
About 8—100 kw r-f output power is fed to the applicator coils through a step-down impedance matching transformer in which the secondary is the slotted case. Filament voltage to the power oscillator tubes is below normal during stand-by, but is raised to somewhat above normal during the short interval of welding, thus high power is obtained from a given unit but tube life is not impaired.

As the metal melts, its resistance doubles thus doubling the heat developed internally. Also, the loading on the oscillator is increased. If overcoupling is used, the increased loading decreases the available output power thus preventing the weld from being heated so much that it flows. By using a preheating, welding, postheating cycle, better welds are obtained. Welding can be controlled so precisely that unsuspected metallurgical variations in metals become apparent. In welding copper, the applicator coil is made of copper and water cooled, otherwise it would melt before the work. Using this technique to form simultaneous ring welds, tube subassemblies can be formed automatically using phototubes to time the welding cycle and machine indexing

Other papers presented at the meeting were made available by preprints through the society at the time of the convention and can be obtained in entirety through the AIEE.

SIX FAMILIES in a mountain valley near Cle Elum, Wash. will have telephone service for the first time this winter, even though the homes are beyond reach of existing telephone lines. Carrier telephone service is to be provided, with Pacific Telephone & Telegraph Co. making the installation on the lines of Kittitas County P.U.D. No. 1.

Finer Plastics...
hot off the griddle!



Heatronics—electronic pre-heating—has become outstanding as a time-saving and otherwise desirable technique in many ways since we pioneered it for the plastics industry back in 1943. K-K experience with it, of course, is most extensive.

WHAT HAPPENS when a custom molder of plastics gets a bright idea? One that cuts production time, improves quality or develops into new applications?

Well—if you're his customer, *you* get the benefit first. If not, maybe your competition gets it.

Kurz-Kasch customers have found their competitive positions thus improved many, many times in relationships frequently going back 30 years. We think these past achievements speak well for more to come. So why not let us tell you our story—now? Your copy of "A Businessman's Guide to the Molding of Plastics" is yours—free—for the asking.

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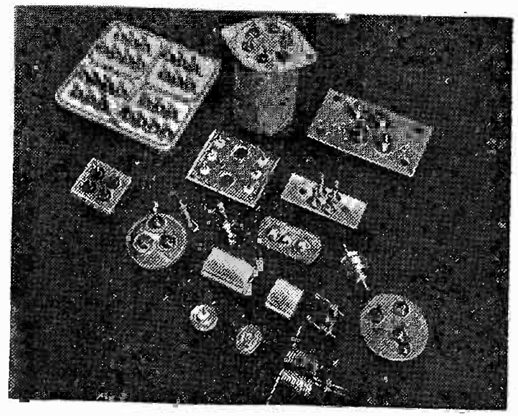
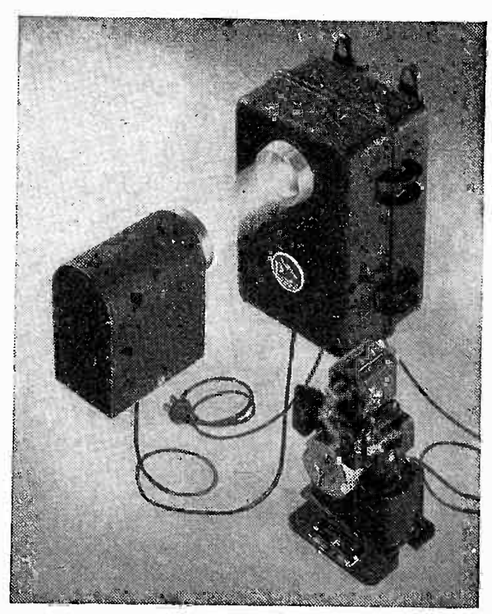
NEW PRODUCTS
(continued from p 160)



they are vacuum tight; have resistance of over 10,000 megohms between body and terminals or between terminals; have a permanent chemical bond between metal and glass; are capable of withstanding shock of hot tin dipping to facilitate soldering. Terminals in the headers may be arranged with a minimum of spacing in any pattern or combination of voltage ratings. An unlimited variety of shapes in multiple headers with as many terminals as desired molded into a cover unit can be made at a substantial saving in material costs.

Photoelectric Counter (17)

PHOTOSWITCH, INC., 77 Broadway, Cambridge 42, Mass. The photoelectric counter type P1 provides a completely packaged, easily installed, general-purpose photoelectric counter at low cost. It consists of a photoelectric control, light source, and electric counter. The only equipment which needs to be located at the point of count is the control and the light source. One or more electric counters (containing the counter face and reset knob)



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The invisible part of any Blaw-Knox Radio Tower is the *accumulated experience* gained by this company in the installation of thousands of towers in many quarters of the globe. This experience counsels the use of better material instead of cheaper material, higher safety factors instead of lower, the best construction instead of "good enough" and, in a word, the best.

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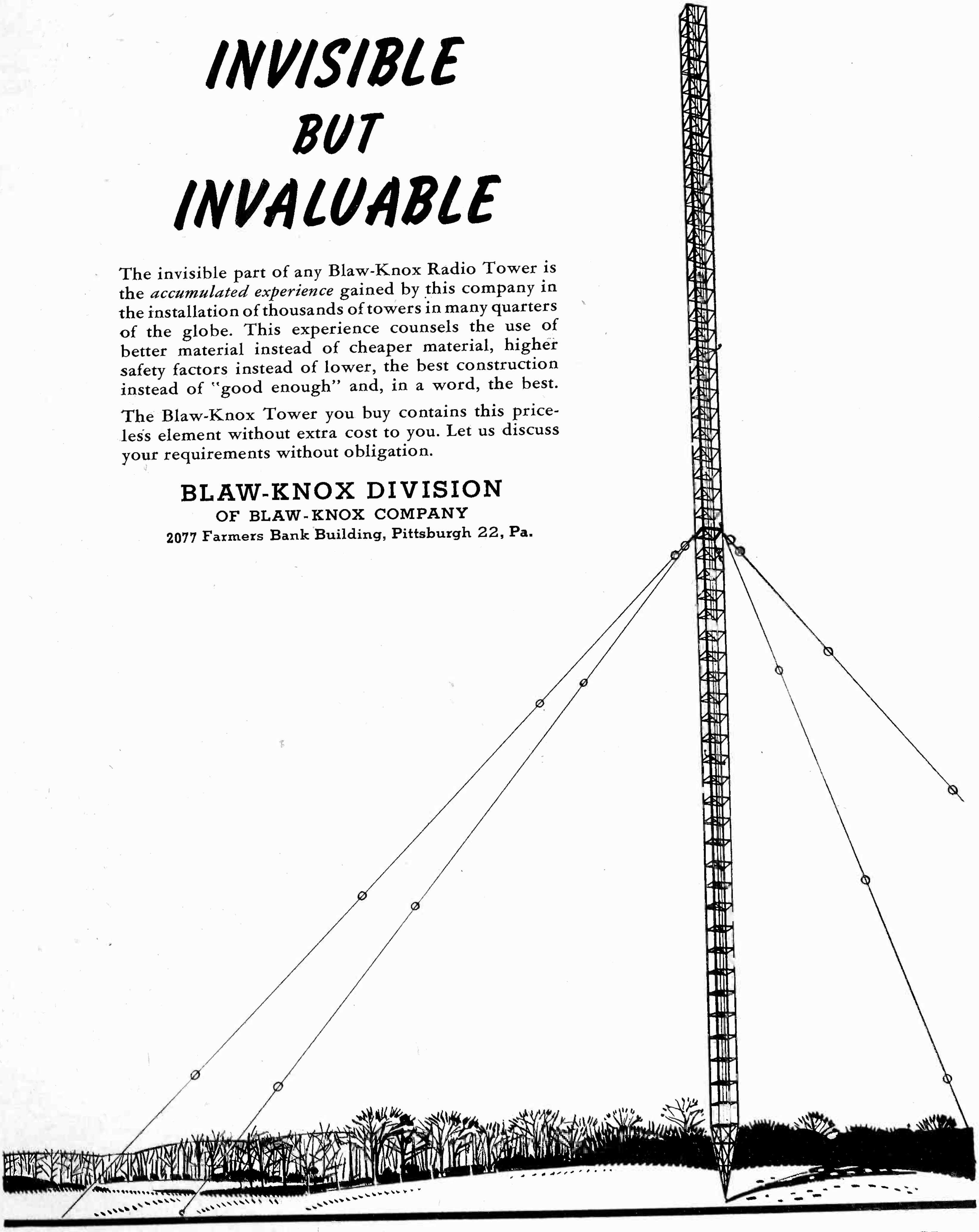
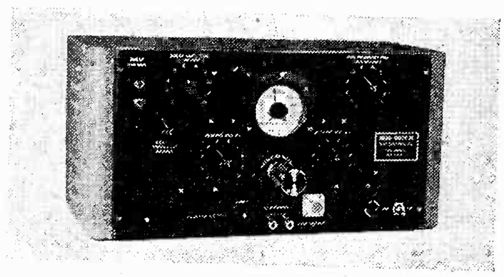


BLAW-KNOX ANTENNA TOWERS

may be placed at any convenient location and wired to the control. Speed of operation is up to 600 counts per minute. Operating range allows 6 feet between photoelectric unit and light source. The device counts to 99,999 before returning to zero. Further details are given in Bulletin 20A1.

Sweep Oscillator (18)

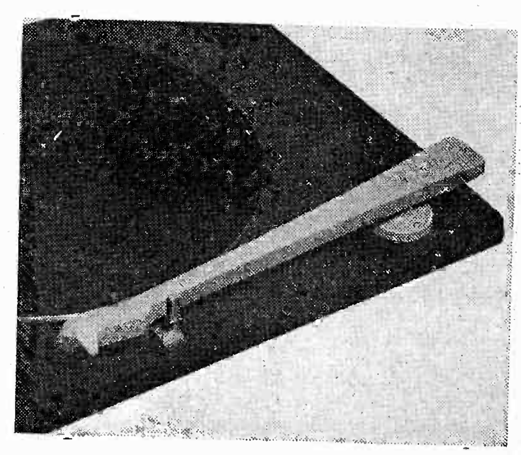
KAY ELECTRIC CO., East Orange, N. J. The Mega-Sweep Jr. provides a frequency sweep up to 30 mc over the spectrum from 400 kc to 500 mc. Output frequency can be increased to 1,000 mc. The output frequency



is measured by means of a precision wavemeter calibrated up to 900 mc and it covers the entire range without switching. The unit has its own power supply encased with the sweep circuit, the total weight being 20 pounds. It sells for $195.

Tone Arm (19)

ROBINSON RECORDING LABORATORIES, 9th and Chestnut Sts., Philadelphia, Pa. A new transcription tone arm for broadcast use is made of cast aluminum and is nonresonant. It is 17½ inches long and is counterbalanced with a lead weight so as to effect less than an ounce pressure on the sapphire point used. A General Electric variable reluctance magnetic cartridge is employed and the unit is arranged to couple directly into a 250-ohm fader input. A two-stage equalizing preamplifier



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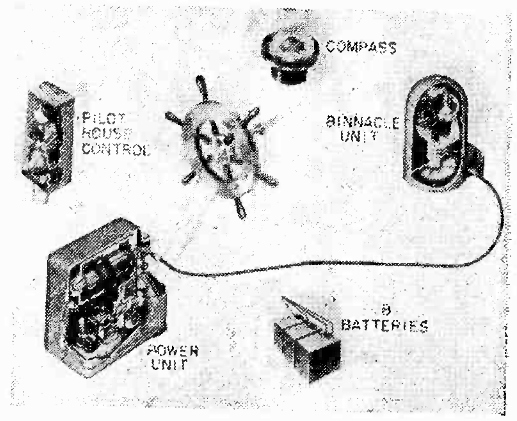
ATTLEBORO, MASSACHUSETTS

50 Church St., New York, N.Y.; 205 W. Wacker Drive, Chicago, Ill.; 2635 Page Drive, Altadena, California; Grant Bldg., Pittsburgh, Pa.

is also furnished. This unit is equipped with a five-position switch that allows reproduction of any type of recording. The tone arm alone sells for $74.50 and the equalizer preamplifier without power supply is $27.50.

Photoelectric Pilot (20)

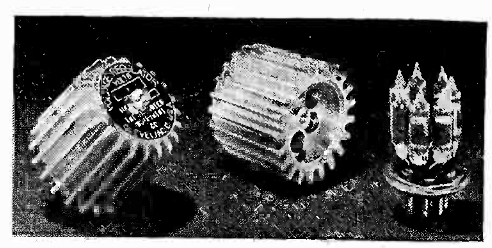
MARINE DIVISION, KIRSTEN PIPE CO., 1165 Eastlake Ave., Seattle 9, Wash. The model 45 photoelectric pilot is a device for automatically steering vessels from 20 feet up to about 50 feet in length and is designed as an attachment for conventional



hand steering gear. The binnacle unit illustrated is the heart of the system that automatically directs the steering system by means of changes in the power unit. The course is set at the pilot house control which may also have a remote control course changing switch. Power is obtained from a block of B batteries and the ship's battery.

Voltage Regulator Unit (21)

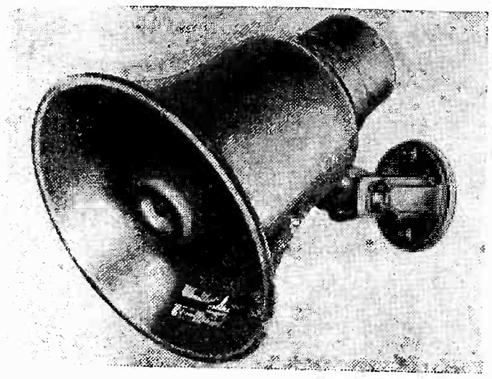
VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland 3, Ohio. The model 348 voltage regulator unit contains seven subminiature gaseous voltage regulator tubes arranged circumferentially and housed in an aluminum casting with octal base. The unit offers close regulation and maintains stability over long periods of time. Its compact arrangement makes it unique for many circuit development ap-



plications where space is at a premium. Individual voltage regulator tubes may be secured separately with operating voltage of 129 to 134 volts at 1.75 ma. Regulation is maintained within 0.5 volt.

Industrial Paging Speaker (22)

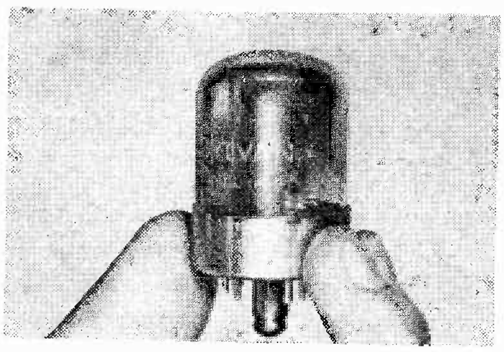
UNIVERSITY LOUDSPEAKERS, INC., 225 Varick St., New York 14, N. Y. The model MIL industrial paging speaker is absolutely immune to moisture, salt spray, and vibration



Dispersion angle is 120 degrees; power output, 5 watts; impedance, 8 or 45 ohms. The diameter is 6 inches, height is 7 inches, and the unit weighs 3½ pounds.

UHF Double Triodes (23)

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Avenue, New York 18, N. Y. Two new double triodes providing single-ended operation for cascade amplifiers operating at frequencies up to 400 mc are available. The high mutual conductance tubes have independent elements with the exception of heaters, permitting an



appreciable saving in space and number of tubes required. Circuit applications include grounded-grid, cathode followers and push-pull amplifiers and converters in the new f-m and television bands where low equivalent noise resistance obtained with triode converters is desirable. Type 7F8 is supplied with a 6.3 volt, 0.300 ampere heater. Similar ratings for type 14F8 are 12.6 volts

electronics READER SERVICE . . .

LITERATURE and NEW PRODUCTS

Manufacturers' Literature as well as further information on New Products described in this issue are important "working tools" for design and production departments. To make it easy to keep up to date, ELECTRONICS will request manufacturers to send readers the literature in which they are interested. Just fill out card as shown in the filled-in sample *(right), being particularly careful to write out in full all the information called for in each section of each card that is used.*

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1. There are two postcards, each divided into four parts. Each of the four parts contains a box. You must write in this box the number that appears in this issue over the literature or new product item in which you are interested. Place one number only in each box.

2. Fill out completely (name, address, etc.) for each piece of literature or new product information you desire.

Do not say "same" in lieu of writing out full information called for when requesting more than one item.

3. This service applies only to literature and new product items in this issue. It does not apply to advertisements. Write directly to the company for information on its advertisements.

PLEASE NOTE: Requests for unnumbered items must be made direct to the manufacturer.

In the event this copy of ELECTRONICS is passed along to other members of your company, please leave this sheet in for their convenience. This assures everyone in your plant the opportunity to fill in their requests. When the round is completed, cards can then be detached along perforated lines and dropped in the mail. Each individual request will be mailed by us to the company offering the information and for that reason must be completely filled out.

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In every issue of ELECTRONICS there's complete coverage of the month by month development by manufacturers of new materials, components and equipment, as well as brief mention of all the important, new, manufacturers' technical pamphlets and catalogs. Some of these items will be of particular interest to specific design and plant engineers, buyers, executives and others of our readers. They will want to make further inquiry concerning the new products described or they will want to read and make a permanent part of their industrial library some of the manufacturers' literature and catalogs. ELECTRONICS Reader Service makes it easy for them to obtain in readily accessible and usable form the information they desire.

FOR THE MANUFACTURER . . .

ELECTRONICS Reader Service will also be welcomed by manufacturers who are desirous of placing the complete news of their product developments as well as their technical bulletins and catalogs in the hands of those members of the electronic industry . . . including design, electrical and production engineers, researchers, physicists, executives, and buyers —who have a particular interest in, or represent a potential buying power for, their products.

SUGGESTIONS FOR THE IMPROVEMENT OF OUR READERS' SERVICE ARE INVITED

ELECTRONICS is constantly seeking new and improved ways of providing its readers with the news and information they want and need, and of assisting the manufacturer in effectively delivering his message to electronic markets. If you have any ideas for us, send them along. They will receive prompt consideration.

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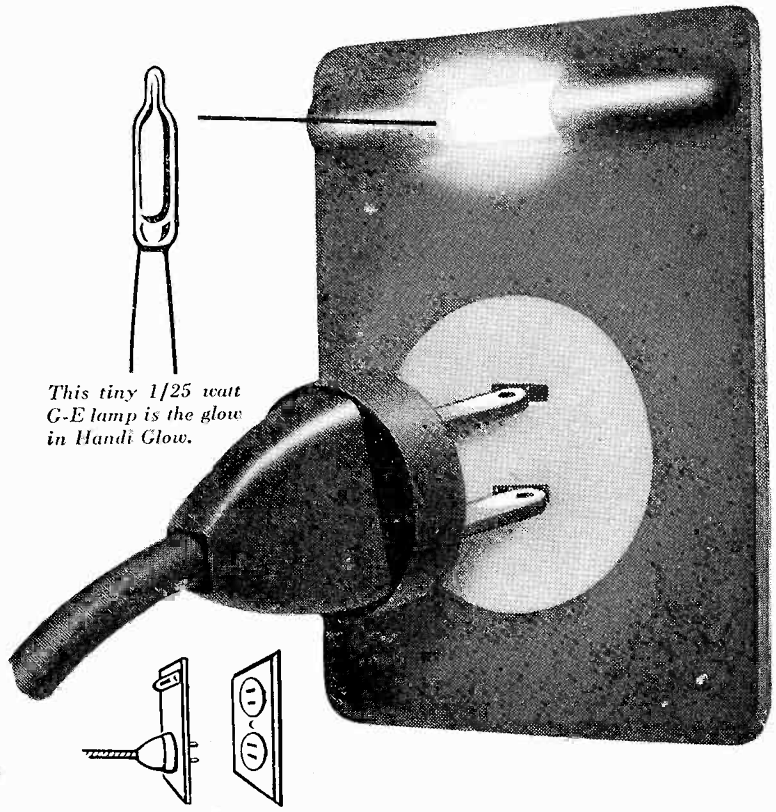
4-1-47

Good news for bad memories

WHAT housewife hasn't put a strain on her husband's good nature by occasionally forgetting to turn off electrical appliances? Industrial Devices, Inc., Edgewater, N. J., has an answer to that universal problem. It's Handi Glow — a simple pilot light attachment that jogs the memory with a visual reminder that the appliance is "on." Fits any standard 2-prong plug. Transfers easily from one plug to another. Also can be used as a voltage test light.

Like many other successful wiring devices, the Handi Glow is equipped with a G-E Neon Glow Lamp—*"the glow that lets you know."*

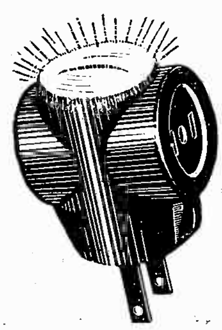


This tiny 1/25 watt G-E lamp is the glow in Handi Glow.

How Handi Glow plugs in.

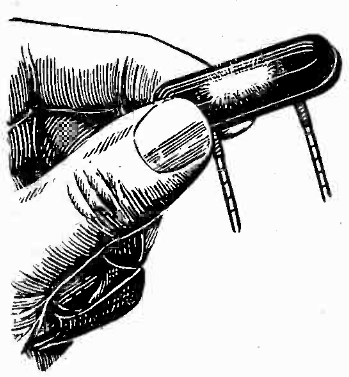
...and it's profit news to you!

TYPICAL WIRING DEVICES USING G-E GLOW LAMPS

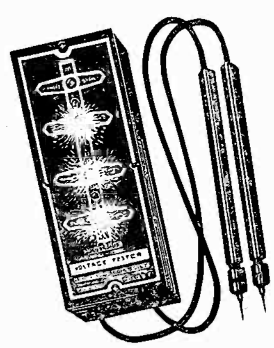


SAFETY PILOT PLUG *combining nite-lite, 2-way plug and electric cord cap.*

LIGHTED SWITCH PLATE *ends fumbling. Light stays on when room is dark.*



MIDGET PILOT LIGHT *for permanent attachment to instrument panels and electrical apparatus.*



CIRCUIT TESTER *uses G-E Glow Lamps to give quick visual indication.*

THESE few wiring devices merely hint at the hundreds of ways G-E Glow Lamps are used to add sales appeal to appliances, instruments and electrical equipment of many kinds. The following G-E Glow Lamp advantages may suggest a valuable profit opportunity for you, too:

1. Distinctive orange-red glow—high visibility.
2. Dependable long life—in some types up to 25,000 hours.
3. Low current consumption—as little as 1/25 watt.
4. Low brightness, low heat.
5. High resistance to shock and vibration.
6. Can be installed in small space.
7. Variety of sizes and wattages.
8. Operate directly from regular 105-125 and 210-230 volt circuits, AC or DC.

REMEMBER—*Every electrical device should have a live circuit indicator. G-E Glow Lamps are ideal for this purpose.*

SEND FOR free bulletin containing full information on G-E Neon Glow Lamps and their application to your product.

G-E LAMPS

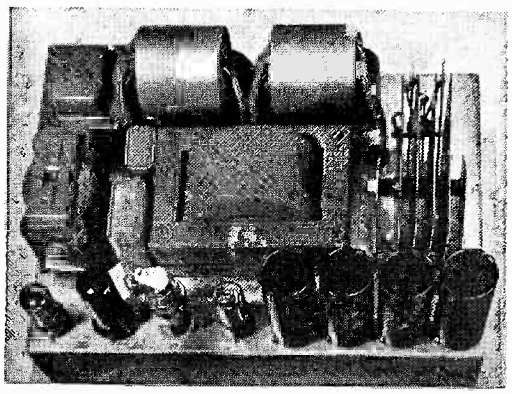
GENERAL ELECTRIC

Nela Specialty Div. Lamp Dept., 1 Newark St., Hoboken, N. J.

and 0.150 ampere. Heaters may be operated from an a-c or d-c source. Direct interelectrode capacitances per section for both types are low. Typical operating conditions and characteristics per section for both types are as follows: plate voltage, 250 v; plate current, 6.0 ma; mutual conductance, 3,300 micromhos; amplification factor, 48.

Battery Simulators (24)

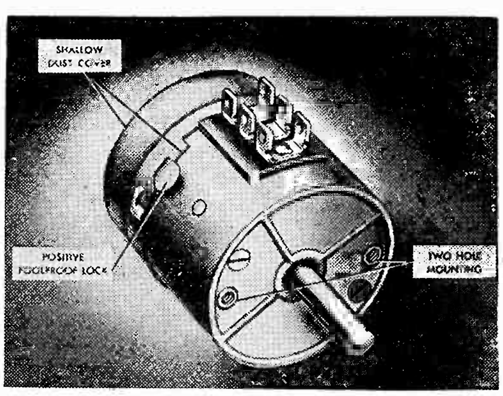
SORENSON & CO., INC., 375 Fairfield Ave., Stamford, Conn. Nobatrons, available in six standard models, operate on a 95-125 volt a-c source of 50 to 60 cycles and provide amperages of 5, 10, or 15 with output voltages of 6, 12, or 28 respectively. Regulation accuracy of one half of one percent, maximum rms ripple voltage of one percent, and recovery



time of one fifth of a second make these devices applicable where constant, unvarying d-c voltages are required. Control features include a switch, a voltage adjustment, a control circuit fuse and a pilot light. Models are available either for panel mounting or encased in a cabinet with a gray wrinkle finish. Further technical specifications are available.

New Attentuator Series (25)

THE DAVEN CO., 191 Central Ave., Newark, N. J. announces a new type of mechanical construction for

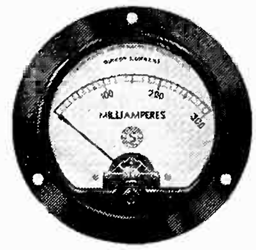


How often have you wished for a meter you could see *clearly*—the whole scale of it, wherever you were using it—in the dark, under low lights, or even in the kind of glare that causes reflections on the glass—a really illuminated meter? Well, here it is—the result of a new Simpson patented method of illumination.

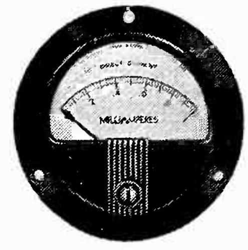
On these new Simpson Illuminated Meters (voltmeters, ammeters, milliammeters, and microammeters), every fraction of the dial face is flooded with light—there isn't a spot of shadow. And this isn't a dull glimmer of light. It's a full and even radiance.

An ingeniously shaped Lucite cone carries the light from a recessed bulb in the back of the instrument through the front edge that surrounds the entire dial. This makes possible the use of the standard Simpson metal dial. Unlike translucent dials, it cannot fade or discolor so that reading becomes difficult. It cannot warp or buckle, causing the pointer to stick, or distorting readings. The bulb recess is neoprene sealed.

Behind the refinement of this superior illumination lies the basic reason for preferring Simpson instruments—their in-built accuracy. That high quality which is the indispensable component of every Simpson instrument makes sure that the accuracy will *stay* there, year after year.



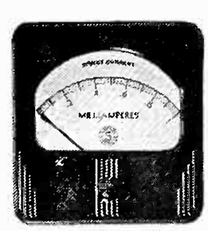
OPEN FACE



SHROUD STYLE

2" Round Case. Flange diameter, 2-3/4"; depth overall, 2-5/16"; body diameter, 2-11/64"; scale length, 1-7/8".

3" Round Case. Flange diameter, 3-1/2"; depth overall, 2-1/4"; body diameter, 2-3/4"; scale length, 2-9/16".



3" Rectangular Case. Width, 3"; height, 3-1/8". Mounts in round hole. Body diameter, 2-3/4"

2" Rectangular Case. 2-3/8" square. Mounts in round hole. Body diameter, 2-3/16".

SIMPSON ELECTRIC COMPANY
5200-5218 W. Kinzie Street, Chicago 44, Illinois
In Canada, Bach-Simpson, Ltd., London, Ont.

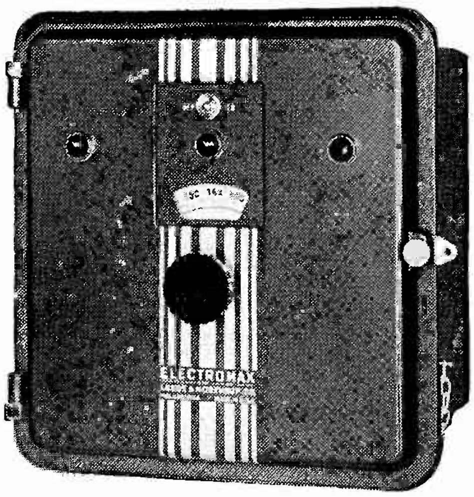
Simpson

INSTRUMENTS THAT STAY ACCURATE

their line of attenuators, with such improved features as: a non-ferrous can; a dust-proof housing that is totally shielded; 50 percent less space is required than heretofore to remove the new shallow dust cover, thus permitting the unit to be mounted in a smaller space. All fiber and other moisture absorbing parts have been eliminated. A two hole mounting is standard on the new type units; however, single hole mounting may be secured.

Temperature Control (26)

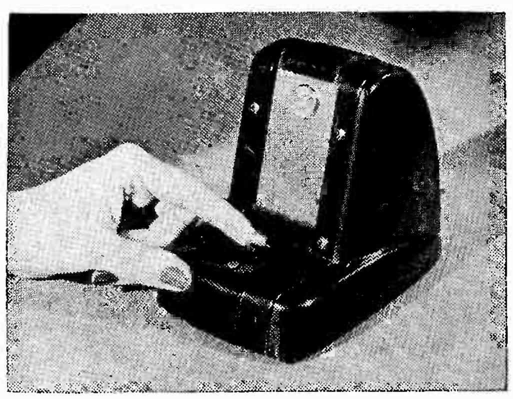
LEEDS AND NORTHRUP CO., 4934 Stenton Ave., Philadelphia 44, Pa. The new Electromax control consists of a Wheatstone bridge circuit with a vacuum-tube amplifier-detector. Standard ranges of control are 0-250 and 0-1,000 F.



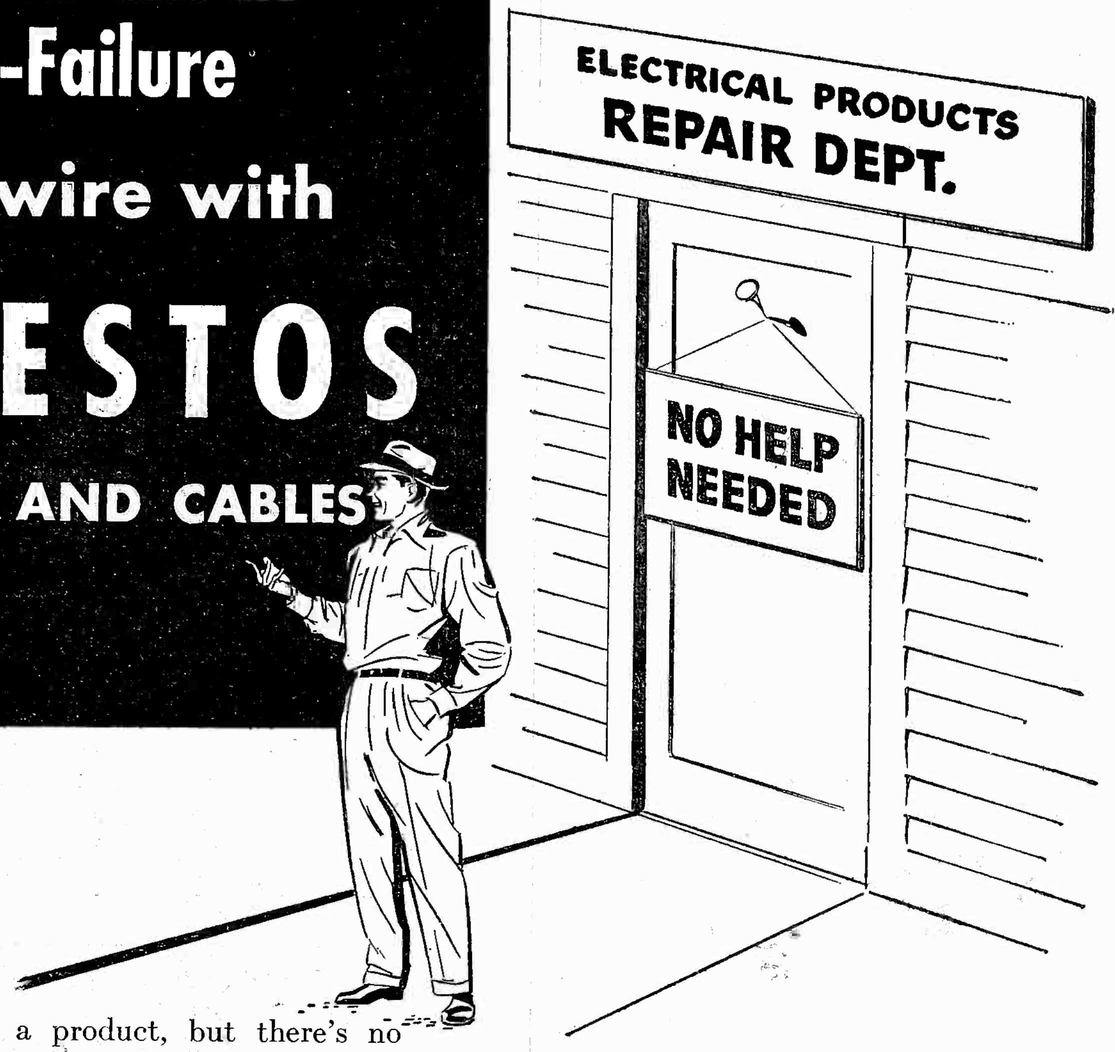
Temperature-sensitive elements are resistance thermometers that can be placed conveniently without regard to lead length affecting calibration. The equipment which is a-c operated is designed for installations where continuous recording is not necessary.

New Intercommunicator (27)

RADIO CORP. OF AMERICA, Camden, N. J. A two-station intercom is designed with amplifier and speaker



Fewer "Make-Goods" For Wire-Failure when you wire with ROCKBESTOS WIRES, CORDS AND CABLES



A guarantee may help sell a product, but there's no substitute for quality when *performance has to keep it sold.* That's why permanently insulated Rockbestos wires win friends and influence sales by reducing wire-failure repairs, serviee calls and replacements.

In heat-generators like waffle irons and rheostats, or products which may be used in failure-creating high ambient temperatures, asbestos insulated Rockbestos wires will operate *continuously* at rated temperatures without drying out, becoming brittle, cracking or flowing. They won't rot under exposure to grease, oil or insulation-destroying fumes. And they are built to outlast products designed to give years of dependable service.

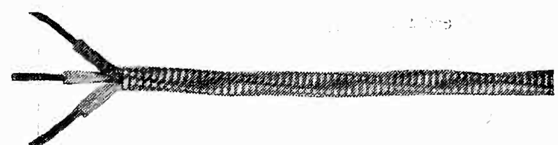
For almost anything you may make, from electronic devices to jet propelled airplanes, there is a *permanently insulated* Rockbestos wire that will help preserve your product's prestige. For recommendations and information write to:

ROCKBESTOS PRODUCTS CORPORATION
446 Nicoll St., New Haven 4, Conn.

A few of the 125 permanently insulated wires, cables and cords developed by Rockbestos to protect product performance and give lasting service.

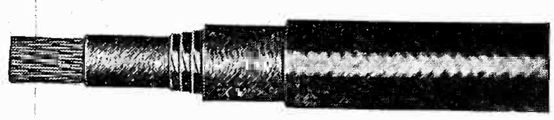
ROCKBESTOS FIREWALL HOOKUP WIRE

This heat, flame and moisture resistant wire, insulated with high dielectric tapes and impregnated felted asbestos and covered with color-coded, lacquered glass braid, has a maximum operating temperature of 125° C. Ideal for radios, television, amplifiers, calculators or small motor, coil, dynamotor and transformer leads. No. 22 to 4AWG in 1000 volt rating — No. 12, 14 and 16 AWG in 3000 volt rating. Also in twisted pair, tripled, shielded and various special multi-conductor constructions.



ROCKBESTOS THERMOSTAT CONTROL WIRE

A multi-conductor control wire for fuel burner controls, safety pilots, intercommunications and signal systems. Its asbestos insulation and steel armor assure trouble-free circuits. Sizes No. 14 to 18 AWG in two to five conductors with .0125", .025" or (for 115 volt service) .031" of impregnated asbestos insulation.



ROCKBESTOS A.V.C. MOTOR LEAD CABLE

Use this 600 volt apparatus cable for coil connections, motor and transformer leads exposed to overloads and high ambient temperatures. Insulated with impregnated felted asbestos and varnished cambric, and covered with a heavy asbestos braid, it is heat-proof and resistant to oil, grease, moisture and flame. Sizes 18 AWG to 1,000,000 CM.

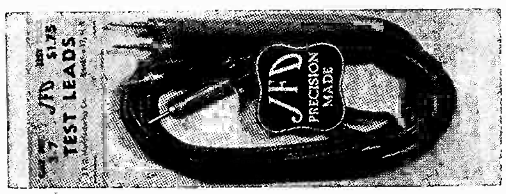
ROCKBESTOS
The Wire with Permanent Insulation

NEW YORK BUFFALO CLEVELAND DETROIT PITTSBURGH CHICAGO ST. LOUIS LOS ANGELES SAN FRANCISCO SEATTLE PORTLAND, ORE.

station in separate units, permitting location of the amplifier at any convenient point and reducing speaker station size to that of a desk clock. Speaker stations are newly styled and housed in streamlined black plastic cabinets with satin-chrome speaker grills. Especially designed for such two-station use as communication between executive and secretary, or doctor and receptionist, the system consists of two speaker stations, separate amplifier, and 100 feet of interconnecting wire. It is easily installed and plugs into any 110-volt a-c or d-c outlet. If desired, additional stations up to five can be connected to the amplifier.

Test Leads (28)

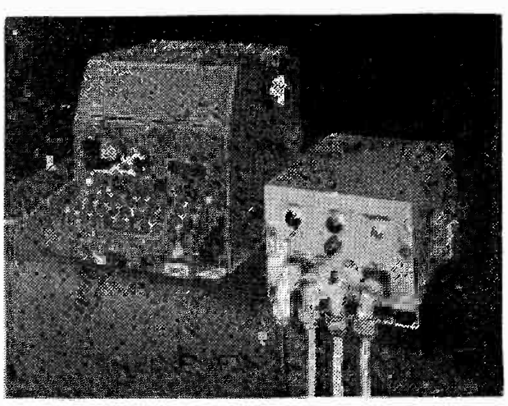
THE JFD MFG. CO., 4117 Fort Hamilton Parkway, Brooklyn 19, N. Y. A new line of test leads and test lead accessories contains 15 different numbers of test leads made with fiber and cast phenolic prod handles. They are made of No. 18 soft-drawn copper, insulated with



kink-free flexible rubber. All end fittings are made of chromium-plated brass, of types including phone tip, phono needle point, spade lugs, alligator clip, banana plug, and the new elbow angle tips.

Airborne Teletype Equipment (29)

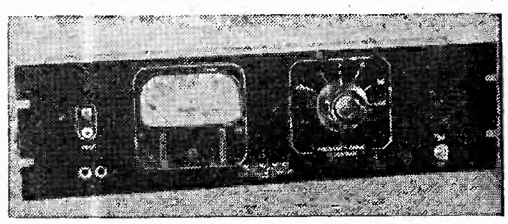
WESTERN ELECTRIC CO., 195 Broadway, New York 7, N. Y. Airborne teletype equipment, developed by Bell Telephone Laboratories and



manufactured by the Teletype Corporation, consists of the Model 31 teletype printer and its associated converter-control unit and adds only 35 pounds to the weight of a plane. The teletype printer illustrated is smaller than a standard typewriter and uses the regular teletype keyboard and signalling code when sending. The converter-control unit changes this telegraphic code into frequency shift signals in the audio frequency range for transmission over existing radio telephone equipment. When receiving, the converter-control changes the frequency shift signals into electrical impulses for operating the receiving-typing part of the teletype printer.

Audio-Frequency Meter (30)

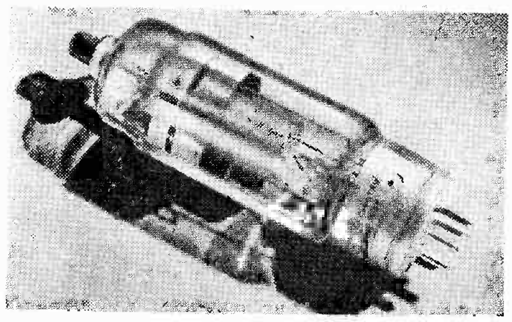
THE DAVEN CO., 191 Central Ave., Newark 4, N. J., announces the new direct-reading frequency meter Type 838. Seven overlapping ranges are available for frequency determination between 20 to 100,000 cycles per second. The accuracy on all ranges is ±2 percent of the top frequency on the range in use. The instrument has a high input impedance and requires a small minimum voltage for stable indication.



Indication is substantially independent of variations in input voltage between 0.5 and 150 volts rms. The instrument panel is designed for standard rack mounting. A walnut case may be supplied for applications requiring bench use.

Industrial Control Tube (31)

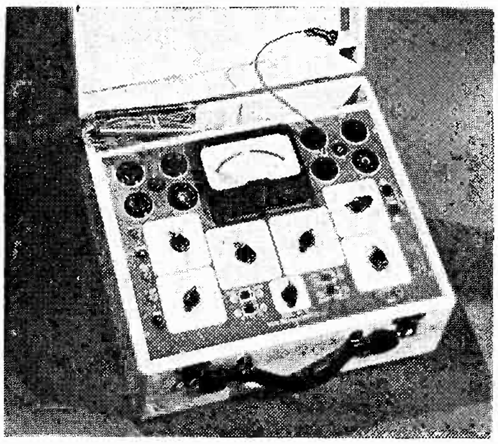
GENERAL ELECTRIC CO., Syracuse, N. Y. The type GL-5545, for use where ambient temperatures range widely, has three major industrial uses: for 220-volt d-c motor control work; in grid-controlled rectifier service; in separate-excitation ignitor circuits. The new tube has a peak-to-average current ratio of 80 to 6.4 amperes and a peak voltage of 1,500 volts. Its inert-gas content



makes possible a short heating time of 60 seconds. Filament voltage is 2.5 volts and filament current is 21 amperes.

Set Tester (32)

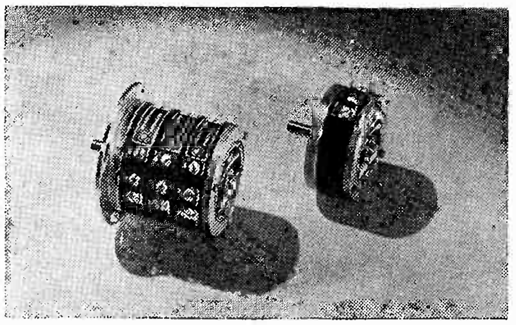
Star Measurements Co., 442 East 166 St., New York 56, N. Y. A new combination tube and set tester, model MT-12, provides for the checking of radio receiving and allied use tubes. The unit measures tube noise and capacitor leakage. The multitester section provides 27 ranges of voltage, current, and re-

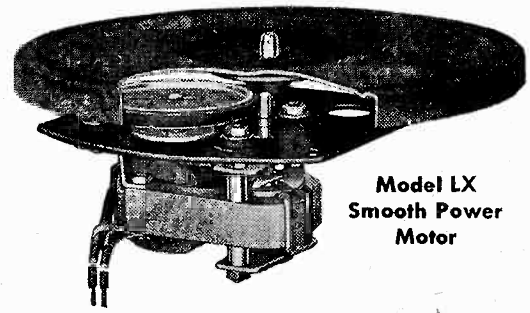


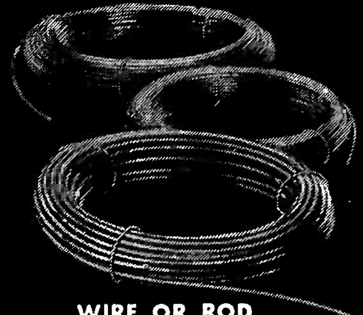
sistance measurements. The entire instrument is housed in a wooden cabinet with removable cover, and is provided with a separate compartment for the storage of line cord and test leads. The size is 14 x 12 x 6 inches and it weighs 10 pounds.

Linear Ganged Potentiometer (33)

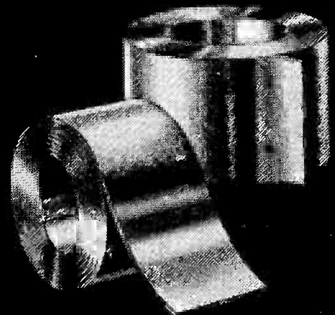
Fairchild Camera and Instrument Corp., Jamaica, N. Y., has announced an improved linear wirewound potentiometer, now available







WIRE OR ROD



SOLDER STRIP

POWDERED SOLDER

BURRED SOLDER

SILVER SOLDERS

for

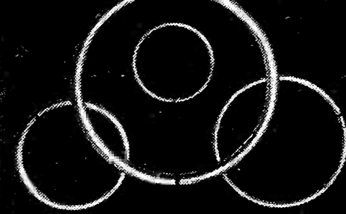
SPEED • ECONOMY • DURABILITY

The D. E. Makepeace Company has long pioneered in the development of silver solders. With more than a half century of accumulated experience behind us, we have, today, developed a variety of silver-brazing alloys to meet practically every industrial requirement.

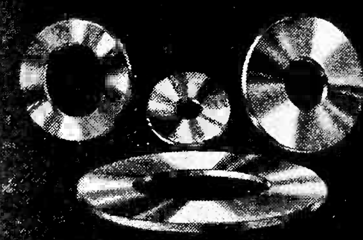
These solders flow easily, penetrate deeply and diffuse evenly. The joints so affected are stronger, in most instances, than the parts joined and the junction is durable, ductile, leakproof, corrosion resistant, and high in electrical and thermal conductivity.

Today, preplaced solder rings or solder washers and induction heating are revolutionizing former soldering methods. Likewise, modern alloys and light gauge metals, likely to be damaged by high temperature brazing or welding, have been particularly aided by the use of our low temperature, fast spreading silver solders.

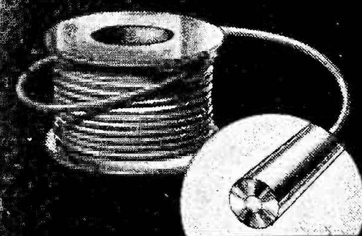
Should you have a special soldering or brazing ploblem, our fully equipped research and testing laboratory is at your service. Our informative folder listing precious metal solders, with helpful melting and flow-point tables, will be sent you upon request.



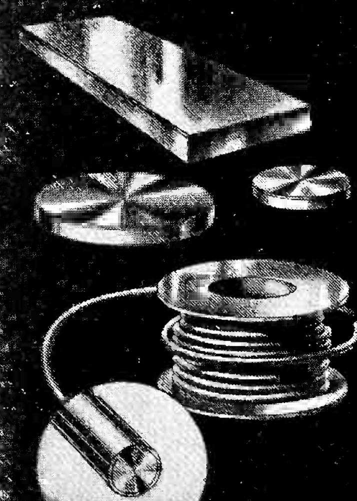
SOLDER RINGS



SOLDER WASHERS



SOLDER FILLED WIRE



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START RIGHT with **Makepeace** PRODUCTS

SHEETS • WIRE • TUBING • SOLDERS • FABRICATED PARTS AND ASSEMBLIES

D. E. MAKEPEACE COMPANY

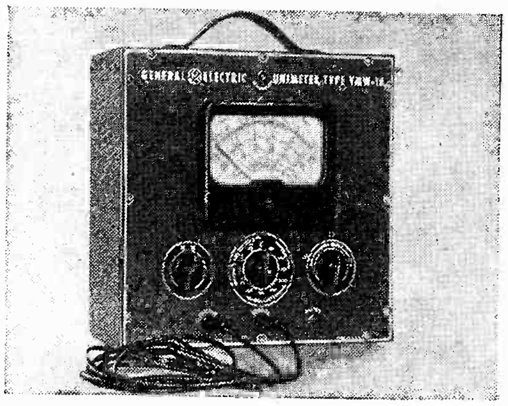
Main Office and Plant, Attleboro, Massachusetts

NEW YORK OFFICE, 30 CHURCH ST. CHICAGO OFFICE, 55 EAST WASHINGTON ST.

in single units or ganged in multiple on one shaft to provide independent voltage outputs for several related variables. The instrument obtains an accuracy of 0.1 percent in the three-inch size, No. 748, and 0.15 percent in the two-inch, No. 747. Service life is generally guaranteed to exceed 1,000,000 cycles. This accurate single or ganged linear potentiometer is intended for communication equipment; sound recording equipment; servomechanisms; computing gunsights; radar navigational equipment; telemetering. Further specifications are available.

Multiple Test Meter (34)

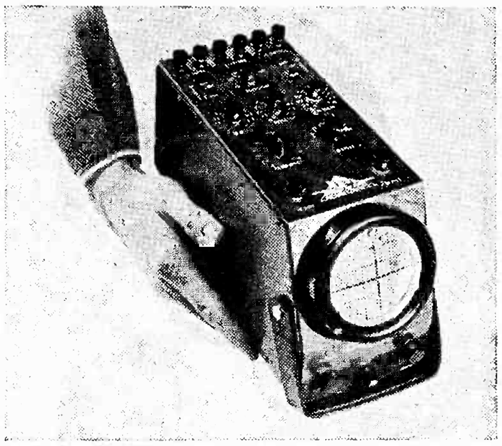
GENERAL ELECTRIC Co., Syracuse, N. Y. A new Unimeter, Type YMW-1A has been designed for rapid, accurate measurement of volts, at 20,000 ohms, current and decibels. All functions of this nine-pound equipment except the 50 microampere and output meter capacitor jacks are available without changing the test



leads. Specifications include resistance with a total coverage of 1 ohm to 20 megohms; voltage, a-c and d-c, 0-1,000 volts; current, 0 to one-half ampere; decibels, minus 4 to plus 62, all designed in convenient ranges.

Small Oscilloscope (35)

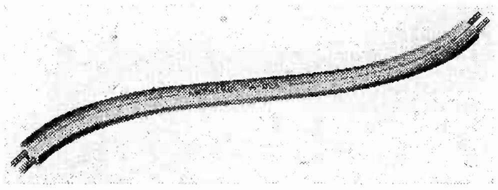
WATERMAN PRODUCTS Co., Inc., 2445 Emerald St., Philadelphia 25, Pa. The new model S-11-A Pocketscope is the second of a series of compact oscilloscopes designed for industrial and television measurements. It differs from the model S-10-A in having a 3-inch cathode-ray tube rather than a 2-inch type and in its greater versatility. Both a-c and d-c measurements are possible. Push-pull amplifiers for horizontal and



vertical deflection, an intensity modulation amplifier, and a linear time sweep from 3 cycles to 50 kilocycles are among the features. Direct connections to deflecting plates and intensity grids are accessible from the rear. The instrument retails for $99 fob Philadelphia.

Transmission Line (36)

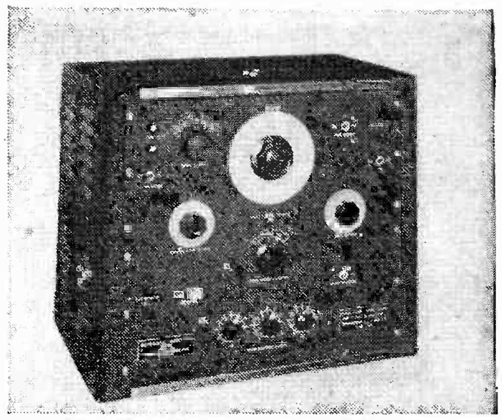
AMERICAN PHENOLIC CORP., 1830 South Fifty-Fourth Ave., Cicero 50, Ill. Amphenol 14-023 polyethylene twin-lead consists of a pair of parallel stranded conductors encased and spaced by a dielectric.



When the line's surge impedance of 75 ohms is mismatched, the conductors will carry a kilowatt of energy. With a standing wave ratio of two-to-one, twice the power can be handled. The conductors are so closely spaced as to substantially eliminate radiation at frequencies up to several hundred megacycles.

Incremental Inductance Bridge (37)

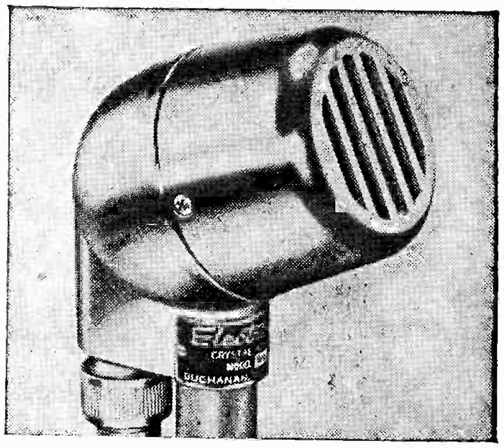
INDUSTRIAL TRANSFORMER Corp., 2540 Belmont Ave., New York 18, N. Y. The model 220 incremental inductance bridge permits testing of self-inductance, regardless of Q, with an overall accuracy better than 1 percent. Any inductance between 1 millihenry and 20 henrys can be measured with any value of superimposed d-c between 0 and 1 ampere. From 20 to 200 henrys the maximum current is limited to 250 milliamperes; over 200 henrys the



maximum current is 25 milliamperes. Three types of connection, Owen, Hay and Maxwell, are possible. A standard decade resistance box up to 100,000 ohms will extend the maximum value of inductance that can be measured at 1 ampere from 20 to 100 henrys.

General Purpose Microphone (38)

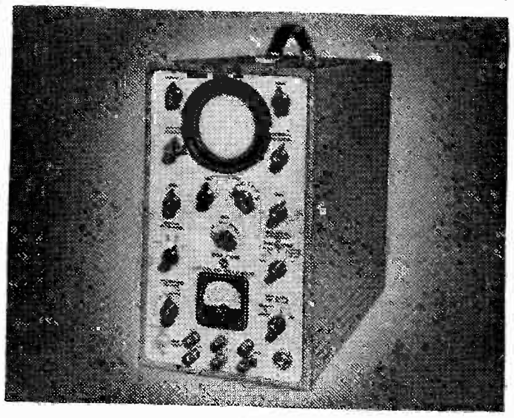
ELECTRO-VOICE, INC., Buchanan, Michigan. A new model 905 crystal microphone at low cost for general sound work has a frequency response substantially flat between 50 and 7,500 cycles and an output level 54 db down. At low audio frequencies the polar pickup pattern is nondirectional, but becomes directional at high frequencies. Head is fixed at a tilt of 22 degrees. The



model 905-8 furnished with eight feet of cable and the Model 423-A desk stand makes a convenient combination for radio amateur use and lists at $16.50. Further details are given in Catalog No. 101.

Portable CRO (39)

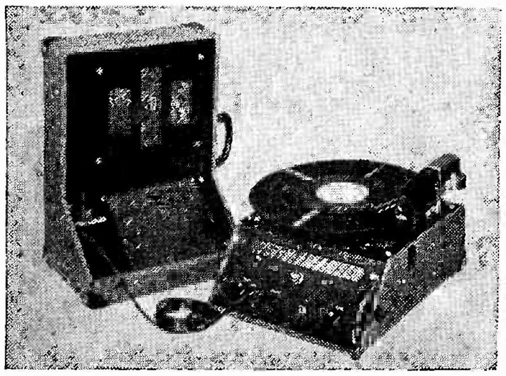
RADIO CORP. OF AMERICA, Camden, N. J. A new portable general purpose oscilloscope, Type WO-79A, makes possible the accurate measurement and display of frequency components up to six megacycles in



transient and pulsed voltages of the order of one microsecond. The major electrical components of the new oscilloscope include calibrated horizontal and vertical input attenuators, high-gain horizontal and vertical amplifiers, a synchronizing amplifier, a time-base oscillator and sweep generator, and intensifying amplifier, low voltage and high voltage power supplies, and a three-inch high-contrast cathode-ray oscilloscope. A triggered sweep makes the unit suitable for photographic study of transient waveforms, for television signal expansion for checking square-wave time, and for checking irregularly timed pulses. The intensifying amplifier increases the brilliancy of the waveform after the time-base generator is triggered, permitting examination and photography of small, otherwise, faint, and extremely short pulses.

Portable Transcription Player (40)

U. S. Recording Co., 1121 Vermont Ave., N.W., Washington 5, D. C. The Panacoustic portable transcription player designed and built for broadcasting stations and advertising agencies plays 6 to 16 inch records and transcriptions at both 33⅓ and 78 rpm. The 12 inch turntable is amazingly smooth and silent. The lightweight pickup, with permanent sapphire stylus, assures reproduction with practically



try this for Size!

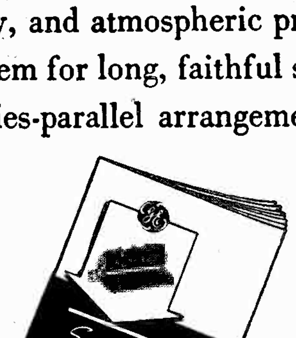
where Space is a limiting factor

CONSIDER GENERAL ELECTRIC SELENIUM RECTIFIERS

Important savings in space and weight are realized when you design General Electric Selenium Rectifiers into electronic equipment. They'll give you more direct current per cubic inch, more per pound, than alternate types. General Electric offers a wide selection of capacities and sizes, from the mighty midget pictured above which delivers 4 volts at 0.1 milliampere to single stacks rated at 110 volts, 4 amperes.

Whatever your requirements, General Electric Selenium Rectifiers pack a lot of punch where space is at a premium. They withstand extreme variations in ambient temperature, humidity, and atmospheric pressure. You can depend upon them for long, faithful service in series, parallel, or series-parallel arrangement.

For a booklet of facts and figures, write direct to Section A-18-431, Appliance and Merchandise Department, General Electric Company, Bridgeport 2, Connecticut.

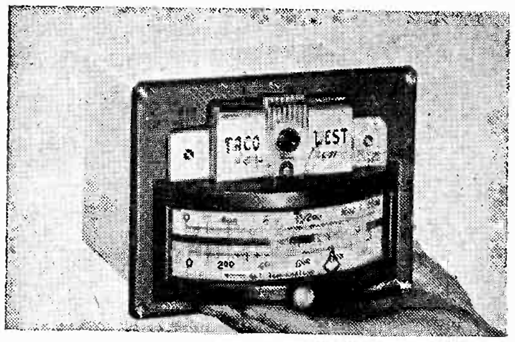


GENERAL ELECTRIC

no distortion over a wide frequency range. The pickup is mounted on a sturdily built extension bracket maintaining proper alignment at all times. Undistorted power output is 4 watts.

Pyrometric Controller (41)

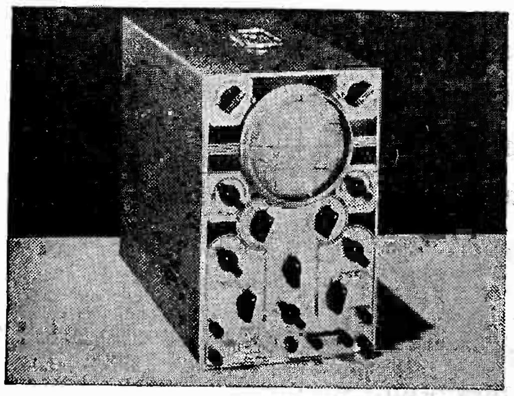
TACO WEST CORP., 2620 South Park Ave., Chicago, Ill. The new Veritron electronic pyrometric controller is a two position device suited for direct installation on industrial furnaces and plastic moulding machines. In operation, the control pointer is set at the desired temperature and control is immediately established within a narrow temperature range. The design permits the instrument movement to operate a heavy duty relay system without any physical contact or reaction ef-

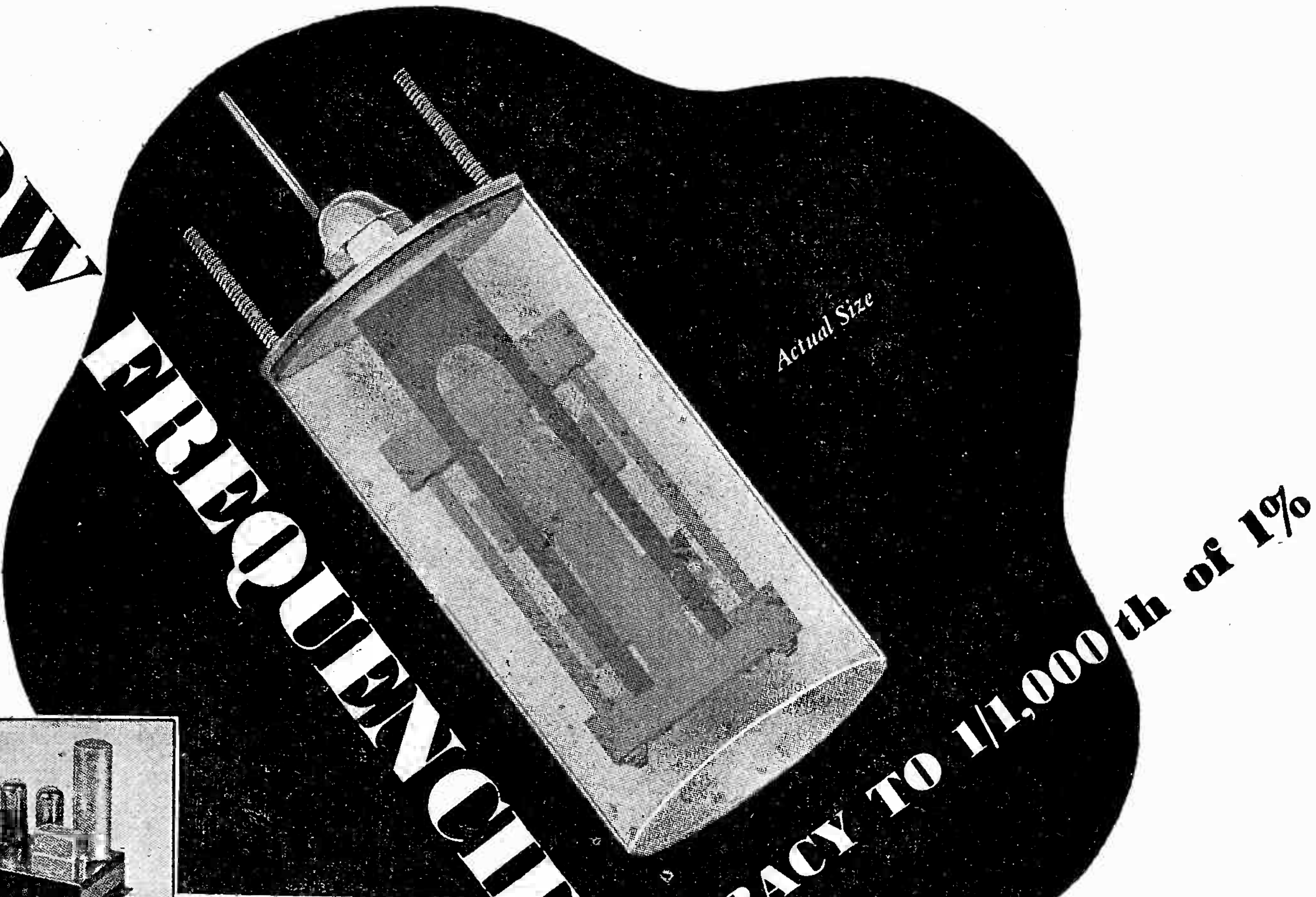


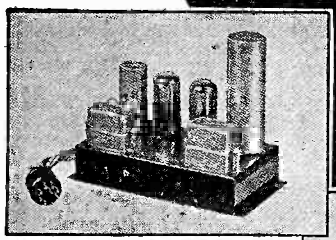
fect on the indicating pointer. The relay is built in and has a load capacity of 3 kw noninductive. The electronic circuit requires no tuning or other adjustments by the user at any time. A pointer movement upon scale of 0.002 inches produces exacting relay operation. Measuring system and electronic mechanism are separately housed in sealed units that plug into the instrument case, described in Bulletin PC-1.

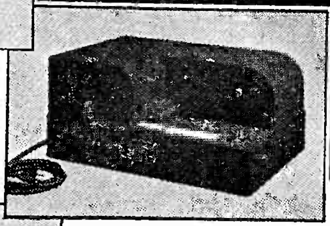
Five-Inch Scope (42)

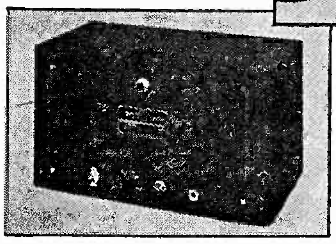
THE HICKOK ELECTRICAL INSTRUMENT CO., 10527 Dupont Avenue,











TOP
FREQUENCY STANDARD
(60 cycle) for use with
external power supply

CENTER
CHRONOGRAPH
Records time intervals
with resolution to .001 second

BOTTOM
FREQUENCY STANDARD
(120 cycles) with
self-contained power supply

These tuning forks which include new engineering principles, provide frequencies from 120 to 1,000 cycles directly with an unqualified guarantee of accuracy to 1 part in 100,000 over a wide temperature range. (Better than 1 second in 24 hours). Closer tolerances are obtainable on special order.

These tuning fork assemblies are available only in single or multi-frequency instruments of our own manufacture which are designed to test, measure or control other precision equipment by mechanical, electrical accoustical or optical means.

The dependability of these frequency standards is being demonstrated for myriad purposes in all climates and under all working conditions.

If you have need for low frequency standards of exceptional accuracy, your inquiries are invited.

American Time Products, Inc.

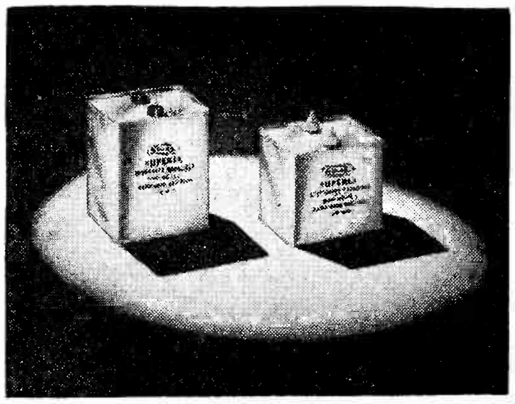
580 Fifth Ave. **New York, N. Y.**

Dist. of Western Electric & Watch Master Watch-rate Recorders

Cleveland 8, Ohio. The Model 195 general-purpose 5-in. oscillograph has a sinusoidal sweep with phasing control. The instrument is designed for visual analysis of the wave shapes of television, f-m, and a-m signals. A type 5 UP-1 cathode-ray tube is used. The unit contains vertical amplifiers allowing a deflection of one inch for each 0.05 volt input.

Discharge Capacitors (43)

SOLAR CORP., 285 Madison Ave., New York 17, N. Y. A new series of type QLX discharge capacitors for pulsed lighting applications, such as speedflash photography, traffic and marine beacons, and airport signals, has just been announced. They



have very heavy internal leads to carry high discharge currents, have a low inherent inductance, and are of special construction to minimize discharge stresses. Complete information as well as a handy watt-second—microfarad—voltage chart is given in Catalog Bulletin SPD-300.

Literature

(44)

Plastic Molders. Kurz-Kasch, Inc., 1415 South Broadway, Dayton 1, Ohio, old-time manufacturers of well-known dials are offering a neat brochure entitled, "A Businessman's Guide to the Molding of Plastics". Besides specifications for various plastic materials, classified according to use, data is given on the company's facilities, equipment and production capacity for molded parts and components.

(45)

Variable Resistors. P. R. Mallory & Co., 3029 E. Washington St., Indianapolis 6, Ind., has announced a new engineering data folder with complete information on carbon and

wire wound variable resistors. Taper charts, dimensional drawings, a specification sheet and lots of other things are given.

(46)
WE Tubes. Graybar Electric Co., 420 Lexington Ave., New York 17, N. Y. In tabular form from a new book gives essential data on 166 Western Electric electron tubes. Characteristics, ratings, dimensions and basing diagrams are yours for the asking.

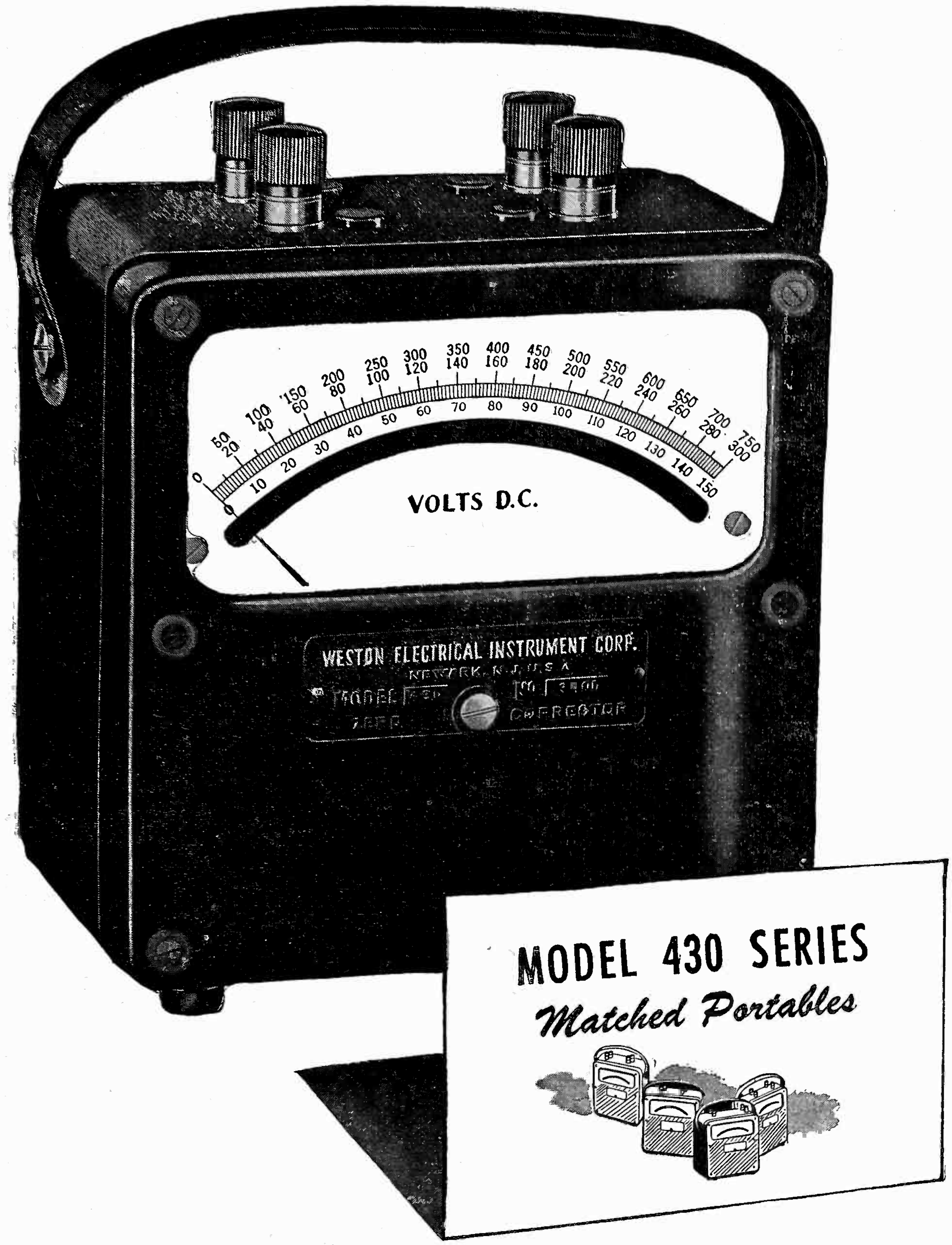
(47)
House Organ. Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn., call their new publication "Currently" and plan to issue bimonthly. Regular features include Transformer Topics and Regulation Hints.

(48)
Reproducer. General Electric Co., Bridgeport, Conn., has issued a catalog bulletin that tells about the new electronic reproducer claimed to banish needle talk, tone arm rumble and make cracked records sound whole.

(49)
Rheostats. Rex Rheostat Co., Baldwin, L. I., N. Y. Catalog 4 lists a series of circular rheostats that can be used in power ranges from 50 to 500 watts. Resistance wire or ribbon is wound on a ceramic core and held in position by a coating of vitreous enamel.

(50)
Insulation Saturants. Bakelite Corp., 300 Madison Ave., New York 17, N. Y., offers a 15-page booklet with no pictures, filled with useful information about Zyrox used in treating fibrous materials for insulating electrical wire and cable. The desirable properties are listed.

(51)
Transmission Lines. Communication Products Co., Inc., Keyport, N. J. supplies pipe-lines for a-m, f-m and television. Having pioneered in this work, their new slick-paper catalog, including pamphlet No. 100, is a convincing presenta-



Universal favorites for electrical testing and maintenance . . . compact and extremely rugged, high-visibility mirror scales and knife edge pointers, accuracy and dependability in the WESTON tradition . . . all at relatively low initial cost. Available for all AC and DC requirements. See your nearest WESTON representative or write direct.., Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark 5, New Jersey.

Weston *Instruments*

ALBANY • ATLANTA • BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI • CLEVELAND • DALLAS DENVER • DETROIT • JACKSONVILLE • KNOXVILLE • LOS ANGELES • MERIDEN • MINNEAPOLIS • NEWARK NEW ORLEANS • NEW YORK • PHILADELPHIA • PHOENIX • PITTSBURGH • ROCHESTER • SAN FRANCISCO SEATTLE • ST. LOUIS • SYRACUSE • IN CANADA, NORTHERN ELECTRIC CO., LTD., POWERLITE DEVICES, LTD.

tion of Seal-O-Flange and Aircore lines that require no apprenticing as a plumber's helper. The lines just bolt together. The complete line of goods includes air fittings and dryers.

(52)
High Sensitivity Meters. Rawson Electrical Instrument Co., Cambridge 42, Mass., has just turned out Bulletin 501 to show how the line of d-c laboratory meters is constructed and what they do. It is a handy thing to have in your files if you use fine meters.

(53)
Flexible Shafting. Walker-Turner Co., Inc., Plainfield, N. J. Flexible shafting design and engineering data are given in a new 20-page bulletin just released. Covering applications in radio, instruments, and the field of industrial machinery, the new bulletin includes engineering formulas and tables to aid in selection of proper shafting for the job.

(54)
Ceramics in Radio. D. M. Steward Mfg. Co., Chattanooga, Tenn., has just put out a booklet describing Lavite, Steatite and technical ceramics that traces the electrical use of these products from 1880 down to the highly specialized components of today.

(55)
Sound Advances. Sound Apparatus Co., 233 Broadway, New York 7, N. Y., announces a new issue of their technical bulletin "Sound Advances" dealing with a new graphic recorder, the twin recorder, and a new regulated power supply.

(56)
Q Indicator. Freed Transformer Co., Inc., 72 Spring St., New York 12, N. Y., has assembled data on its low frequency Q meter on two pages with the meter itself as cover adornment. This catalog sheet tells details and is worth writing for.

(57)
Silver Brazing. American Platinum Works, 231 New Jersey R. R. Ave., Newark 5, N. J., supplies necessary

NEW PRODUCTS (continued)

silver solder and fluxes for the new electronic world of hermetically sealed components and microwave plumbing, to mention a couple of the problems. A four-page, two-color brochure lists the materials available, classified as to size and shape.

(58)
Wire Stripper. Lead-All Products Co., 24 East 21st St., New York 10, N. Y., manufactures hand and foot operated wire stripping machines as well as motor driven screwdrivers and other production devices. Bulletin No. 16 devotes four pages to text and illustrations that will give you a clear picture of this company's products.

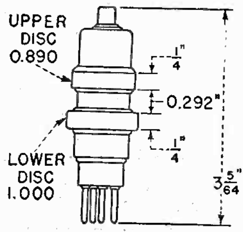
Tube Registry

The information furnished by the RMA Data Bureau has been abridged and only the more significant dimensions are given.

Type 6BL6

Velocity modulation reflex oscillator—external cavity, heater type, 4 pin base, disc seal glass envelope, maximum operating frequency 2¾ mode 4,800 mc.

E_h = 6.3 v
I_h = 0.65 amp
E_{c1} = 0.0 v
E_{c2} = E_{c3} = 325 v
I_k = 25 ma
Repeller (at f = 2,140 mc, 2 3/4 mode) = − 40 v

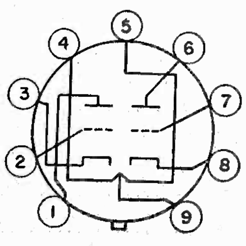


This information represents a correction and revision of data given on this tube in the Feb. 1947 issue of ELECTRONICS.

Type 12AU7

Twin - triode voltage amplifier, heater type, T6½ integral glass en-

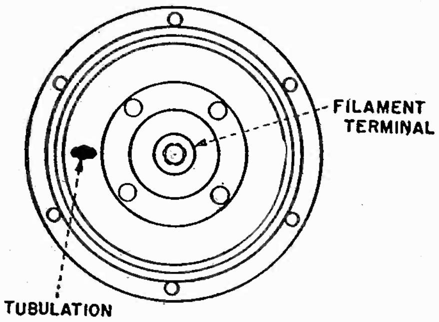
E_f = 6.3/12.6 v
I_f = 0.3/0.15 amp
E_b = 300 v (max)
W_p = 2.75 watts
I_k = 20 ma
E_b = 250 v
I_b = 10.5 ma
E_c = − 8.5 v
μ = 17
g_m = 2,200 μmhos
r_p = 7,700
C_{in} = 1.6 $\mu\mu$f
C_{out} = 0.50/0.35 $\mu\mu$f
C_p = 1.5 $\mu\mu$f
Basing 9A

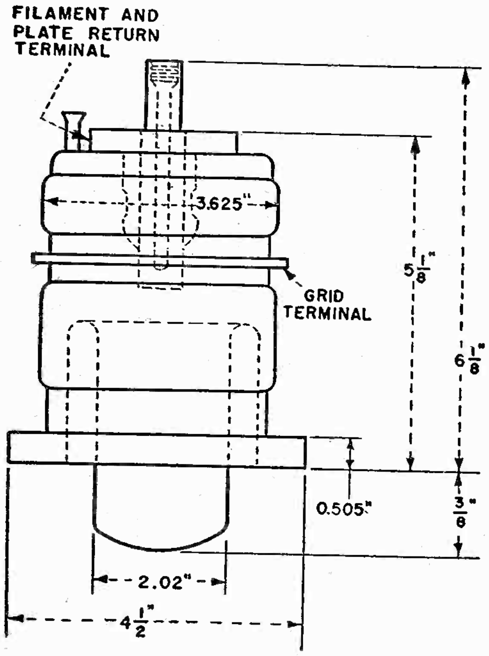


velope-base; overall height $2\frac{3}{16}$ in.; diameter, $\frac{7}{8}$ in.; small button noval 9-pin base.

Type 9C24

Triode power amplifier-oscillator, filament type; metal-glass construc-





E_f = 6.3 to 6.6 v
I_f = 230 to 250 amp
C_{in} = 24 $\mu\mu$f
C_{out} = 0.47 $\mu\mu$f
$_gC_p$ = 15.7 $\mu\mu$f
I_b = 1.0 amp
E_c = − 50 v
μ = 21

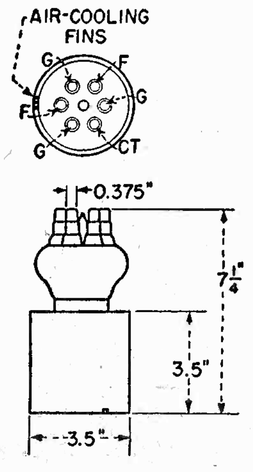
g_m = 11 millimhos
E_b = 6,500 v (max)
I_b = 2.0 amp (max)
E_c = − 850 v (max)
I_c = 0.25 amp (max)
W_p = 5 kw (max)

tion; concentric plate, grid, filament terminals. Class-C amplifier.

Type 7C30

Triode power amplifier-oscillator,

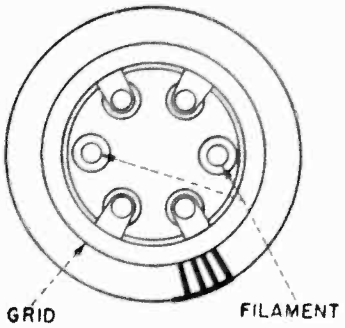
E_f = 16 v
I_f = 28.5 amp
μ = 27
C_{in} = 18 $\mu\mu$f
C_{out} = 0.4 $\mu\mu$f
$_gC_p$ = 14 $\mu\mu$f
E_b = 6,000 v (max)
I_b = 2 amp (max)
E_c = − 1,000 v (max)
I_c = 0.2 amp (max)
W_p = 3 kw (max)

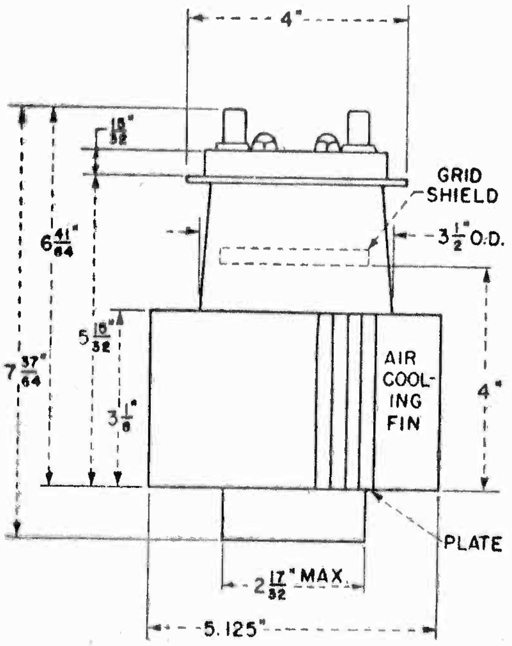


filament type; maximum ratings up to 1.6 mc.

Type 5530

Triode power amplifier-oscillator, forced air cooled, filament type,





E_f = 5 v
I_f = 55 amp
E_b = 1,300 v
I_b = 2.25 amp
μ = 26
g_m = 12,500 μmhos
C_{in} = 20 μμf
C_{out} = 0.6 μμf
$_gC_p$ = 23 μμf
E_b = 4,500 v (max)
I_b = 2.25 amp (max)
W_p = 3 kw (max)

metal-glass envelope. Maximum ratings up to 110 mc.

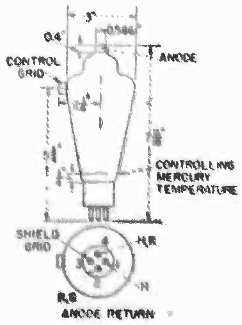
Type 5560

Tetrode mercury thyratron, heater type; heating time 5 minutes; ioni-

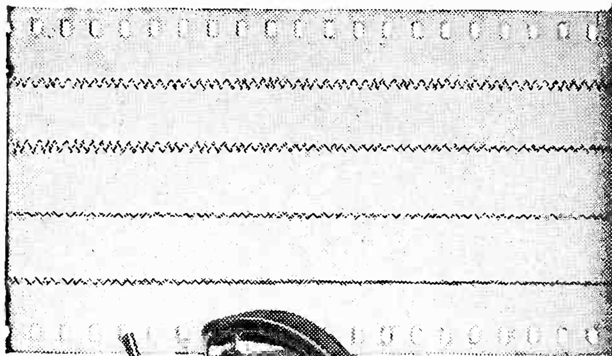
E_f = 5 v
I_f = 4.5 amp
E_{drop} = 16 v
$_gC_b$ = 4.4 μμf
$_gC_p$ = 0.2 μμf
E_{inv} = E_{fwd} = 1,000 v (max)
I_b = 0.5 amp (peak)
I_b = 2.5 amp (average for 15 sec)

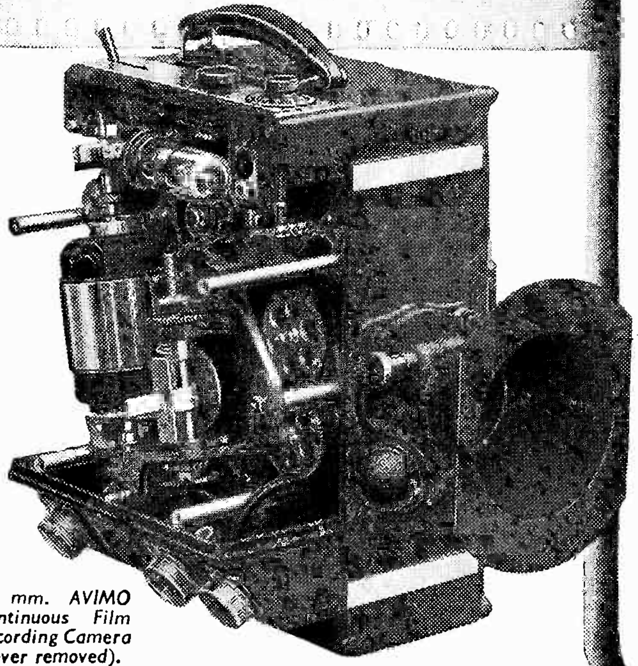
Control:

E_b	E_{c2}	E_{c1}
1,000 v	0 v	−9 v
100 v	0 v	+1 v



4 Oscillograph traces on 70 mm. paper.





35 mm. AVIMO Continuous Film Recording Camera (cover removed).

9016E

RECORDING TRANSIENT PHENOMENA

The behaviour of moving parts under actual working conditions may be studied by means of standard commercial oscillographs, which translate mechanical or electrical variations into evanescent traces on a fluorescent screen. Avimo cameras record these traces on continuous film or paper, so that they may be subsequently checked, examined, and measured. Write for Publication C3, giving full details of AVIMO Cameras including types with built-in cathode ray tubes.

AVIMO

AVIMO Ltd., TAUNTON
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Designers and Manufacturers of Scientific Cameras

Alexander Graham Bell achieved fame before our time, but since 1920, we have answered local and long distance calls for help, parts and all types of radio and electronic equipment for customers from all sections of the country.

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FOR RADIO & ELECTRONIC EQUIPMENT

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DINION COIL COMPANY, Inc.
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THERE'S A DRAKE SOLDERING IRON FOR EVERY TYPE OF ELECTRONIC WORK

From that mighty mite

the Drake No. 400 to the high-speed production "honey"

the Drake No. 600-10 there is a high quality Drake Soldering Iron "just right" for the job.

Drake Heat Controls and the Drake "Magic Cup" Stand are important soldering aids.

SEE YOUR RADIO PARTS JOBBER

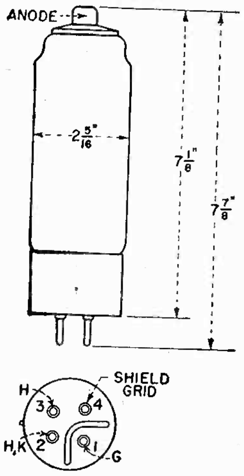
DRAKE ELECTRIC WORKS, INC.
3656 LINCOLN AVE. CHICAGO, ILL.

zation time 10 microseconds; deionization time 1 millisecond. Maximum ratings up to 150 cps; mercury temperature 40 to 80 C.

Type 672A

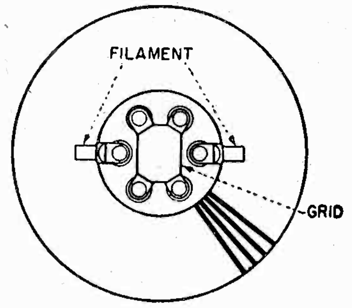
Tetrode mercury thyratron, heater type; heating time 5 minutes; ionization time 10 microseconds; deionization time 1 millisecond; temperature range (condensed mercury) 40 to 80 C. Maximum ratings up to 150 cps.

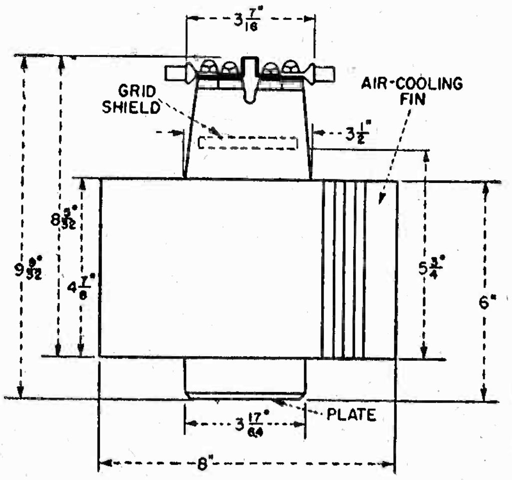
E_f = 5 v
I_f = 5 amp
E_{drop} = 12 v
${}_pC_{g1}$ = 0.04 $\mu\mu$f
${}_pC_{g2}$ = 3 $\mu\mu$f
E_p = 2,500 v (peak forward or reverse)
I_p = 3.2 amp (average)
I_p = 40 amp (peak)
E_g = 1,000 v (peak negative before conduction)
E_{sg} = 300 v. (peak negative before conduction)



Type 5541

Triode power amplifier-oscillator, forced air cooled, filament type. Maximum ratings up to 110 mc.





E_f = 7.5 v	C_{out} = 1.5 $\mu\mu$f
I_f = 55 amp	${}_gC_p$ = 25 $\mu\mu$f
E_b = 3,100 v	E_b = 8,500 v (max)
I_b = 3.25 amp	I_b = 3.25 amp (max)
μ = 26	W_p = 10 kw (max)
g_m = 20,700 μmhos	
C_{in} = 21.0 $\mu\mu$f	

NEWS OF THE INDUSTRY
(continued from p 162)

fered by the Massachusetts Institute of Technology for study and research in the field of electronics.

Applicants for graduate fellowships having $1,200 to $1,500 stipends must satisfy the requirements for admission to the Graduate School. Recipients of such fellowships will pursue programs of study and research leading towards advanced academic degrees in physics or electrical engineering. It is expected that the area of specialization of a fellow will fall within the field of electronics.

A few advanced research fellowships carrying stipends of $2,000 to $3,000 will be awarded to candidates possessing graduate academic degrees or equivalent research experience. In most cases these will be post-doctorate fellowships. They are open also to candidates with the requisite experience on leave from industrial or other research laboratories.

Applicants for an Industrial Fellowship in Electronics should communicate with J. A. Stratton, Director, Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Mass. Under normal circumstances application must be made at least four months prior to the intended date of entrance.

New England IRE Meeting

An all-day radio engineering meeting will be held at the Hotel Continental in Cambridge, Mass. on Saturday May 17, under sponsorship of the newly created North Atlantic Region of the IRE. New England manufacturers of radio and electronic products will present exhibits. Social events scheduled include a luncheon and banquet. Chairman is L. E. Packard, Technology Instruments Corp., Waltham, Mass. The six technical papers scheduled for presentation, none concurrently, are:

Low-Drag Aircraft Antennas for Frequencies from 2 to 18 Mc—John V. N. Granger, student, Harvard University.

The Commercial Design of Geiger-Muller Counter Tubes—Herbert Metten of Sylvania Electric Products, Inc.

Recent Developments in Frequency Stabilization of Microwave Oscillators—William G. Tuller of MIT.

VHF Bridge for Impedance Measurements

at Frequencies between 20 and 140 Mc—R. A. Soderman of General Radio Company.

Design Problems of F-M Receivers—Aldo Miccioli, associated with Dale Pollack.

Wartime Developments in Wave-Guide Theory—Julian S. Schwinger, Research Laboratory of Physics, Harvard University.

G-M Counter Laboratory

A NEW LABORATORY to test Geiger-Muller counters and associated electronic equipment has been established in the Radioactivity Section of the National Bureau of Standards. The laboratory will test performance qualities, utility, and construction of counters now being manufactured. It will aid purchasers by assisting them in formulating specifications. It will help manufacturers by accumulating test data and determining the types of counters necessary for various fields of scientific research. No attempt will be made at present to set up standard specifications because of lack of uniform types and design of counters.

Fellowships in Physics

FIFTY all-expense General Electric Science Fellowships will be given to high school and preparatory school teachers of physics in nine central and midwestern states, to enable teachers to review recent developments in physics in a six-week summer program at Case School of Applied Science in Cleveland from June 23 to August 1, 1947.

Applications must be sent in by April 15, to Dr. Elmer Hutchisson, Dean, Case School of Applied Science, Cleveland 6, Ohio. Teachers from Ohio, Michigan, western Pennsylvania, West Virginia, Kentucky, Indiana, Illinois, Wisconsin, and Maryland are eligible.

Eta Kappa Nu Awards

AFTER a lapse of five years, Eta Kappa Nu will resume the granting of Recognition Awards to outstanding young electrical engineers. Those who were eligible for the award during the war years will still be eligible even though now

nominally beyond the limits specified in the conditions of the award (under 35 years of age, and not more than 10 years out of college). Accordingly, if sufficient and suitable candidates are nominated, it may be possible in 1947 to name a Recognition winner (and Honorable Mentions) for each of the six years from 1942 through 1947. Except for those few who do not meet the age requirements, all E.E. graduates in the class of 1932 or later will be eligible for honors in one or more of the above years.

The names of the past winners and their present positions are:

1936—Frank M. Starr, Sales Engineer, General Electric Co.
1937—C. Guy Suits, Vice-President and Director of Research, General Electric Co.
1938—Winston E. Kock, Research Department, Bell Telephone Laboratories, Inc.
1939—Larned A. Meacham, Research Department, Bell Telephone Laboratories, Inc.
1940—Jesse E. Hobson, Director, Armour Research Foundation
1941—Cledo Brunetti, Chief, Project Engineering Section, National Bureau of Standards

Nominations for the award should be sent to Mr. A. B. Zerby, Executive Secretary, Eta Kappa Nu, P. O. Drawer C, Dillsburg, Pa. As much information as possible should be given about the nominee; the award committee will go on from there. There is no limit on the number of candidates who may be proposed by any nominator. Achievement of the nominee may be all or in part in any field including industrial, educational, political, research, civic, artistic, athletic, etc.

By the conditions of the award, a young engineer with high technical achievements plus exceptional activity in civic and social affairs will have the greatest chance of winning the coveted Recognition. All nominations must be mailed by May 1, 1947. The awards for the several years will be made at a banquet to be held during the AIEE midwinter meeting in January 1948.

1947 Chicago IRE Conference

Dr. W. R. G. Baker, IRE president, will make the opening address at a one-day technical conference to be held April 19 at Northwestern Technological Institute, Chicago. Conducted tours through the Institute's laboratories and demonstrations of the electron microscope, servomechanisms, a high-voltage surge gen-

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—Two KWIK-HEAT Built-in Thermostatic irons, 225-watt and 450-watt, plus our low cost KOPPERKORE 100-watt iron. The Kordless KWIK-HEAT facilitates production of small work. See KWIKHEAT demonstrated at your Radio, Electrical or Hardware distributor, or write for data:

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VANATTA KWIKHEAT THERMOSTATIC SOLDERING IRON

DIVISION-SOUND EQUIPMENT CORP. of CALIF. GLENDALE 4, CALIF.

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CATALOG SHOWS DOZENS MORE

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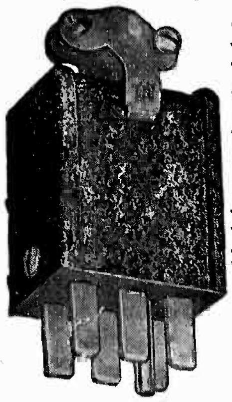
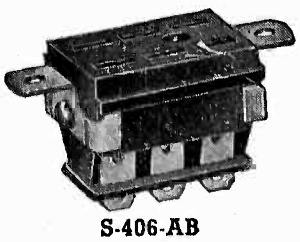


P-406-CCT

A medium size Plug and Socket that fulfills practically every requirement in the public address, radio and kindred fields. Socket contacts are of phosphor bronze, cadmium plated.



S-406-AB

Plug contacts are of hard brass, silver plated. Insulation is of molded Bakelite. All Plugs and Sockets are Polarized. Made in 2, 4, 6, 8, 10 and 12 contacts. Caps are of steel with baked black crackle enamel. A quality item at popular prices.

Send today for catalog No. 14 listing complete line of Jones Electrical Connecting Devices—Plugs, Sockets and Terminal Strips.

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THERMOSTATIC METAL TYPE DELAY RELAYS

PROVIDE DELAYS RANGING FROM 1 TO 120 SECONDS

FEATURES:—Compensated for ambient temperature changes from —40° to 110° F . . . Hermetically sealed; not affected by altitude, moisture or other climate changes . . . Explosion-proof . . . Octal radio base . . . Compact, light, rugged, inexpensive . . . Circuits available: SPST Normally Open; SPST Normally Closed.

PROBLEM? *Send for "Special Problem Sheet" and Bulletin.*

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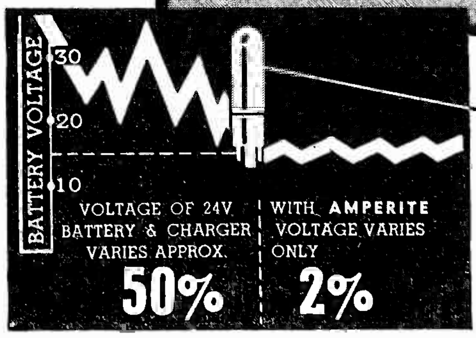


Amperite REGULATORS are the simplest, lightest, cheapest, and most compact method of obtaining current or voltage regulation . . . For currents of .060 to 8.0 Amps . . . Hermetically sealed; not affected by altitude, ambient temperature, humidity.

Write for 4-page Illustrated Bulletin.

AMPERITE CO., 561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp., Ltd., 560 King St., W. Toronto erator, and microwave optics will supplement presentation of the following papers:

A Magnetic Compass with Cathode-Ray Sensing Element—W. H. Kliever of Minneapolis-Honeywell Regulator Co.

Photocells and Low-Noise Amplifiers—Dr. H. S. Snyder, Physics Dept., Northwestern Technological Institute.

Patents and the Engineer—Curtis F. Prangley, patent attorney.

A Compact Electromechanical Filter for the 455-KC I-F Channel—Dr. R. Adler of Zenith Radio Corp.

A Viscous Termination Crystal Pickup—Thomas E. Lynch of Brush Development Co.

Factory Testing of Television Receivers—Dean Shankland of Farnsworth Radio & Television Corp.

Crystal Synthesizer—member of Collins Radio Co.

R-F Performance of Some Receiving Tubes for Television—R. Cohen of RCA Tube Division.

Mobile Radio Telephone—P. R. O'Connor of Illinois Bell Telephone Co.

A Variable-Frequency Oscillator with Narrow-Band F-M—Leonard Mayberry of Hallicrafters Co.

Personal Plane Radio—R. S. Bowditch of Galvin Mfg. Corp.

F-M Monitor—C. A. Cady of General Radio Co.

Phase Shift Modulator—M. Marks of Raytheon Mfg. Co.

A System of High-Efficiency Modulation Applied to Television—J. F. Bell of Zenith Radio Corp.

RMA Spring Meeting

FRED R. LACK, RMA director and vice-president of Western Electric Co., will speak on "Thirty Years in Transmitter Design" at a dinner Tuesday evening April 29 in connection with the Spring Meeting of the RMA Engineering Department, to be held at the Hotel Syracuse, Syracuse, N. Y. April 28-30. Technical sessions will include the following papers:

Absolute vs Industrial Standardization—C. H. Crawford of General Electric Co.

Characteristics and Circuit Applications of a New Low-Power Tetrode—H. C. M. Longacre of Sylvania Electric Products Inc.

Color Television Transmitter Design in the UHF—J. P. Wilmer of Columbia Broadcasting System.

Design Consideration in an Automatic Gain Control and Limiting Amplifier—William Jurek of Langevin Co.

Frequency-Modulated Link—E. Ostlund of Federal Telecommunications Laboratories.

Design Considerations for Commercial Radar Equipment—Coleman London of Westinghouse Electric Corp.

Television Studio Control Including Camera Dolly Considerations—C. E. Hallmark of Farnsworth Television & Radio Corp.

Navigational Computers—A. C. Omberg of Bendix Aviation Corp.

MEETINGS

MARCH 31-APRIL 2: Midwest Power Conference, Palmer House, Chicago; technical sessions at 3:30 p.m. April 1 and 9 a.m. April 2 covering Electronics in Industry.

APRIL 19: 1947 Chicago IRE Conference, Northwestern Technological Institute, Chicago; three concurrent technical sessions starting at 10 a.m. and 2 p.m., with a total of

14 papers; chairman—H. S. Renne, Room 2114, 185 N. Wabash Ave., Chicago.

APRIL 21-25: SMPE semiannual convention, Drake Hotel, Chicago.

APRIL 28-30: RMA Spring Meeting, Hotel Syracuse, Syracuse, N. Y.; technical sessions.

APRIL 28-MAY 9: International Merchant Marine Radio Aids to Navigation meetings; first week at Hotel Roosevelt, New York City; second week on three ships working out of New London, Conn.

MAY 3: IRE spring technical conference in Cincinnati, featuring television papers and exhibits; information—E. J. H. Bussard, The Crosley Corp., Cincinnati.

MAY 4-8: National Electrical Wholesalers Association meeting, Traymore Hotel, Atlantic City, N. J.

MAY 6-10: National Plastic Exposition, sponsored by The Society of the Plastics Industry, in the Coliseum, Chicago.

MAY 13-16: 1947 Conference and Show by Radio Parts and Electronics Equipment Shows, Inc., Chicago.

MAY 17: New England Radio Engineering Meeting of North Atlantic Region of IRE; six technical papers, luncheon, and banquet at Continental Hotel, Cambridge, Mass.

BUSINESS NEWS

THE HALLICRAFTERS CO., Chicago, has moved into their new plant at 4401 W. Fifth Ave.

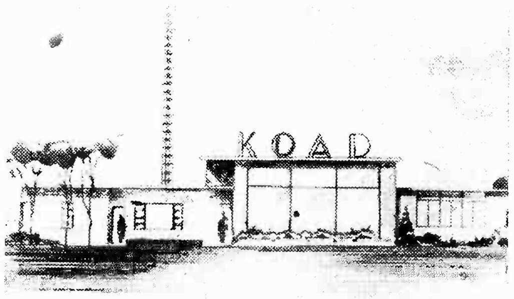
AUTOMATIC ELECTRIC CO., Chicago, has acquired rights under Finch patents to manufacture and sell or lease Finch facsimile equipment.

SHAKEPROOF INC., Division of Illinois Tool Works, Chicago, has been licensed by Tinnerman Products, Inc., Cleveland, Ohio, to manufacture and market fasteners on which Tinnerman holds patents.

UNITED AIR LINES has been installing Sperry A-12 electronic autopilots, incorporating automatic approach controls, in all its four-engined Mainliner 230 planes and has ordered similar equipment from Eclipse-Pioneer Division of Bendix

for planes to be delivered in 1947 and 1948. After training of flight personnel with the aid of Link trainers equipped with new Curtiss-Wright devices for simulating automatic airport approach, instrument approach will be adopted as standard procedure.

General Electric Co. is constructing a 50-kw f-m transmitter at its Syracuse, N. Y. plant for station KOAD in Omaha, Nebraska.



New modern transmitter building that will house the 50-kw f-m transmitter of KOAD, on a 40-acre plot southwest of Omaha

The Donald M. MacMillan Co., Bergenfield, N. J. has been newly formed to provide electronic research, development, and design service for industrial clients.

Times Facsimile Corporation is the new name chosen to more adequately describe the activities of Times Telephoto Equipment Inc., New York City. Products now being manufactured by this subsidiary of the New York Times Co. include page-type transmitters, photographic recorders, direct recorders, transceivers for 12 x 18-inch copy, tuning fork-controlled a-f oscillators, and facsimile recording papers.

Jefferson Electric Co. has purchased from WAA a modern plant in Fall River, Mass., used during the war by Submarine Signal Corp. Floor area is approximately 250,000 sq ft and full operation will require over 1,200 workers.

Atlas Sound Corp., Brooklyn, N. Y. has purchased a fireproof modern building that will provide additional production space for loudspeakers and associated sound equipment.

KSD-TV, St. Louis, claims to be the first completely postwar television station to go into operation on a regular schedule. Much of the equipment, including supersensitive RCA image orthicon cameras,

was flown to St. Louis to make possible a schedule of 21 hours of programs for the first week of operation. Equipment includes an RCA microwave radio relay link and a three-bay turnstile antenna.

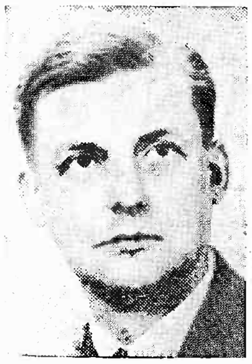
STANWYCK-WEBB MAGNETIC CORE CORP., Ossining, N. Y., was formed recently by John C. Webb. Production is under way, and several new iron-core developments for low-frequency applications have been completed.

PERSONNEL

HARRY E. LEROY, in the newly created position of director of manufacturing for the RCA Victor Division, will coordinate and direct manufacturing activities of RCA's ten plants throughout the country.

J. A. WALDSCHMITT has joined the firm of E. C. Page, consulting radio engineers in Washington, D. C. He was formerly assistant technical supervisor in charge of f-m and television for Bamberger Broadcasting System.

JOHN H. MILLER is vice-president and chief engineer of Weston Electrical Instrument Corp., Newark, N. J. He became assistant chief engineer of the company in 1931 and was made chief engineer in 1944.



J. H. Miller

J. J. Glauber

JOHN J. GLAUBER has been appointed chief engineer in charge of engineering and development of radio transmitting tubes at United Electronics Co., Newark, N. J. He was formerly with Federal Telecommunications Laboratories.

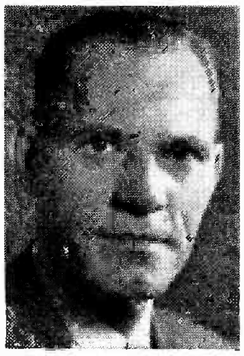
CHARLES M. SLACK becomes director of research for the Westinghouse Lamp Division, succeeding Harvey C. Rentschler, director of Westinghouse lamp and electronic tube research for the past 30 years, who will devote himself to complet-

ing certain research projects before his approaching retirement.

VICTOR M. HARKAVY is in charge of new product development and design at Insuline Corporation of America, Long Island City, N. Y. He was previously assistant division chief at Crystal Research Laboratories, Hartford, Conn.

B. V. K. FRENCH is now director of field relations for Howard W. Sams & Co., Inc., Indianapolis, Indiana. His previous affiliation, with P. R. Mallory & Co., Inc., began in 1937. Late in 1944 he became supervisor of the Mallory research laboratory established in New York City for further development of mercury dry batteries.

B. V. K. French



L. Brendel

LYNN BRENDEL has been promoted to the post of general service manager of the Hallicrafters Co., Chicago, Ill. During the war he was radio engineer for the Chicago Signal Corps depot.

DORMAN D. ISRAEL, vice-president of Emerson Radio and Phonograph Corp., was awarded a Certificate of Appreciation by the War Department for outstanding contributions to the war effort in the research, development, and production of v-t fuzes.

WALTER A. WEISS becomes supervisor of quality control for the Radio Tube Division of Sylvania Electric Products Inc., Emporium, Pa.

H. I. ROMNES, with the Bell System for the past 18 years, became radio engineer with the American Telephone and Telegraph Co. on Dec. 1. He will head the radio section of the company's engineering division.

JOSEPH L. COLLINS is now chief engineer of Aerovox Corporation,

New Bedford, Mass. He had been head of the electrolytic engineering division since 1938, and before that was in charge of electrolytic engineering at Sprague Electric Co. for nine years.

WELLS L. DAVIS has joined the staff of Battelle Institute, Columbus, Ohio, where he will be engaged in electronic research.

ROBERT W. LARSON is now administrative assistant to the director of General Electric Research Laboratory in Schenectady, N. Y.

JOHN BALLANTYNE, president of Philco Corporation, was awarded a Certificate of Appreciation by the War Department for his wartime services in "directing the research, development, engineering, and production of highly complicated radar and associated equipment for the Signal Corps".

HARRY F. RANDOLPH becomes general plant manager of the RCA tube department, while continuing as acting plant manager of the Harrison, N. J. tube plant.

DANIEL E. NOBLE, general manager of the communications and electronics division of Motorola, has been made vice-president in charge of that division.


D. E. Noble S. L. Parsons

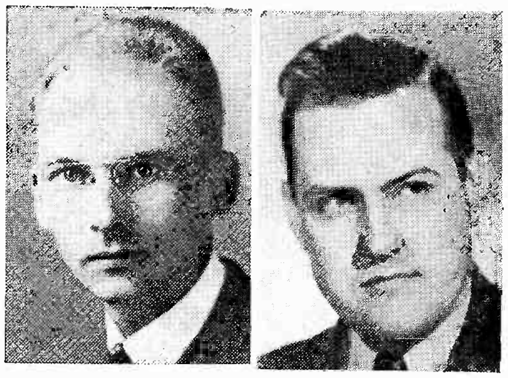
STUART L. PARSONS was made chief engineer for the Tungsten and Chemicals Division of Sylvania Electric Products Inc. at Towanda, Pa. He will direct engineering and research associated with production of tungsten salts and fluorescent powders for fluorescent lamps and television viewing tubes.

SAMUEL M. THOMAS becomes assistant chief engineer of RCA Communications, Inc., having joined the organization in March 1946 after attaining the rank of Brigadier General during the war. As Chief

of Staff to the Commanding General of the Persian Gulf Command, he developed a communications system that supported movement of military and lend-lease supplies to Russia through the Persian Corridor.

George H. Phelps of Westinghouse Electric Corp. is RMA representative in connection with formation of the Radio Technical Commission for Marine, a new government-industry agency.

Fred M. Andrews has been named chief engineer of stations WROL and WROL-FM in Knoxville, Tennessee. During the war he headed a Philco group preparing Signal Corps radar equipment training manuals at Fort Monmouth.



F. M. Andrews L. L. Helterline, Jr.

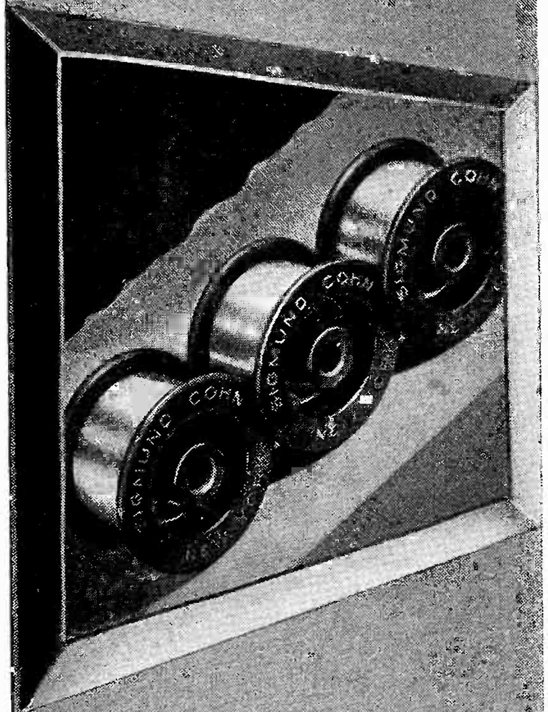
Leo L. Helterline, Jr. is chief engineer for Sorensen & Co., Inc., Stamford, Conn., supervising design and development of their lines of voltage regulators, transformers, and special electronic equipment.

Albert C. Gable, with General Electric Co. since 1929, becomes assistant engineer of the Tube Division in their Electronics Department at Schenectady, N. Y.

Ralph A. Galbraith is now professor of electrical engineering at Syracuse University and chairman of the Department. He comes from Georgia School of Technology, where he held a similar position since March 1946. The previous two years were spent as a staff member of MIT Radar School, where he was contributing author to "Principles of Radar".

Lee de Forest received the Edison medal at the annual AIEE winter meeting in New York City for "pioneering achievement in radio and for the invention of the grid-controlled vacuum tube with its profound technical and social consequency".

MICRODIMENSIONAL
WIRE & RIBBON FOR VACUUM TUBES



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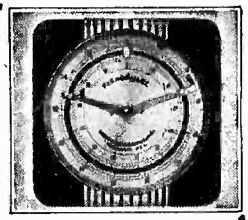
EAGLE TIMERS
for Controlling Industrial Processes

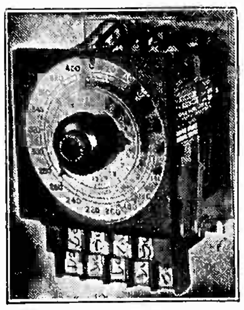
REPEAT CYCLE

Use where ON-OFF operation is continuously repeated. The ON time and OFF time are each adjustable on the dial. (FLEXOPULSE)



COUNTER

Use for limiting a process to an exact number of operations The counter contact opens after 1 to 400 electrical impulses as selected on dial. Automatic spring reset. (MICROFLEX COUNTER)



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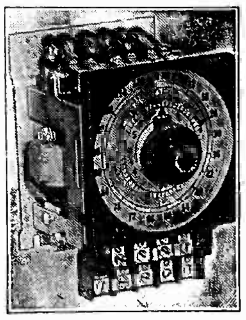
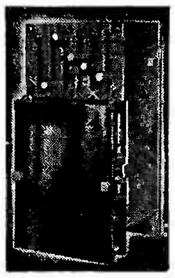
Provides exceptional timing accuracy where a circuit is to close or open with a time delay. Timing adjustable over wide range. (MICROFLEX TIMER)



MULTIPLE CIRCUIT —ADJUSTABLE

Use where several circuits are to close in a predetermined sequence. Time of closing and opening each circuit is adjustable. (MULTIFLEX TIMER)



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Theater Sound and Projection Equipment

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Scientific Instruments	Television Transmitters
Communication Equipment	Commercial Sound Equipment
Test and Measuring Equipment	Government Radiation Equipment

Aviation Communication and Navigation Equipment

Write to
National Recruiting Office
RCA Victor Division
Camden New Jersey

NEW BOOKS

Drafting for Electronics

By L. F. B. CARINI. *McGraw-Hill Book Co., Inc., New York*, 1946, 211 *pages*, $2.50.

WRITTEN for the draftsman and for trade-school students specializing in electronics, this book presents mechanical aspects of schematic circuit layout and drawing. It also includes chapters on such general drafting techniques as use of instruments and lettering. The book is significant in that its appearance on the market recognizes the special aspects of drawing electronic circuits and emphasizes need for universal use of ASA standard symbols. As a guide in teaching drafting, a bibliography of visual aids is appended.—F.R.

Cathode Ray Oscillograph in Industrial Electronics

By HAROLD W. RANNEY and MALACHI WHELAN. *Published by New York State Vocational and Practical Arts Association; distributed by Delmar Publ., Inc., 49 Sheridan Ave., Albany 6, N. Y.*, 96 *pages*, $3.00.

PHOTOGRAPHS of waveshapes obtained across various parts of rectifiers are presented with descriptive text explaining the significance of the waveforms. Here is a comprehensive and utilitarian reference for servicing rectifiers with an oscilloscope—a technique that, as the book makes clear, is very quick and simple.—F.R.

Electrical Transmission in the Steady State

By PAUL J. SELGIN, *McGraw-Hill Book Co., Inc., New York, N. Y.*, 1946, 427 *pages*, $5.00.

WRITTEN AS A REVIEW for college graduates who find themselves in need of refreshing their appreciation of the underlying concepts of electrical transmission, this mathematical presentation of circuit analysis probes the fundamentals of circuit theory. The idea of an engineering refresher is novel and attracted this reviewer to the book with a predisposition to rate it highly; the book sustained the anticipation.

The presentation serves both to review the electrical concepts of lumped and distributed circuits (for the most part communication) in the steady state and to review the algebra, calculus, and—to a lesser extent—the vector analysis wherewith these concepts are manipulated. The book will appeal more to the basic engineer than to the application one. Many of the angles of approach to the subject will arouse one from his lethargy of conventional thinking with the result that old accepted ideas will take on new depth and clarity.—F. R.

Applied Mathematics for Engineers and Physicists

By LOUIS A. PIPES, *Research and Electronics Division, Hughes Aircraft Co. McGraw-Hill Book Co., Inc., New York*, 1946, 618 *pages*, $5.50.

IN CONTENT this book is much like the several other excellent texts on applied mathematics. In presentation, however, it stresses application to engineering more than other similar books do, and—of particular interest to this audience—uses electronic problems frequently as illustrative material.—F.R.

Trigonometry Refresher for Technical Men

By A. ALBERT KLAF, *Civil Engineer, Board of Water Supply, City of New York. McGraw-Hill Book Co., Inc., 1946, 629 pages, $5.00.*

FOR THOSE who sometimes check fundamental trigonometric functions by recalling that the sine of a is the ratio of opposite to adjacent side, the author's concept of the matter falls unfamiliarly, but pleasantly, on the senses. His angle has three parts; initial line, terminal line and vertex. The hypotenuse is represented by a "distance" laid off on the terminal line, the adjacent side by a "shadow" cast by the assumed distance upon the initial line, while the opposite side is a "perpendicular" from the distance to the shadow. This concept, and the question-answer technique, are a key to the modern and practical tone of the text.

Spherical trigonometry is presented briefly with emphasis on its use in air and sea navigation, carrying through the basic philosophy of the book—trigonometry as an aid to live technology.—A. A. McK.

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FOR THE FIELD OF ELECTRONICS

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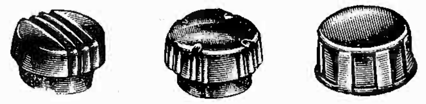

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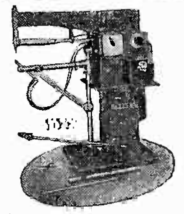
WET GLASS SLICING and cutting machines for laboratory use
GENERAL GLASS working machines and burners
COLLEGE GLASS working units for students and laboratory

AC ARC WELDERS from 100 to 400 Amps



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Section

supplements other advertising in this issue with these additional announcements of products essential to efficient and economical operation and maintenance. Make a habit of checking this page, each issue.

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ROTARY DRIVE RHEOSTATS
WITHOUT BACK LASH
PROTECTED & UNPROTECTED
ADJUSTABLE RESISTORS
UP TO 1000 WATT
PROMPT SHIPMENTS

If this or other advertising does not supply the information concerning products or services wanted, please write:

ELECTRONICS

Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

Ultrasonics

Dear Editor:

I AM glad to applaud ELECTRONICS' decision to use "supersonics" for velocities and "ultrasonics" for high frequencies and will probably not be the first to point out the inconsistencies of usage exhibited in the Beeper paper in the same issue by Walker and Kendig.

I am in a peculiarly vulnerable position to complain about Walker's usage of supersonic to mean ultrasonic since it was only during the completion report sweep-up era of HUSL that we settled down to agree on ultrasonics as a designation for the high-frequency sound field.

F. V. HUNT
Cruft Laboratory
Harvard University
Cambridge, Mass.

R-F Heating Data

Gentlemen:

ON PAGE 126 of January ELECTRONICS, you have published two tables giving electronic heating requirements.

Please accept my thanks for the information which you have given in these tables as it is going to save our staff a great deal of time and energy.

We are using high-frequency current to heat steel of various cross sections and it would be a very great help to us if you could publish a table showing the relationship between efficient frequency and cross section of steel.

G. J. MANSON
Acting Assistant Chief Engineer
Canadian Arsenals Limited
Ottawa, Canada

ACCORDING TO A RECENT RMA definition, a live part involving a potential of more than 1,000 volts is considered to be accessible if it is so located that contact with the part can be made by a ten-inch straight rod $\frac{1}{8}$ inch in diameter, inserted through the opening.

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Rate: UNDISPLAYED
90¢ a line. Minimum 4 lines. To figure advance payment count 6 average words as a line. Address c/o publication is 10 words. Positions Wanted ads half rate.

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NEW ADVERTISEMENTS received by April 11th will appear in the May issue, subject to space limitations

POSITIONS VACANT

SALES ENGINEER—For factory sales office to work under assistant Sales Manager—Industrial. Handle technical correspondence, quotations, orders expediting. Needs good broadcast and industrial electronic engineering background. B.S. degree desirable but not mandatory. Must have sales experience. Write describing experience and salary expected. E. F. Johnson Co., Waseca, Minnesota, Attention: Wally B. Swank.

PUBLICITY AND Sales Production Man—For factory sales office to work under Sales Manager. Correspond with distributors and amateurs; work on new applications of company products; write publicity articles; etc. Must be licensed, experienced Radio Amateur with sales experience. Write describing experience and salary expected. E. F. Johnson Co., Waseca, Minnesota, Attention: Wally B. Swank.

RADIO ENGINEER with experience in design of microwave components required by Research Department of Galvin Manufacturing Corporation, 4545 W. Augusta Boulevard, Chicago, Illinois, Write attention of D. E. Noble.

PHYSICIST WITH vacuum tube laboratory experience on photo surfaces and phosphors. Important project in small company. Permanent position, state experience. P-320, Electronics, 330 W. 42nd St., New York 18, N. Y.

(Continued on page 284)

FACTORY ENGINEER

We have an opening in our factory engineering division for an outstanding man. This position requires experienced background of at least 5 years engineering work on factory problems relating to receiving tubes manufacture. An engineering degree would be helpful but the primary requirements of the position are the experience and the ability to successfully solve every-day problems encountered in the manufacture of receiving tubes.

Apply by letter to Personnel Dept.

NATIONAL UNION RADIO CORPORATION
Lansdale, Pa.

Additional EMPLOYMENT ADVERTISING on pages 284 & 285

MATURE MOTOR DEVELOPMENT ENGINEER

Our medium-sized Company has an opening for a thoroughly experienced Design Engineer on sub-fractional A.C. motors. It is essential that this man have a minimum of 5 to 8 years experience directly in this field with well known large quantity producers and that he be able to handle both the mechanical and electrical development of sub-fractionals.

We are an established manufacturer in the small motor field and are interested only in a capable and experienced engineer. If you have the proper background, write us in confidence.

The arrangements will be attractive for the man who can meet our requirements.

P-300, Electronics
330 West 42 St., New York 18, N. Y.

(Continued from page 283)

SELLING OPPORTUNITIES OFFERED

SALES ENGINEER to sell electronic test equipment. Should have background of electronics plus knowledge of manufacturing methods. Small company with great opportunity for right man. State qualifications. SW-319, Electronics, 330 W. 42nd St., New York 18, N. Y.

WANTED SALES Representative for manufacturer of electronic coils—developed and made to specifications of user. RW-321, Electronics, 330 W. 42nd St., New York 18, N. Y.

EMPLOYMENT SERVICES

SALARIED POSITIONS $2,500 - $25,000. This thoroughly organized confidential service of 37 years' recognized standing and reputation carries on preliminary negotiations for supervisory, technical and executive positions of the calibre indicated, through a procedure individualized to each client's requirements. Retaining fee protected by refund provision. Identity covered and present position protected. Send only name and address for details. R. W. Bixby, Inc., 278 Dun Bldg., Buffalo 2, N. Y.

EXECUTIVES $3,000-$25,000. This reliable service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. E, 109 Church Street, New Haven, Conn.

POSITIONS WANTED

ENGINEER presently employed as supervisor of test equipment design section for large manufacturer desires position with smaller progressive organization actively planning production of television receivers. Have successfully organized both prewar and postwar television receiver production test programs. Familiar with preproduction model analysis, test process, establishment and standards, production methods of assembly and test, equipment costs, quality and reject control. Age 35. Position must carry direct responsibility for setting up and initiating production—with commensurate salary. PW-297, Electronics, 330 W. 42nd St., New York 18, N. Y.

GRADUATE ELECTRICAL Engineer desires position as specialist in audio frequency devices and controls. Highly interested in Cinemaphotography and associated sound work. Can offer some valuable ideas and improvements. Willing to travel anywhere in the U. S. or abroad. Position must carry direct responsibility. PW-322, Electronics, 330 W. 42nd St., New York 18, N. Y.

INTERESTED IN Telemetering? Electronics Engineer (with background of seven years experience in design, development, manufacture, and field service of test equipment and special electronic apparatus) is currently concluding advanced development program on telemetering project for aircraft flight research and guided missile work. Desires responsible position, with commensurate salary, with well established concern. PW-323, Electronics, 330 W. 42nd St., New York 18, N. Y.

ELECTRICAL ENGINEER, graduated 1939 from Swiss Fed. Inst. of Technology (equivalent to M.S.) desires position in Electronics or Acoustics. 7 years experience in communication techniques and acoustics. Several publications. First papers. PW-326, Electronics, 330 West 42nd St., New York 18, N. Y.

BUSINESS OPPORTUNITY

Coil Winding Plant, modern machinery, requires capital for expansion or will consider selling outright. Location 30 miles from Philadelphia. BO-324, Electronics, 330 W. 42nd St., New York 18, N. Y.

MR. MANUFACTURER

Can you use a sales engineer with wide acquaintance throughout Midwest industries? Broad acquaintance in radio, electronics, allied fields. Plenty on the ball. Much to offer right company. Married, established but young, adaptable. Available shortly. Minimum $6,000. Reply in strict confidence.

PW-325, Electronics
520 North Michigan Ave., Chicago 11, Ill.

PRODUCTION COORDINATOR

PRODUCTION MANAGER WITH EXPERIENCE IN ELECTRONIC ENGINEERING, QUALITY CONTROL, SALES, ESTIMATING, AND PROCESS, DESIRES POSITION AS PRODUCTION COORDINATOR OR MANAGER IN PROGRESSIVE COMPANY.

PW-315, Electronics
330 West 42nd St., New York 18, N. Y.

ATTENTION ENGINEERS

Experienced engineers with Bachelor's, Master's, or Doctor's degrees in Electrical Engineering, Communications, Radio, Physics, Mathematics. At least two years experience in design and development of radar and television systems, electronics navigational systems, automatic computors, servomechanisms, etc., required. Specialists in High Frequency transmitters, receivers, antennas, aircraft electronic components particularly desired. Starting salary commensurate with experience. Exceptional opportunity for the right men. Write

McDONNELL AIRCRAFT CORPORATION
Lambert—St. Louis Municipal Airport, Box 516, St. Louis (21) Missouri

Engineers

Broadcast Radio receiver Project Engineers, Television receiver Project Engineers and Mechanical Engineers experienced in broadcast receiver engineering methods. Excellent opportunity for advancement in a growing engineering department.

Reply giving full details to

Personnel Manager
BENDIX RADIO
Division of Bendix Aviation Corporation
Baltimore 4, Maryland

WANTED
SALES ENGINEERS

Long established, well-known manufacturer of Electrical Controls, desires to increase strength of sales organization.

Only well established, financially sound sales engineers or firms of highest calibre with electrical engineering background, experienced in electrical circuits will be considered.

State qualifications, sales staff, territory covered, lines representing and other pertinent information.

P-317, Electronics
68 Post Street, San Francisco 4, Cal.

WANTED
Development Engineers
(Project)

Several positions available for graduate engineers experienced in VHF techniques, communication equipment design. Excellent opportunity for right men. Midwest location.

P-313, Electronics
520 North Michigan Ave., Chicago 11, Ill.

AUTOMATIC CONTROL ENGINEER

Need graduate engineer with experience in automatic controls such as servomechanisms for experimental work covering automatic, hydraulic, and electrical controls and instrumentation used in process industries. Must have creative mind and ability to assimilate and follow thru to completion any new assignments.

P-312, Electronics
520 North Michigan Ave., Chicago 11, Ill.

RADIO EXECUTIVE

With Established
Sales Organization Throughout
EUROPE and NEAR EAST

Seeks Representation

Have engineering background: wide experience in managing own business in Europe; seeks connection with responsible manufacturers in electronic and related fields for representation in Europe and Far East. Now in U. S. A. and available for interviews.

Write Box 121, Suite 617, 1457 Broadway,
N. Y. City 18

WANTED
TEST EQUIPMENT ENGINEER

Must be versed in television and F. M. Receiver test practice, and capable of developing such equipment as may be required for factory production test of component parts and completed receivers.

COLONIAL RADIO CORPORATION
254 Reno St. Buffalo, 7, N. Y.

WANTED
REPRESENTATIVES AND EXPORTERS

To distribute Nationally advertised plastic control knobs. Territories open in most of the larger cities. Interested parties please reply, giving full details of your sales organization.

RW-314, Electronics
520 North Michigan Ave., Chicago 11, Ill.

Additional Selling opportunity Advertisements on page 285

SURPLUS METERS

MICROAMMETERS, GALVONOMETERS

Triplett, 3½" square, 100 microampere movement. 950 ohms resistance, made for 666-SC Analyzer; Scale marked in volts and ohms $6.95

Marion, 2½", 200 microamp undamped mvt., spec. sc. $3.50

G. E., DO-41, 3½", 200 MICROAMP Mvt., SPEC. SC. KNIFE EDGE POINTER, COMP. WITH PAPER V-O-M.A. SCALE $6.00

W.E.,3½", concentric style, 0-200 microamp $4.00

G.E., DO-41, 3½", 0-50 microamp mvt. scale 20 K.V., comp with paper V-O-M-A. scale.......... $4.95

G.E., DO-53, 3½", square, 500 microampere movement; 15 K.V. scale; Complete with paper Volt Ohm Milliameter Scale.......... $4.50

D. C. MILLIAMMETERS

W.H., RX-35, 3½" square, 0-1 M.A., 55 ohms, internal resistance, complete with paper V-O-M-A. scale. $4.95

G.E., DW-41, 2½", 1 M.A........ $3.95

Gruen, 2½", 3 M.A. movement scale 0-30, 450 & 300 volts M.A...... $2.00

Simpson 26, 3½", 0-15 M.A....... $4.50

G.E., DO-53, 3½" square, 20 M.A. $3.25

G.E., DO-41, 3½", 50 M.A. Black scale $3.25

W.H., NX-35, 3½" 200 M.A...... $4.00

Simpson 3½", 0-200 M.A.......... $4.50

Burlington, 3½", 0-200 M.A....... $2.75

DeJur Amsco, 3½", 0-1000 M.A... $3.00

D.C. VOLTMETERS & KILOVOLT METERS

G.E., DW-41, 2½", 15 VOLT BLACKSCALE, 15 MARKINGS, NO CAPTION..$2.50

Western Electric, 3½", Concentric Style, 0-75 volt D.C., 1000r/..... $3.00

W.E., 3½", 500 volt, 1000 r/v Concentric Style $5.00

W.H., NX-35, 3½", 1.5 K.V. comp. with 1000 r/v ext prec resist... $6.95

W.H., NX-35, 3½", 20 K.V. com with 1000 r/v ext prec resist L.P. $210.00
Your cost $21.00

D.C. AMMETERS

Triplett, 3½", 0-15 amp.......... $4.00

Weston 506, 2½", 200 amp. with ext shunt $7.50

G.E., WD-41, 3½", 200 amp. with ext shunt $12.50

RADIO FREQUENCY AMMETERS

Weston 425, 3½", 120 M.A., F.F.. $8.50

G.E., DW-44, 2½", 0-1 A.R.F., Black scale $3.50

G.E., DO-40, 3½", 1.5 Amp....... $6.50

Weston 507, 2½", 0-1.5 A.R.F. Black scale, Metal case......... $2.95

Westinghouse, NT-35, 3½",3 A.R.F. $5.50

Weston 507, 2½", 3 Amp bk sc.... $3.50

G.E., DW-52, 2½", 3 A.R.F., Bl. scale $2.95

Simpson 2½", 3 Amp, expanded at lower part of scale............ $3.50

A.C. VOLTMETERS

G.E., AW-42, 2½", 0-10 V.A.C.... $3.95

G.E., AO-22, 3½", 150 Volt...... $5.50

W.H., NA-35, 3½", 15 Volt....... $3.95

W.H., NA-35, 3½", 150 volt...... $5.50

Triplett, 331-J.P., 3½", 150 Volt.. $4.50

Weston, 476, 3½", 300 Volt....... $8.00

Weston, 517, 2½", 300 Volt...... $6.00

Triplett 232 C, 2½", 300 Volt, metal case $4.00

G.E., AO-22, 3½", 500 Volt...... $12.00

A.C. AMMETERS

Triplett, 331-J.P., 3½", 30 Amp... $4.00

Simpson, ½" square case 60 amp S.C. $3.50

Triplett, 3½", 0-75 Amps A.C..... $3.50

G.E., AO-22, 3½", 80 Amp S.C.... $3.50

SPECIAL METERS

Weston, 301, Type 61 Decibel Meter, 3½", —10 to +6, 6 M.W. 600 Ohms; High speed type .29—.35 Sec. to final reading. Complete with external wire wound precision resistors to extend the range to any or all of the following ranges:

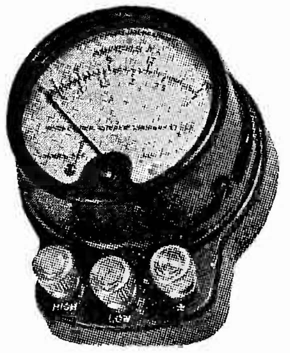
— 20 to + 16 DB	— 50 to + 46 DB
— 30 to + 26 DB	— 60 to + 56 DB
— 40 to + 36 DB	— 70 to + 66 DB

List Price = $31.10....Your cost $9.50

Marion, 2½", ring mtd "S" meter made for National Co. 1 M.A. mvt scale "1-9 S units 0-40 D.B. above S 9" $3.50

Roller Smith, miniature, 1½" sq 1.37 M.A. mvt, spec bk sc.......... $2.50

Roller Smith, miniature, 1½" sq 2 M.A. mvt, with 2' lead & plug jack 0-10 div sc............... $2.50



PORTABLE A.C. AMMETERS Surplus New WESTON MODEL 528

DUAL RANGE 0-3 Amp. and 0-15K Amp. full scale for use on any frequency from 25 to 500 cycles. The ideal instrument for all commercial, industrial, experimental, home, radio, motor and general repair shop testing. Comes complete with a genuine leather, plushlined carrying case and a pair of test leads. A very convenient pocket sized test meter priced at less than 50% of manufacturers list. Your cost ONLY. $12.50

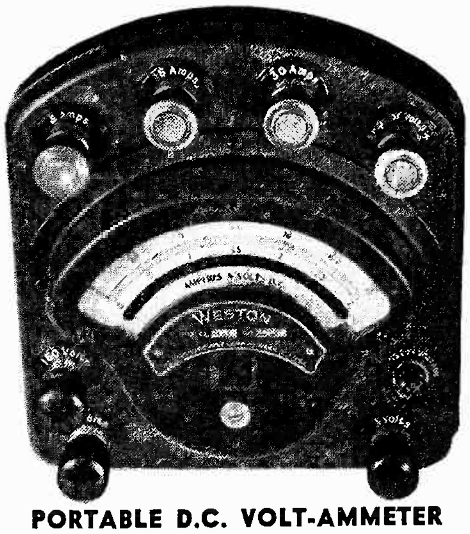
Portable A.C. Voltmeters

(See illustration of Ammeters)

SURPLUS NEW WESTON MODEL 528

DUAL RANGE 0-15 and 0-150 Volts for use on any frequency from 25 to 125 cycles. Complete with plushlined leather carrying case and a pair of test leads. This Voltmeter, with the matching model Ammeter as illustrated above, makes an ideal pair of test meters for any mechanic to carry around in his tool box....Only $9.50

Combination Offer; 528 Voltmeter
528 Ammeter
BOTH For $21.00



PORTABLE D.C. VOLT-AMMETER

WESTON MODEL 280, 0-3, 0-15 and 0-150 volts; 0-3, 0-15 and 0-130 Amps D.C. *SIX RANGES IN ONE INSTRUMENT*, Accuracy within 1%; Hand Calibrated Mirror scale 2.76" long with 60 Scale divisions; Knife edge pointer, magnetically shielded. Condition — Only very slightly used — like new. List Price $43.00
Surplus Price $15.00

MARITIME SWITCHBOARD • **Worth. 4-8217. 338 Canal St., N. Y. 13, N. Y.**

All meters are white scale in round, flush, bakelite cases, unless specified otherwise. Add sufficient money on parcel post orders, excess will be refunded.

ALL SHIPMENTS F.O.B. N.Y.C.

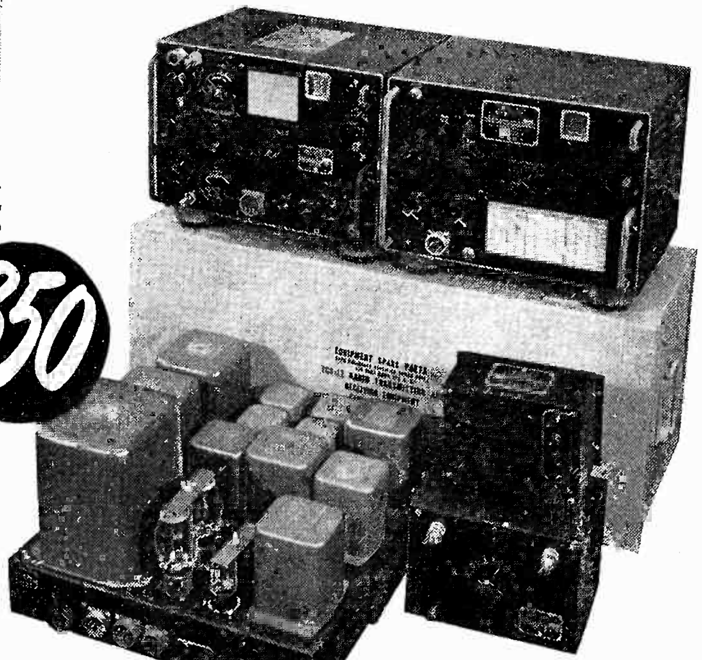
HERE'S YOUR OPPORTUNITY to make a real saving on a *Complete Radio Station*

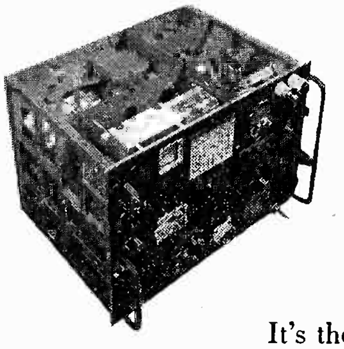
COLLINS

FOR REGULAR OR EMERGENCY SERVICE

- ★ FIXED STATION
- ★ PORTABLE
- ★ MOBILE
- ★ MARINE

$350





It's the U.S. Navy Model TCS-12 Radio Telephone and Telegraph Transmitting and Receiving Equipment—built by COLLINS and now offered—brand new—*in its original, unopened, export packing*—at an astoundingly low price.

This is an ideal communications equipment for municipalities, utilities, airports, and commercial users—it's complete and finished with enough spare parts for a lifetime of normal maintenance; 203-page manual gives detailed data, photographs, diagrams, and instructions for operation and service.

The Complete Equipment Includes
#52245 7-tube Radio Transmitter —
25 watt telegraph; 10 watt phone; band switching 1.5—3—6—12 mc; provision for 4, crystal-controlled frequencies or continuous coverage with VFO; very stable and easy handling.

#46159 7-tube Radio Receiver
3-band superheterodyne using either crystal or master oscillator control; 6 milliwatts output at 15 microvolts input; ample selectivity and low distortion.

#20218 115-volt 60 cycle Power Unit
with two, full-wave vacuum tube rectifiers for plate supply and a dry-disc rectifier for filament supply in transmitter and receiver.

#23270 Remote Control Unit
for both transmitter and receiver; includes loudspeaker, phone jack, and output selector switch.

Accessories
Antenna loading coil; telegraph key; microphones; and all necessary cables and plugs for interconnecting the various units.

Spare Parts
The spare parts chest includes over 200 items of transformers, capacitors, relays, resistors, switches, cables, plugs, insulators, etc.

Every part of this equipment is painstakingly and sturdily built to withstand the severest possible service. It's a heavy-duty, professional equipment of the highest quality. Price — as described $350.

ALSO AVAILABLE

these useful pieces of radio receiving, transmitting, and measurement apparatus—

BC-348 RECEIVER - $49.50
6-band switching 200 kc to 18 mc (less BC band). Dynamotor for 28-volt d-c use; detailed instructions for converting to 110-volt a-c.

SCR-522 VHF-XMTR RECEIVER $39.50
push-button operation on 4 crystal-controlled channels. 28-volt d-c dynamotor powers entire apparatus.

FREQUENCY STANDARD BC-221 $39.50
fundamental ranges 125-250 & 2000-4000 kc with stability better than .005%. 110-volt a-c, vibrapack, or battery operation.

BC-375 XMTR $35.00
covering 200 kc to 12 mc (less BC band) with 7 tuning units. With BC-306-A antenna tuning unit and PE-73-C dynamotor unit.

All of the above equipment is used, but in excellent physical and electrical condition.

The RADIO SHACK Corp.
CABLE ADDRESS · RADIOSHACK
167 E WASHINGTON ST., BOSTON, MASS., U.S.A.

IN STOCK

2000 Dynamotors GE input 27V at 1.75A, output 285V at .075A and Black & Decker input 28V at 1.4A, output 260V at .07A, $1.35 each
500 New Steel Junction Boxes 14 ga. 17" x 25" x 6½" with screw type. Brass hinges on lid. Two access panels. Watertight, $2.75 each.
65,000 Extension Cords over 8 ft. long male plug on one end. Rubber covered wire. U. L. Inspected. $12.50 per 100.
3500 Selsyn Differential Motors 115 V. A. C., 60 Cy. Packed for overseas, $1.75 each.
500 Relays Struthers-Dunn 115V. A.C. 6A contacts, 4 pole double throw. $2.65 each.
100 Motors G.E. Explosion Proof 250 V.D.C. 1/6 H.P. Brand New. $16.00 each.
Brass Machine Screws 2-56, 4-40-632, 8-32 Washers, Allen Head Set Screws.
6,000 Shock Mounts in 9 different types and sizes.
800 Selenium Rectifier 18V input 12V output at .6 amps., $1.00 each.
And over $300,000 worth of Radio Parts, Mica Condensers, Resistors, Aluminum Tubing Coax Cable, Small Gears and Tube Sockets.

Mail us your inquiries

Reliance Merchandising Co.
Arch corner of Croskey St.
Rittenhouse 6-4927 Phila. 3, Pa.

ROTATORS

Plenty husky for any beam a Ham can dream up! Navy SO-1 Radar type. Beautifully built. Automatic lock-in. Instantaneous reversing. No over-swing. Demountable reflector, wave-guide nozzle. $59.50 fob. N.Y. new in original heavy crates. Shipping weight 490 lbs. (stripped for Ham use 150).

110v 60 cycle operation using your parts, or our kit with tapped transformer (permitting 1-2 rpm.), seleniums, condensers, instructions $10.50. Further details, photograph, 25 cents.

ELECTRONICRAFT, Inc.
5 Waverly Place Tuckahoe 7, N. Y.

Special Values

Panel & Portable Meters

D. C. Microammeters:
50-100-200-500 microamps. High Resistance Voltmeters Vacuum Thermo-Couple Meters 3½" & 4½" Round & Rectangular
Multirange Portables:
readings from 10 microamps. full scale

Precision Electrical Instrument Co.
146 Grand Street New York 13, N. Y.

METERS
AND INSTRUMENTS

VOLTMETERS	BRIDGES (Wheatstone)
AMMETERS	MEGOHMMETERS
MICRO AMMETERS	RHEOSTATS
OHMMETERS	VARIABLE TRANSFORMERS
FREQ. METERS	RELAYS

ELECTRO-TECH Equipment Co.
119 Lafayette St. New York 13, N. Y.

INDEX TO ADVERTISERS

INDEX TO ADVERTISERS

LS SERIES

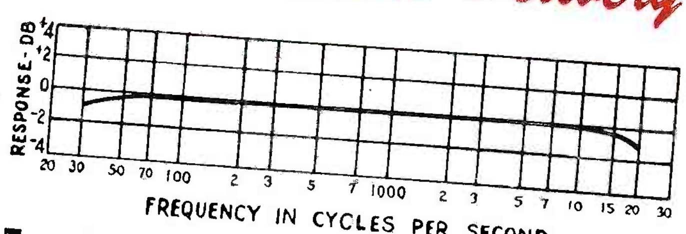
The Ultimate in Quality

UTC Linear Standard Audio Transformers represent the closest approach to the ideal component from the standpoint of uniform frequency response, low wave form distortion, high efficiency, thorough shielding and utmost dependability. Wartime restrictions having been lifted, and UTC production running at full capacity, we now offer these transformers for immediate delivery.

UTC Linear Standard Transformers feature...

- **True Hum Balancing Coil Structure** . . . maximum neutralization of stray fields.
- **Balanced Variable Impedance Line** . . . permits highest fidelity on every tap of a universal unit . . . no line reflections or transverse couplings.
- **Reversible Mounting** . . . permits above chassis or sub-chassis wiring.
- **Alloy Shields** . . . maximum shielding from induction pickup.
- **Multiple Coil, Semi-Toroidal Coil Structure** . . . minimum distributed capacity and leakage reactance.
- **Precision Winding** . . . accuracy of winding .1%, perfect balance of inductance and capacity; exact impedance reflection.
- **Hiperm-Alloy** . . . a stable, high permeability nickel-iron core material.
- **High Fidelity** . . . UTC Linear Standard Transformers are the only audio units with a guaranteed uniform response of ± 1.5DB from 20-20,000 cycles.

For Immediate Delivery



Typical Curve for LS Series

Type No.	Application	Primary Impedance	Secondary Impedance	Max. Level	Relative hum-pickup reduction	Max. unbalanced DC in primary	List Price
LS-10	Low impedance mike, pick-up, or multiple line to grid.	50, 125, 200, 250 333,500 ohms	60,000 ohms in two sections	+15 DB	−74 DB	5 MA	$25.00
LS-10X	As above	As above	50,000 ohms	+14 DB	−92 DB	5 MA	$32.00
LS-21	Single plate to push pull grids	8,000 to 15,000 ohms	135,000 ohms; turn ratio 1.5:1 each side. Split Pri. and Sec.	+14 DB	−74 DB	0 MA	$24.00
LS-30	Mixing, low impedonce mike, pickup, or multiple line to multiple line	50, 125, 200, 250 333, 500 ohms	50, 125, 200, 250, 333, 500 ohms	+17 DB	−74 DB	5 MA	$25.00
LS-30X	As above	As above	As above	+15 DB	−92 DB	3 MA	$32.00
LS-50	Single plate to multiple line	8,000 to 15,000 ohms	50, 125, 200, 250, 333, 500 ohms	+17 DB	−74 DB	1 MA	$24.00
LS-55	Push pull 2A3's, 6A5G's, 300A's, 275A's, 6A3's	5,000 ohms plate to plate and 3,000 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	+36 DB			$28.00
LS-57	Same as above	5,000 ohms plate to plate and 3,000 ohms plate to plate	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	+36 DB			$20.00

The above listing includes only a few of the many units of the LS Series. For complete listing — write for catalogue.

United Transformer Corp.
150 VARICK STREET NEW YORK 13, N. Y.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"