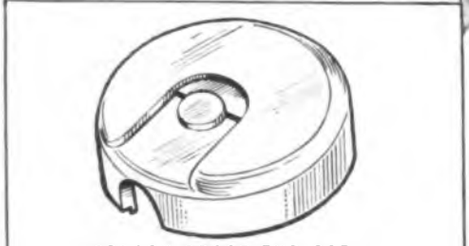
ELECTRONIC INDUSTRIES

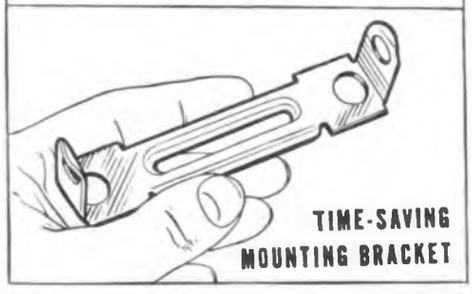
CALDWELL-CLEMENTS, INC. ★ FEBRUARY 1946

Microwave Technic

MOISTURE-PROOF CASE



SPLASH-PROOF END CAP



TIME-SAVING MOUNTING BRACKET

ONE trouble with ordinary motor-starting capacitors is that they're not too well insulated—the cardboard sleeves get soggy in time. *Not so with this plastic encased Mallory Type P capacitor!*

Then, too, many manufacturers have trouble with tight fitting end caps — or with padding expedients that are intended to stop rattling. *Not true of this Mallory Type P AC capacitor with its lock-in end cap!*

Finally, most AC capacitors are troublesome to mount — they need all kinds of expensive and extraneous gadgets. But Mallory Type P has its own mounting bracket. *Only two screws are needed to put it in place!*

For eliminating replacement headaches, improving appearance, speeding up assembly time—you've got to hand it to this Mallory Motor-Starting Capacitor. We'll be glad to send you specification sheets — write for form #746-C.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

ELECTRONIC INDUSTRIES

Including INDUSTRIAL ELECTRONICS

★ IN THIS ISSUE FEBRUARY, 1946 ★

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CALDWELL-CLEMENTS, INC.—TEL. PLAZA 3-1340—480 LEXINGTON AVENUE, NEW YORK 17, N. Y.

Electronic Industries®, January, 1946. Vol. V, No. 2. Regular price per copy 35 cents. December Directory Issue; $1.00 per copy. Published monthly by Caldwell-Clements, Inc., 480 Lexington Avenue, New York 17, N. Y. M. Clements, President; Orestes H. Caldwell, Treasurer. Subscription: United States and possessions, Mexico, Central and South American countries, $3.00 for one year; $5.00 for two years; $6.50 for three years. Canada, $3.50 per year; $5.50 for two years; $7.15 for three years. All other countries $5.00 a year. Entered as Second Class Matter, September 20, 1943, at the Post Office at New York, N. Y., under the act of March 1, 1879.

Printed in U. S. A. *Reg. U. S. Pat. Off.

hallicrafters *new Model* S-40

New beauty and perfect ventilation in the perforated steel top

Separate electrical bandspread with inertia flywheel tuning.

Tuning range from 540 kc to 42 Mc continuous in four bands

Self-contained, shock mounted, permanent magnet dynamic speaker

All controls logically grouped for easiest operation. Normal position for broadcast reception marked in red, making possible general use by whole family.

Automatic noise limiter

3-position tone control

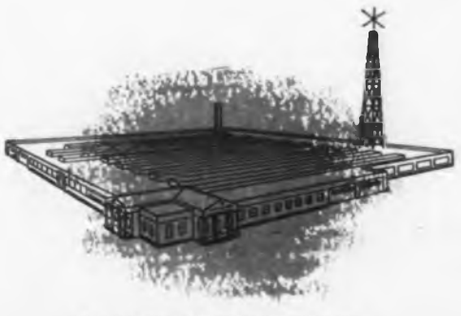
Standby receive switch

Phone jack

New design, new utility in a great new communications receiver . . .

(APPROXIMATELY) **$79.50**

Here is Hallicrafters new Model S-40. With this great communications receiver, handsomely designed, expertly engineered, Hallicrafters points the way to exciting new developments in amateur radio. Read those specifications . . . it's tailor-made for hams. Look at the sheer beauty of the S-40 . . . nothing like it to be seen in the communications field. Listen to the amazing performance . . . excels anything in its price class. See your local distributor about when you can get an S-40.



INSIDE STUFF: Beneath the sleek exterior of the S-40 is a beautifully engineered chassis. One stage of tuned radio frequency amplification, the S-40 uses a type 6SA7 tube as converter mixer for best signal to noise ratio. RF coils are of the permeability adjusted "micro-set" type identical with those used in the most expensive Hallicrafters receivers. The high frequency oscillator is temperature compensated for maximum stability.

From every angle the S-40 is an ideal receiver for all high frequency applications.

hallicrafters RADIO

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U. S. A.

Sole Hallicrafters Representatives in Canada: Rogers Majestic Limited, Toronto - Montreal

THE COVER

Parabolic transmitting and receiving reflectors, located atop the headquarters building of the International Telephone and Telegraph Corp., 67 Broad Street, New York, beam single microwave carrier for radio-telephone circuits permitting 24 simultaneous two-way conversations. This station is one in a network set up by the Federal Telephone and Radio Corp., International Telephone and Telegraph associate, between New York, Telegraph Hill, near Hazlet, New Jersey, and Nutley, New Jersey, utilizing the pulse time modulation system developed by Federal laboratories and described in Electronic Industries for November, 1945.

Pulse time modulation communication, in which intelligence is conveyed by varying the time between short pulses, constitutes a multiplex system whereby a number of separate two-way conversations with high audio fidelity can be carried on simultaneously over the same carrier. The present system has 24 channels. The system has a high signal-to-noise ratio and provides the additional advantages of transmission of DC for dialing or bell-ringing, and elimination of cross-talk and other interferences. Further, any noise which enters the system is not cumulative in the repeaters and so the number of repeaters which may be used in a system does not appreciably affect its efficiency of operation.

"What, No Pressure Cookers??"

Wartime shortages and the general scarcity of certain consumer goods reared its head again this week in the form of human interest at The Daven company, manufacturers of the Daven potentiometers and attenuators.

The Daven company recently received a strange request from a non-priority source. A young bride-to-be wrote:

"Gentlemen:

I've heard that you made or carried aluminum pots and pans. I expect to get married soon, and I can't seem to find any more aluminum pots. If by any chance you may have any in stock, I would appreciate it very much if you could let me know what you have and the price of them. Thank you."

EVERY G-E tube performs AS RATED— assuring you of 100-percent efficient service!

TUBES carrying the G-E monogram, when you place them in their sockets, will do exactly what they were designed to do. Reasons are: (1) the most modern high-precision equipment is used in their manufacture, (2) G-E tubes are pretested for service by methods which safeguard and enforce the correct rated performance.

This high level of efficiency is supported by a strong written warranty, which further assures you of full dollar-value from every G-E tube you purchase and install.

Furthermore . . . G-E thyratrons, ignitrons, pliotrons, and other types are easy to obtain, as well as dependably efficient! There is a G-E tube distributor or dealer near you, equipped to make quick deliveries.

Telephone this G-E tube supply source! Learn how his fast local service, given out of stock, can prevent machine shutdowns due to unexpected tube failures. Knowing your nearby G-E tube distributor or dealer, and his facilities, is a real stride toward the full-time performance of your plant. *Electronics Department, General Electric Company, Schenectady 5, New York.*

DISTRIBUTORS AND DEALERS EVERYWHERE, BACKED UP BY ADDITIONAL G-E TUBE STOCKS IN CENTRALLY LOCATED CITIES FROM COAST TO COAST

GENERAL ELECTRIC

103-83-8880

TRANSMITTING, RECEIVING, INDUSTRIAL, SPECIAL PURPOSE TUBES • VACUUM SWITCHES AND CAPACITORS

A NEW AND DIFFERENT
SWEEP GENERATOR
Needed in
TELEVISION, FM, RADAR, HIGH FREQUENCIES

.1 Volt, Max., 500 Kc to 110 Mcs; 100 Ohms, 10 Mc. Sweep Width

SAVES TIME
—In Production and in Testing

LIGHT
—Only 16 lbs.

SMALL
—14½" x 8" x 8"

$395.00 APPROXIMATE PRICE

For your work in television, FM, radar, high frequencies, etc., you will need one of these newly developed electronic frequency modulated signal generators covering a continuous range between 500 Kc and 110 Mc. Designed primarily for use for field, laboratory, or production alignment of wide band r.f., i.f., or video amplifiers used in radar, direction finders, television, or other wide-band systems.

Sweep range is adjustable from 10 Mc. down to 5,000 cycles at any frequency within the above range for alignment of narrow-band receivers or amplifiers. Self-contained power supply. Input 110 V., 50-60 cycles. A.C. 60 watts. Two internal "markers" are provided, one at intervals of 10 Mc., the other at intervals of 1 Mc. for band-width measurement. The amplitude of these markers is adjustable from the panel. The main dial is marked in megacycles/sec. and when set at any frequency the sweep is plus and minus 5 Mc. from this setting.

An attenuator is provided which reduces the output signal of .1 V. to about 30 microvolts, which is well below the gain control region of most receiver or amplifier systems.

Also Available Immediately In Sample Quantities

HIGH VOLTAGE RF POWER SUPPLIES
(10 KV, 24 KV, or 30 KV) for 7, 10, 12, or 14 inch direct-viewing Kinescopes and for projection sets

ICONOSCOPE YOKES

CATHODE RAY RECEIVING TUBE YOKES

DEFLECTION TRANSFORMERS

Write for preliminary technical data. A limited number of orders placed now for the Sweep Generator can be filled immediately.

UST
Window to the World

UNITED STATES TELEVISION MFG. CORP.
106 Seventh Avenue • New York 11, N. Y. • CHelsea 2-1154
RADIO • TELEVISION • ELECTRONIC PRODUCTS

REVERE COPPER IN FEDERAL 200 KW TUBE

THE 200 KW vacuum tube made by Federal Telephone and Radio Corporation is the most powerful h-f tube yet built in this country. It has been used in OWI short-wave transmitters and has demonstrated its capabilities as to power output, and dependability.

Revere OFHC (Oxygen-Free High Conductivity) Copper is one of the principal materials used in the tube. The anode is machined from a large tube of this material, which is also employed in the form of heavy sheet for making the cup that closes the anode at the bottom, in the form of strip for drawing the terminal cups. All copper used in the tube is from Revere, which thus again demonstrates its ability to meet the most rigid requirements as to electrical and thermal conductivity, workability and uniformity. For high-quality copper and brass for radio purposes, see Revere.

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

Listen to Exploring the Unknown *on the Mutual Network every Sunday evening, 9 to 9:30 p. m., EST.*

Federal 134 Transmitting Tube, 200 KW oscillator and amplifier; length, 34-5/8".

no rust
no corrosion
in this container

The illustration shows Mr. Otto Mueller, packaging foreman, inspecting one of his Ampro Sound-On-Film Projectors sealed tightly within a representative moisture vapor-proof barrier, ready to be placed in a shipping carton. Packed within the barrier, with the Projector, are three small bags of Jay Cee Silica Gel . . . which adsorb "in-the-package" moisture and prevent damage from rust or corrosion.

(Cellophane packaging was used in this illustration as a substitute for the actual wrapping).

SHIPPERS! Your product can be seriously damaged by rust, corrosion, or mildew . . . because of "in-the-package" moisture. Avoid such damage. Include Jay Cee Silica Gel, the ideal drying agent, in the packages with your product.

Your container may be sealed "tight as a drum" against outside moisture. Yet, the vapor within can cause untold harm. Particularly, a slight drop in temperature can release dangerous moisture.

Jay Cee Silica Gel keeps the air in the package dry . . . adsorbs the vapor . . . prevents moisture damage. Jay Cee Silica Gel is a crystalline substance resembling rock salt in general appearance . . . chemically inert. Has amazing power to take up moisture without its particles changing in size or shape. Packed in 1, 2, 4, 8 oz. and 1 and 5 lb. bags. Used widely with shipments of metal parts, precision instruments, electronic equipment, dehydrated foods, fabrics, and chemicals.

JAY CEE
SILICA GEL

JOLIET CHEMICALS, LTD.
108 INDUSTRY AVENUE
JOLIET, ILLINOIS

IMPORTANT!

For Faster, Better and More Complete Service to All Customers,

Maguire Industries, Inc.,

formed its new

Electronic Distributor

and

Industrial Sales Department

This New Department Will Assume All

Merchandising, Sales & Customer Relation

Duties and Responsibilities Essential in Marketing the Combined Products of the

Thordarson, Meissner & Radiart Divisions

★ ★ ★

ELECTRONIC DISTRIBUTOR AND INDUSTRIAL SALES DEPARTMENT

PERFORMERS... TOGETHER!

ONE SALES SOURCE...ONE MARKETING RESPONSIBILITY
YOUR GUARANTEE OF BETTER SERVICE!

★ ★ ★

MEISSNER

COMPONENTS AND KITS

Meissner *precision built* components include Antenna, R.F. and Oscillator Coils; plastic, standard and Ferrocart Transformers; Cartwheel and replacement Windings; Coils, Chokes and Accessories.

★ ★ ★

MEISSNER ANALYST

SERVICE INSTRUMENTS

Meissner Analyst operates by the "signal tracing" method, fastest and most reliable. Furnished complete, ready to go to work. *Portable Signal Calibrator* designed for accurate checking and adjusting of radio equipment.

RADIART

RUST-PROOF AERIALS

RADIART RUST-PROOF AERIAL

A complete line of newly designed aerials to fit all cars; cowl, fender and under hood types. Featuring water-proofed leads, "static muffler" magic ring and permanent all metal anti-rattler.

★ ★ ★

VIBRATORS

Radiart Correct Replacement Vibrators are individually engineered to meet exactly the physical as well as the electrical requirements of each application.

THORDARSON

TRANSFORMERS

Quality built and precision-engineered for all requirements; replacement, communications, sound amplifier, industrial, experimental and amateur. Tropex-impregnated for protection against moisture, salt air and humidity.

★ ★ ★

THORDARSON TRU-FIDELITY AMPLIFIER

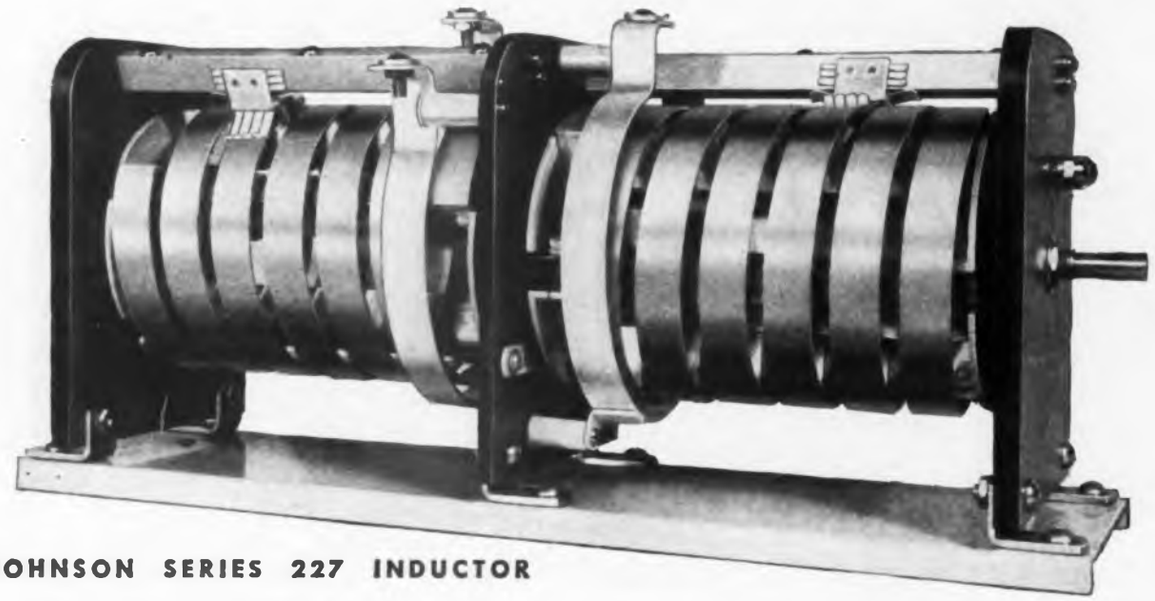
TRU-FIDELITY AMPLIFIERS

True-Fidelity Amplifiers, in new modern designs, feature advanced tone compensation, conservative ratings, ample ventilation for continuous operation, low hum level, multiple input channels, and maximum flexibility of controls.

MAGUIRE INDUSTRIES, INC.

936 NORTH MICHIGAN AVENUE, CHICAGO 11, ILLINOIS

VARIABLE INDUCTORS



JOHNSON SERIES 227 INDUCTOR

SERIES 212

SERIES 226

SERIES 204

ELECTRONIC HEATING—Designed for high current, the variable inductor shown above is especially adaptable for electronic heating installations. Available in single and dual models, with or without coupling links, the series 227 inductors are engineered to meet the rigid requirements of electronic heating circuits. Wound with heavy copper ribbon, conductor and contact surfaces may be heavily silver plated for minimum R.F. resistance. The dual model features counter-rotating coils, providing automatic balancing for push-pull circuits. Machined Mycalex is used for end frames and supporting bars. For lower power electronic heating applications the Johnson series 212 variable inductor, shown at left, is designed to give maximum efficiency. Conductor surfaces are of edge-wound copper strip, frames and supporting bars are of machined Mycalex.

TRANSMITTERS—The series 227 variable inductor shown above, is also engineered to meet demands of high-power transmitter tank designs, while the series 212 is recommended for applications at lower frequencies in medium power transmitters. The Johnson series 226 variable inductor is applicable for high-frequencies and for a wide frequency range by means of its variable pitch design. The Johnson series 204 inductor is widely used for tank coupling and other transmitter applications and can be supplied with either a variable coupling rotor or as a variometer.

VARIABLE INDUCTORS—Offer many important advantages to the electronic engineer and manufacturer. They provide close control and adjustment of fixed and limited frequency range circuits and allow the use of smaller, lower-cost, fixed capacitors. In series filters or networks where it is desired to simulate high-capacity, low-impedance conditions variable inductors again serve as desirable means of control.

Whether you need inductors for electronic heating equipment or transmitters, you will find Johnson's engineering and production facilities ready to meet your needs. Johnson fixed and variable inductors range in size from small, wire-wound units for oscillator and low-power stages to the large, high-power models where copper tubing acts as the conductor for both radio-frequency current and liquid for cooling.

TUBE SOCKETS • VARIABLE CAPACITORS • INSULATORS • BROADCAST COMPONENTS

Write for Specific Information

JOHNSON
a famous name in Radio

E. F. JOHNSON COMPANY • WASECA • MINNESOTA

Engineered

Especially for HEAVY DUTY Industrial Applications

This high power industrial tube built by Federal is the result of the widening use of induction heating for heavy applications...especially designed for the purpose...built to meet the exacting demands of severe operating conditions.

Federal's 9C23 is a tube that can stand the gaff...with extra ruggedness for stamina...heavy duty filament for long life and high power output . . . and with the inherent reliability and exceptional qualities that characterize every tube in the extensive Federal line.

Here is another instance where Federal's long experience and leadership in tube design and construction contribute to electronic progress. And it is a good reason to see Federal first for industrial power . . . rectifier . . . transmitting tubes.

Remember—"Federal Always Has Made Better Tubes."

Technical Data for Type 9C23

Maximum Ratings for Maximum Frequency of 20 Megacycles

D C Plate Voltage	15,000 volts
D C Plate Current	4.0 amperes
Plate Dissipation	25 kilowatts
Filament Voltage	22 volts
Filament Current	82 amperes
Overall Length	19⅛ inches
Type of Cooling	water

FEDERAL TELEPHONE & RADIO

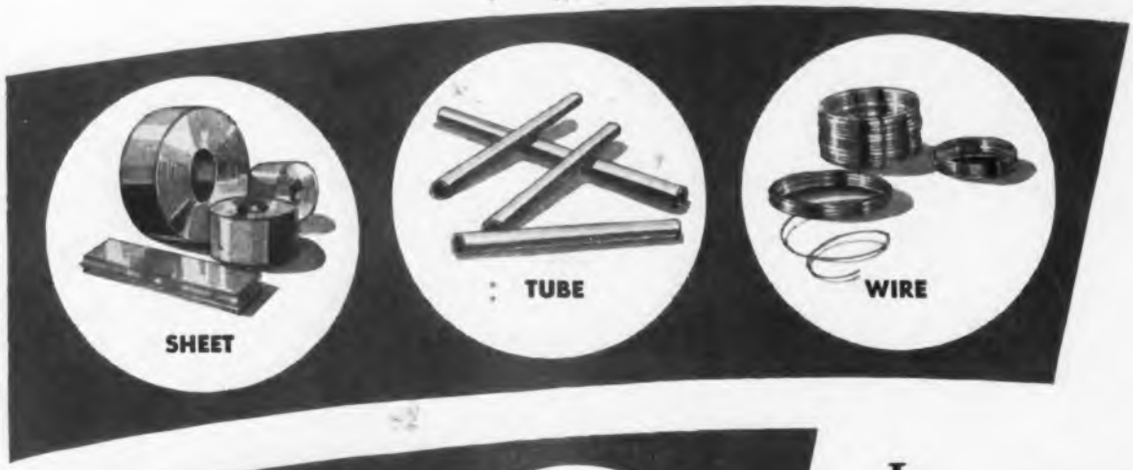
Federal Telephone and Radio Corporation

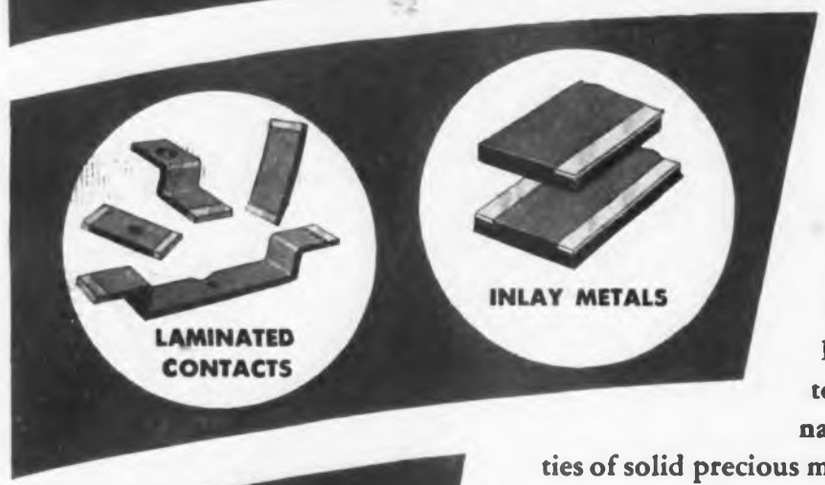
An IT&T Associate

Newark 1, N.J.

GENERAL PLATE
Laminated Metals

Give Solid Precious Metal Performance at Low Cost





If you are looking for better electrical performance, corrosion resistance, ease of workability, long life... and exceptionally low cost, then look into the advantages provided by General Plate Laminated Metals.

By permanently bonding base metals to precious metals, General Plate Laminated Metals give you all the properties of solid precious metals at a fraction of the cost of solid precious metals. In addition, the base metal adds strength and rigidity not usually found in precious metals. You'll find General Plate Laminated Metals ideal for use in such applications as electrical contacts, chemical apparatus, radar and radio equipment, mobile equipment and instruments. They'll help you cut costs, increase production and improve product performance.

General Plate Laminated Metals are available in sheet, tube and wire or as fabricated parts. Base to base metal combinations... providing physical and structural properties not found in single base metals... are also available. Write for information today.

GENERAL PLATE DIVISION

of Metals & Controls Corporation

50 Church St., New York, N. Y.; 205 W. Wacker Drive, Chicago, Ill.; 2635 Page Drive, Altadena, California
Grant Bldg., Rm. 603, Pittsburgh, Pa.

ATTLEBORO, MASSACHUSETTS

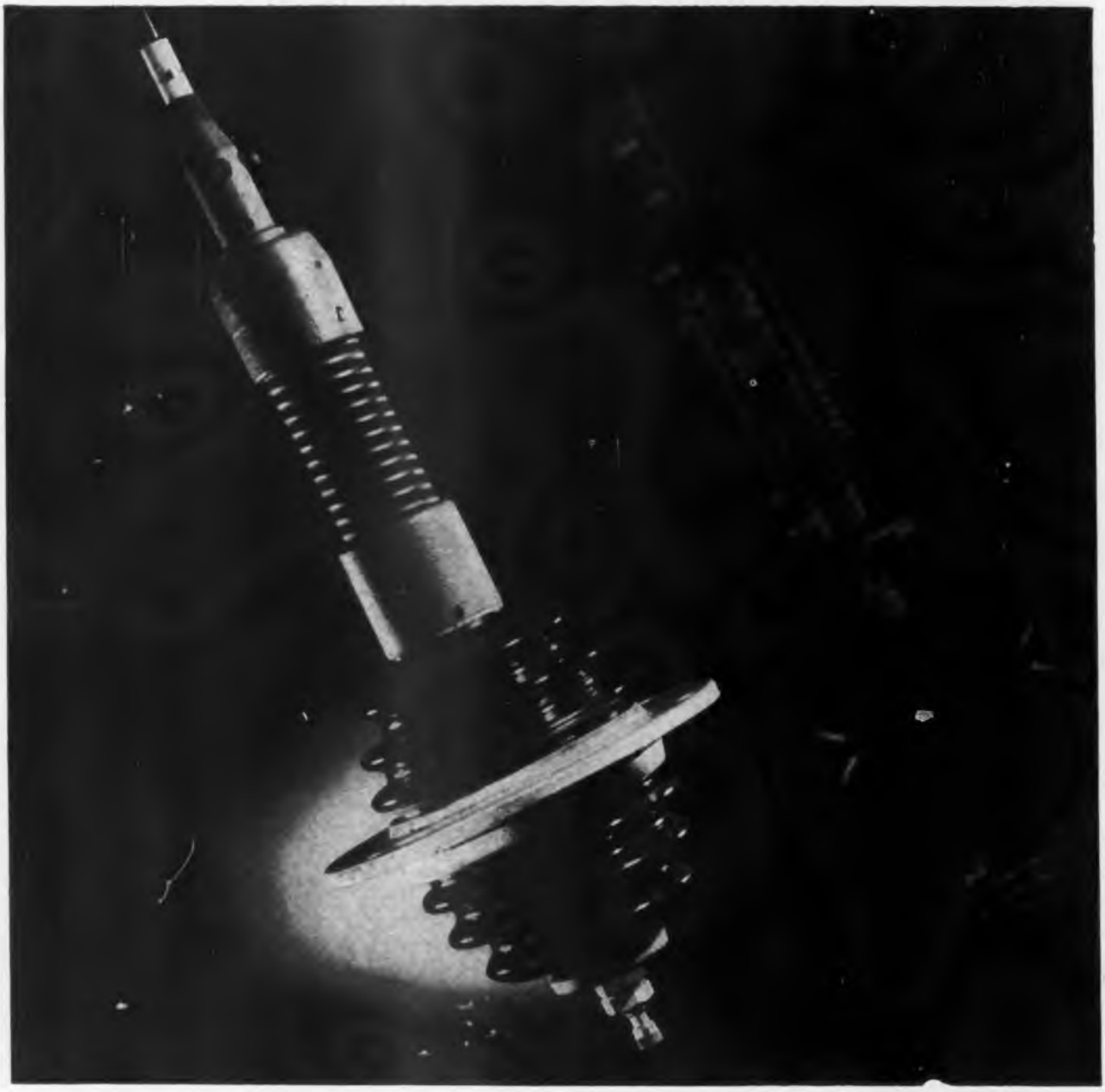
In contrast with the conventional L-shaped bracket, this U-bend construction minimizes the stress on the metal chassis and prevents distortion when mounting bolts are tightened. The mounting foot is sufficiently flexible to compensate for normal tolerances in height of case, and for variations in dimensions of the bracket itself.

The brackets are sufficiently thick to provide strong, rigid support. A corrosion-resistant finish of lacquered zinc plate assures a good ground from capacitor to chassis. The brackets have either one or two mounting holes depending upon the width of the capacitor.

These brackets are an exclusive feature on G-E capacitors. Spade-type and L-shaped brackets can still be obtained when desired. Ask for Bulletin GEA-4357 for information on the G-E capacitors that can now be furnished with this improved feature. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

CAPACITORS

GENERAL ELECTRIC



LAPP-DESIGNED, LAPP-BUILT—TO DO A SPECIFIC JOB

This is an antenna base insulator for use on a communications center transmitter. It is one of several Lapp designs for transmitter and receiver mast bases for military vehicular radio—on jeeps, halftracks, tanks and other rolling equipment.

Whether or not this special-purpose gadget has application to anything you build or propose to build, there's a moral in it for you. In this case, as in hundreds of others, an original and impractical design was modified by Lapp engineers—to provide a part that meets all electrical and mechanical requirements, and that Lapp can build economically and efficiently.

Lapp engineering talent and Lapp production methods are such that we can say, "If it's an assembly that can be made of porcelain or steatite and metal parts, tell us what the requirements are and how you think it might be made; Lapp will tell you how it can best be made—and will make it." Our right to that claim has been proved over and over in military electronic production; it's going to be a competitive advantage to smart post-war electronic producers. *Lapp Insulator Co., Inc., LeRoy, N. Y.*

Lapp

TURNER Microphones
present a *New* concept
in microphone application

THE TURNER COLORTONES

Microphones in Color

LAZING new trails in the field of practical microphone application, Turner introduces the Colortones. . . . New Crystal and Dynamic Microphones in a choice of rich color finishes. Conceived to meet the demands for functional color, their sparkling, streamlined beauty blends with modern electronic communications equipment. Executed in tough, rugged plastic, they incorporate all those sound engineering principles which have won Turner's world-wide reputation for faithful performance under difficult acoustic and climatic conditions. Now in the final stages of manufacture, Turner Colortones will be available soon. Write today for particulars and specifications.

THE TURNER COMPANY — Cedar Rapids, Iowa

PIONEERS IN THE COMMUNICATIONS FIELD

Licensed under U.S. Patents of the American Telephone and Telegraph Company and the Western Electric Company. Incorporated Crystals licensed under Patents of the Brush Development Company.

ASSURES CONSTANT IMPEDANCE

for all positions of rotating element

* DeMornay-Budd X-Band Rotating Joint #212

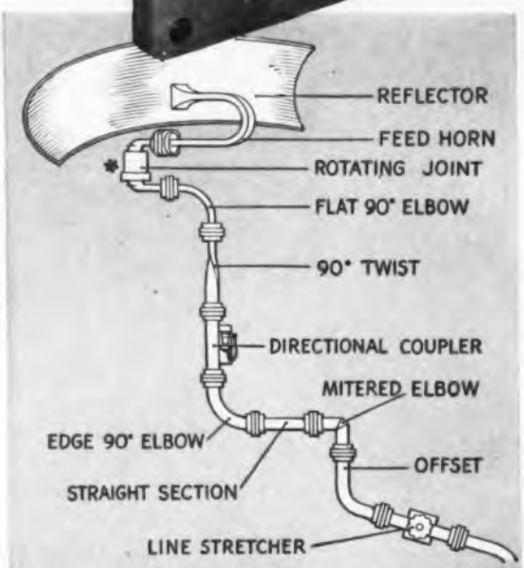
When two transmission lines, the relative positions of which are variable, are coupled by a rotating joint, it is essential that the impedance be constant for all positions of the rotating element.

Varying impedance will have a pulling effect on the R. F. oscillator and produce a variation of frequency and power output due to a changing load. The reflection coefficient of the transmission line will also vary.

The Voltage Standing Wave Ratio of the DeMornay-Budd Rotating Joint is the same for either direction of power transfer, providing balanced energy transfer for both directions. Careful engineering and precision finishing eliminate sharp corners or small radii projections which would cause arcing and breakdown.

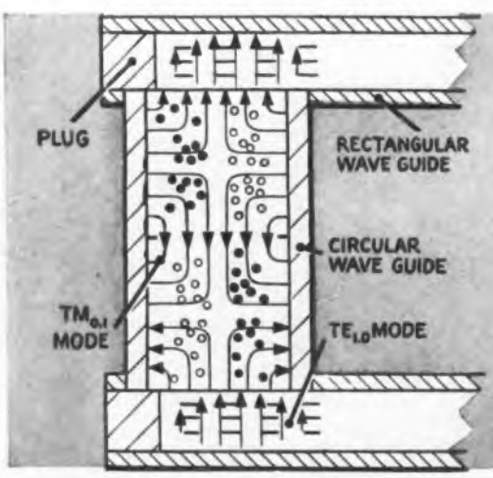
★ ★ ★

Our extensive engineering and manufacturing experience with wartime radar is at your disposal. Consult us on any of your transmission line problems, without obligation.



Asterisk indicates position of #212 Rotating Joint in above plumbing arrangement. In broad band joints it is necessary to include impedance matching devices such as tuning plugs or irises to keep the Voltage Standing Wave Ratio to a minimum and the mode constant.

DeMornay-Budd Rotating Joints are available with either choke or plain flange coupling or any combination.



Sketch illustrates a method employed by DeMornay-Budd in designing a rotating joint. The $TE_{1,0}$ mode in the rectangular wave guide is changed to a $TM_{0,1}$ mode in the circular wave guide and, as a result, a 360° rotation can be obtained without any theoretical variation in V.S.W.R.

DE MORNAY BUDD

EQUIPMENT FOR 97% OF ALL RADAR SETS

DEMORNAY-BUDD, INC.
475 GRAND CONCOURSE, NEW YORK, N. Y.

THESE S N C REPRESENTATIVES *offer you*

184 YEARS of RADIO EXPERIENCE

We invite you to call on them and their long experience for assistance in solving any problems having to do with the transformer field. Because of the long experience of these men . . . the invaluable knowledge they have accumulated . . . their demonstrated integrity and sincerity, our sales and production policies will be coordinated with the advice and suggestions they bring from their field contacts.

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SWAIN NELSON COMPANY

For tubes of Uniform Performance...

BEAT THE HEAT

with SPEER GRAPHITE ANODES

In manufacturing transmitter and rectifier tubes that are truly uniform in performance, the high heat dissipation value of SPEER Graphite Anodes is an important factor. It's one of the many reasons why SPEER Anodes are consistently specified by so many leading tube manufacturers and tube users.

Tubes containing SPEER Graphite Anodes can handle greater plate power dissipation as they disperse the heat of operation faster, and because SPEER Anodes minimize heat transfer to other component parts of the tube. SPEER Graphite Anodes will withstand any temperature up to 3500° F. without warping—temperatures at which many anode materials may soften and distort.

SPEER Anodes are carefully processed and are 99.9% pure electro-graphite. They can be machined to extremely close tolerances to conform with your tube design. Internal face spacings of SPEER Graphite Anodes can be held to .002 inch.

The many advantages of SPEER Graphite Anodes listed here are available to manufacturers and users of almost every type of electronic tube. Write today for further details, without obligation.

Do You Know?

SPEER GRAPHITE ANODES

- *Lower temperatures of associated tube parts.*
- *Withstand severe overloads.*
- *Defy warping.*
- *Prevent hot spots or fused holes.*
- *Minimize bulb darkening and insulator leakage.*
- *Improve degassing qualities.*
- *Decrease gas troubles.*
- *Enhance tube appearance.*
- *Provide precise anode dimensions.*
- *Produce uniform tube characteristics.*
- *Retain original dimensions in service.*
- *Maintain normal tube characteristics.*
- *Allow wide latitude of anode design.*

595

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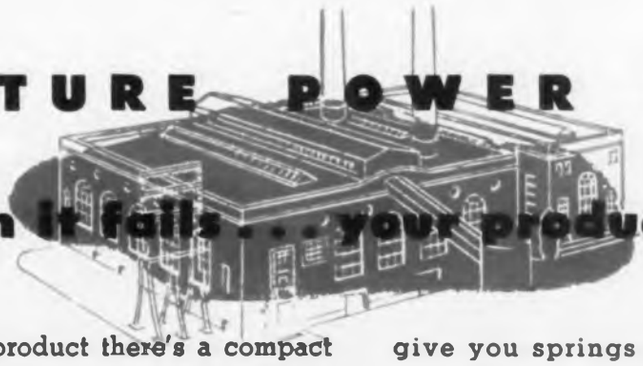
MINIATURE POWER PLANT



when it fails . . . your product fails

If, in your product there's a compact little power plant—commonly called a spring—you depend on that spring to deliver mechanical power as planned. Its function may be active or passive, but it *must* perform when called upon. If it doesn't, the *product* is blamed, *not* the spring.

Insure your product's good reputation with springs from Accurate . . . where everything possible is done to give you springs you can depend upon. Our experienced spring engineers will help you be sure you have planned the right spring for the job... our skilled craftsmen and modern machinery assure you of fine workmanship . . . and, careful testing through critical stages of manufacture will give you springs that you can rely on to function well and long. Call us. We'd like to work with you.

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that won't
let your
product down

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Why this team could do

There are three reasons why the team of Bell Telephone Laboratories and Western Electric was able to handle big war jobs fast and well.

(1) It had the men — an integrated organization of scientists, engineers and shop workers, long trained to work together in designing and producing complex electronic equipment.

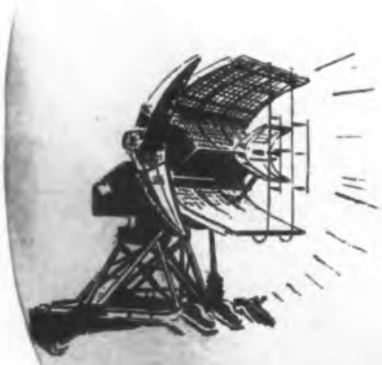
(2) It had unequalled physical facilities.

(3) Perhaps most important of all, it had a long-established and thoroughly tested method of attack on new problems.

What is this method of attack?

In simple terms, it is this. Observe some phenomenon for which no explanation is known — wonder about its relationship to known phenomena—measure everything you can—fit the data together—and find in the answer how to make new and better equipment.

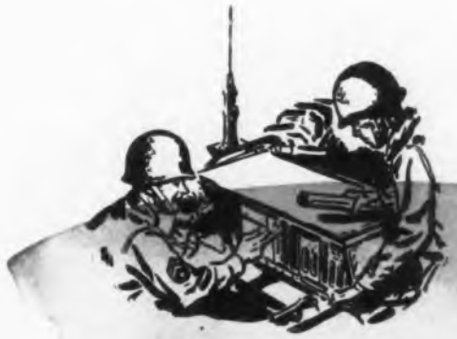
In the realm of *pure research*, Bell Laboratories have carried on continuing studies in all branches of science, with particular emphasis on physics, chemistry and mathematics. Often they have set out to gain new knowledge



Bell Laboratories and Western Electric teamed up to supply more than 56,000 radars of 64 types—approximately 50% of the nation's radar production on a dollar volume basis.

Bell Laboratories designed and Western Electric produced more than 1600 electronic gun directors and gun data computers which greatly increased the accuracy of anti-aircraft and coast defense guns.

More than 1,000,000 airborne radio receivers and transmitters were furnished by Western Electric to help coordinate attack and defense in the air.



Bell Laboratories designed and Western Electric furnished more than 139,000 multi-channel FM receivers and 74,000 multi-channel FM transmitters for use by the Armored Forces and Artillery.

Bell Laboratories and Western Electric furnished revolutionary carrier telephone terminal equipment in great quantities—all "packaged" for quick installation in the field.

war jobs like these

with no immediate prospect of an application in the communications field. Time after time, their discoveries have eventually brought about fundamental scientific advances.

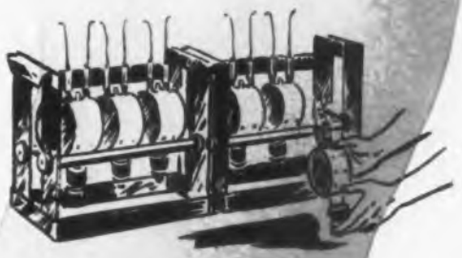
Applying new discoveries

As new discoveries have reached the stage of application, Western Electric manufacturing engineers have always worked closely with Bell Laboratories men to assure a final design suited to quantity production of highest quality equipment.

During the war, the capabilities of this unique research-production team expanded rapidly. New techniques were explored—new methods were developed—new ideas were born, rich with possibilities for the future.

What this means to YOU

Today Bell Laboratories and Western Electric are once more applying their facilities and their philosophy to the development and production of electronic and communications equipment for a world at peace. Depend on this team for continued leadership in AM, FM and Television broadcasting equipment.



Bell Laboratories and Western Electric played outstanding roles in the design and production of magnetrons and other essential vacuum tubes for use in radar and communications.

BELL TELEPHONE LABORATORIES

World's largest organization devoted exclusively to research and development in all phases of electrical communication.

Western Electric

Manufacturing unit of the Bell System and nation's largest producer of communications and electronic equipment.

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THE answer to that is easy! They're like a tin can because they also form permanent hermetic seals when soldered in place. By means of the famous Corning metallizing process, metal is attached to glass so firmly it can't be removed without taking glass with it. This means that there is no possibility of leakage and assembly parts and operations are cut in half.

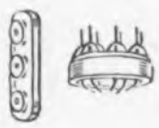
These bushings have high voltage rating, high volume and surface resistivity and high dielectric strength. They're strong, too, and being glass, resist chemical action and weathering. And the Pyrex Brand low-expansion glass makes them able to withstand great thermal shock. As you can see they come in both tubular and skirted form. Many standard items are available for immediate shipment. Or special items can be quickly made in any quantity desired.

If metallized glass can improve your product through hermetic seals or faster assembly, Corning can help you. Look at the Corning Electronic products below. If something like these is what you've been looking for, write, wire or phone The Electronic Sales Department, I-2, Technical Products Division, Corning Glass Works, Corning, New York. There'll be a Corning engineer working on your problem as soon as he can get there.

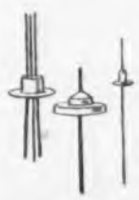
NOTE—*The metallized Tubes and Bushings, Headers and Coil Forms below are all made by the famous Corning Metallizing Process Can be soldered into place to form true and permanent hermetic seals. Impervious to dust, moisture and corrosion.*

Metallized Tubes *for resistors, capacitors, etc. 20 standard sizes ⅛" x 2" to 1¼" x 10". Mass-produced for immediate shipment.*

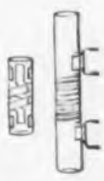
Metallized Bushings. *Tubes in 10 standard sizes, ⅜" x 3/16" to 1" x 4⅞" in mass production for immediate shipment.*



Headers — *The best way to get a large number of leads in a small space for assembly in one operation.*



Eyelet Terminals — *Single or multiple eyelets permit design flexibility. Standard items readily available in quantity.*



Coil Forms—*Grooved for ordinary frequencies—metallized for high frequencies. In various designs and mountings.*

VYCOR Brand cylinders—*very low loss characteristics. Stands thermal shock up to 900°C. Can be metallized.*

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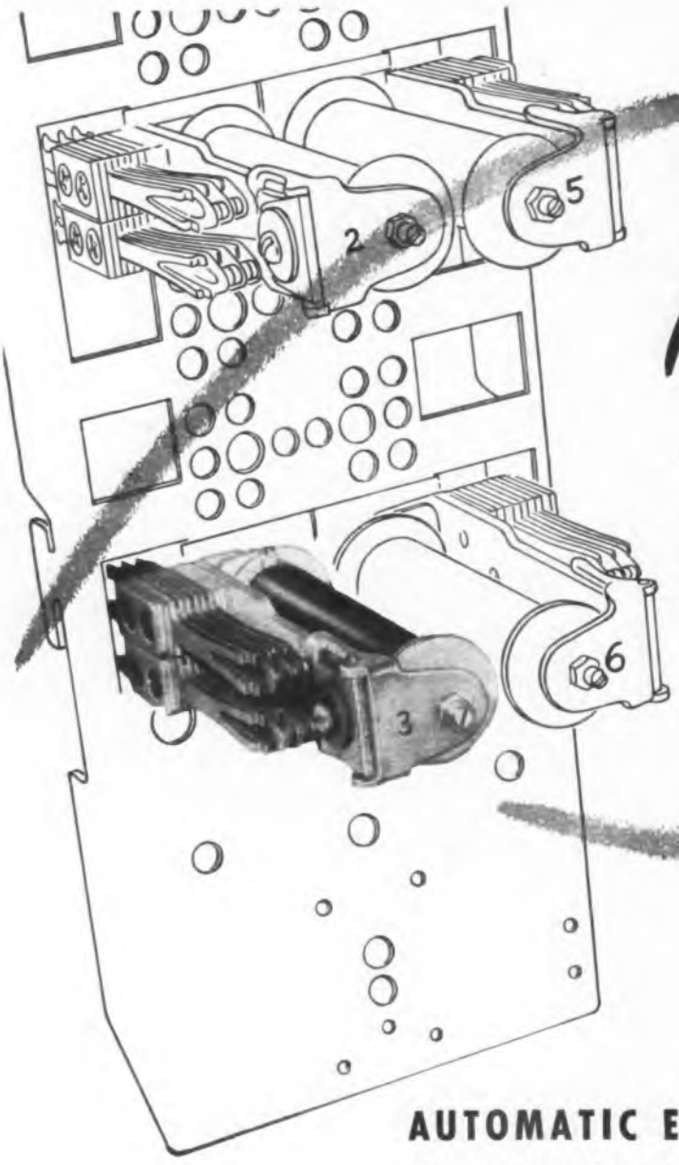

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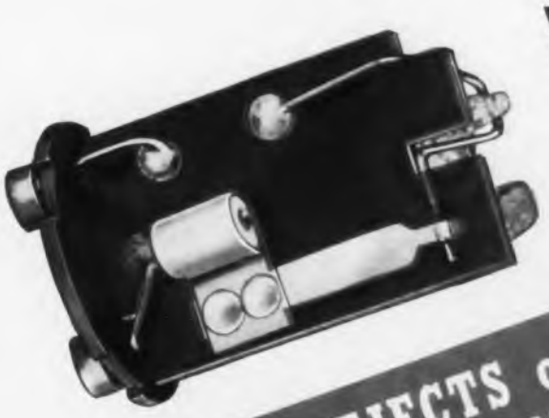

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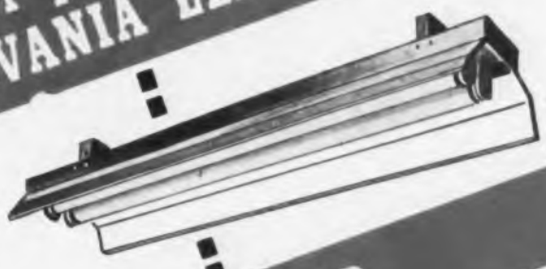

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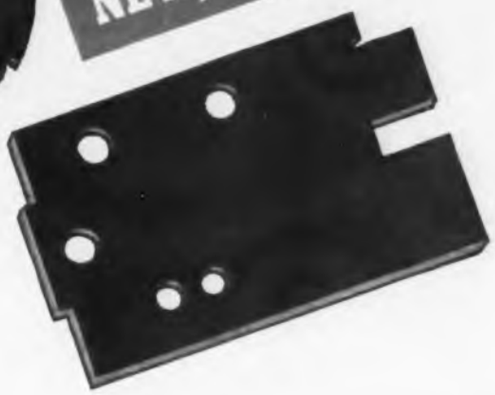

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For full information on FORMEX* magnet wire (round and rectangular) ask for our Bulletin GEA-3811. Or, see your G-E representative. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

*Trade-mark reg. U. S. Pat. Off.

FORMEX MAGNET WIRE

GENERAL ELECTRIC

Night aerial photo of St. Lo in Normandy on D-Day. Taken with the new "super" flash tube.

During the closing stages of the war, many a lone plane, traveling fast at medium altitudes, would roar over enemy territory in the dead of night.

As it winged over certain areas, an intermittent series of blindingly brilliant flashes would dart like lightning from its belly.

Then, the plane would speed away.

Such planes were on photo reconnaissance. Each was equipped with a "super" flash tube a thousandfold brighter than a news photographer's strongest flash bulb. In its split-second bursts of dazzling light, nocturnal troop movements were easily filmed from altitudes as high as 10,000 feet.

How the "Super" Flash Tube Works

The source of light is a 4,000-volt discharge between two electrodes in a coiled quartz tube filled with a rare gas. The outer container is a cylinder of Pyrex.

A single discharge gives plenty of light ... *and plenty of heat.* It is this intense heat that has made Inconel the choice for the springs, clips and wire used to support the quartz coil within the Pyrex cylinder.

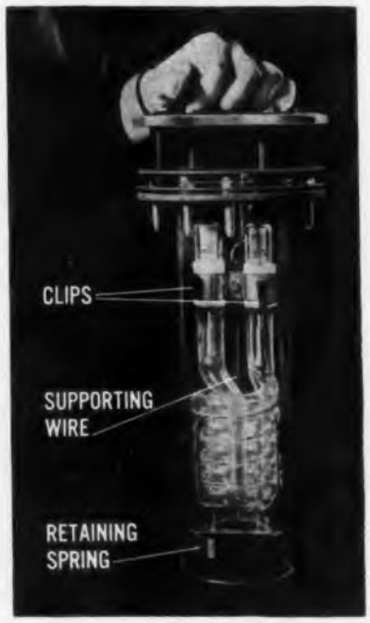
No other metal could stand up under such extreme temperatures. Before Inconel was used, previous supporting metals either lost their springiness or became distorted.

With Inconel on the job, there has been no trouble. This high-Nickel alloy retains its properties at elevated temperatures ... doesn't scale away ... never rusts.

Thermally durable Inconel is used on many jobs where high heat is a problem. Perhaps in your product, too, you can use Inconel in some form *"to build-in the performance you plan."*

Detailed information on this INCO Nickel Alloy is given in Technical Bulletin T-7, "Engineering Properties of Inconel." For your copy, write:

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



The "super" repeating flash tube built by General Electric's Lamp Department, Nela Park, Cleveland, Ohio. Arrows indicate the metal supporting parts.

Possible peacetime uses for the flash tube's sudden bolts of sun-like radiance include aerial beacons, marine lighthouses, and scientific photography.

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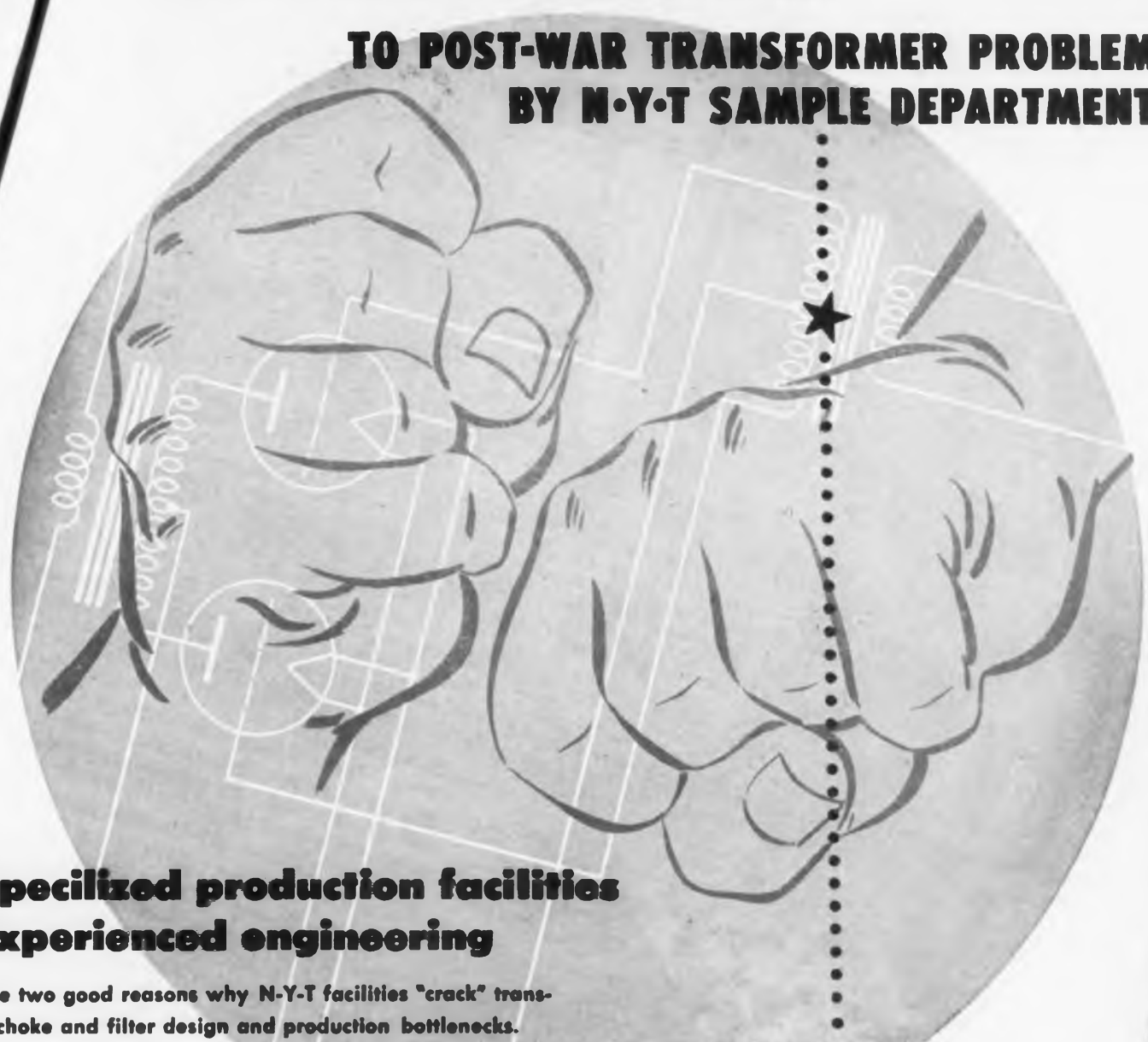

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This is what we mean by "two-fisted" N-Y-T problem solutions — production that follows thru, ever under labor and material shortages; engineering that lowers costs and betters product.

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Uncased paper sections are checked prior to impregnation. Completed units are tested for capacitance, power factor, insulation resistance, terminal-to-terminal and terminal-to-can, as well as for dielectric strength and tightness of seal.

The porosity of paper dielectric is important. This porosity test is made on each roll of paper.

Production control of impregnating materials. Electrical test is preceded by careful checking of temperature of oils.

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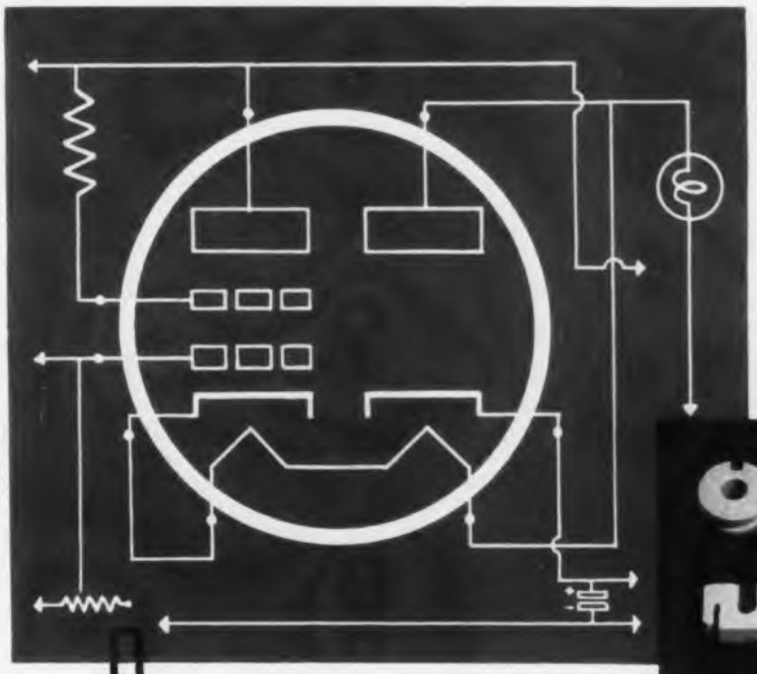

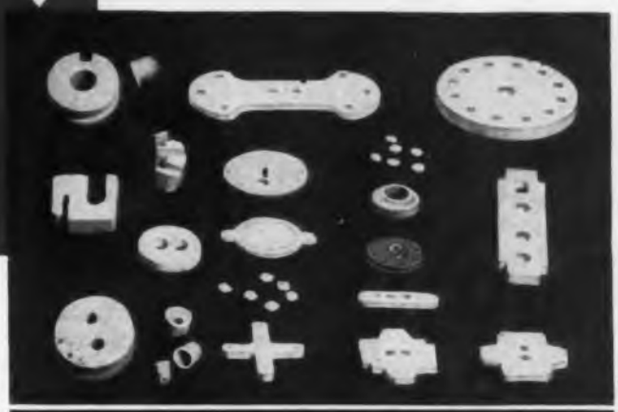

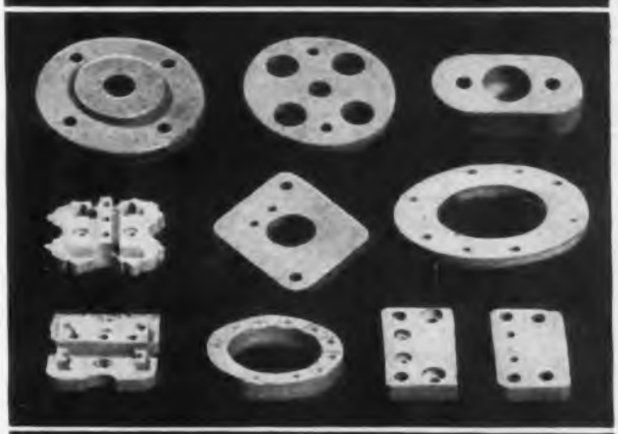

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Stupakoff quality control means . . .

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These advantages of Stupakoff Ceramics are gained through carefully selected and laboratory controlled materials . . . competent engineering, backed by years of experience and research . . . plus modern manufacturing facilities and constant inspection. For the finest ceramic insulators . . . specify Stupakoff.

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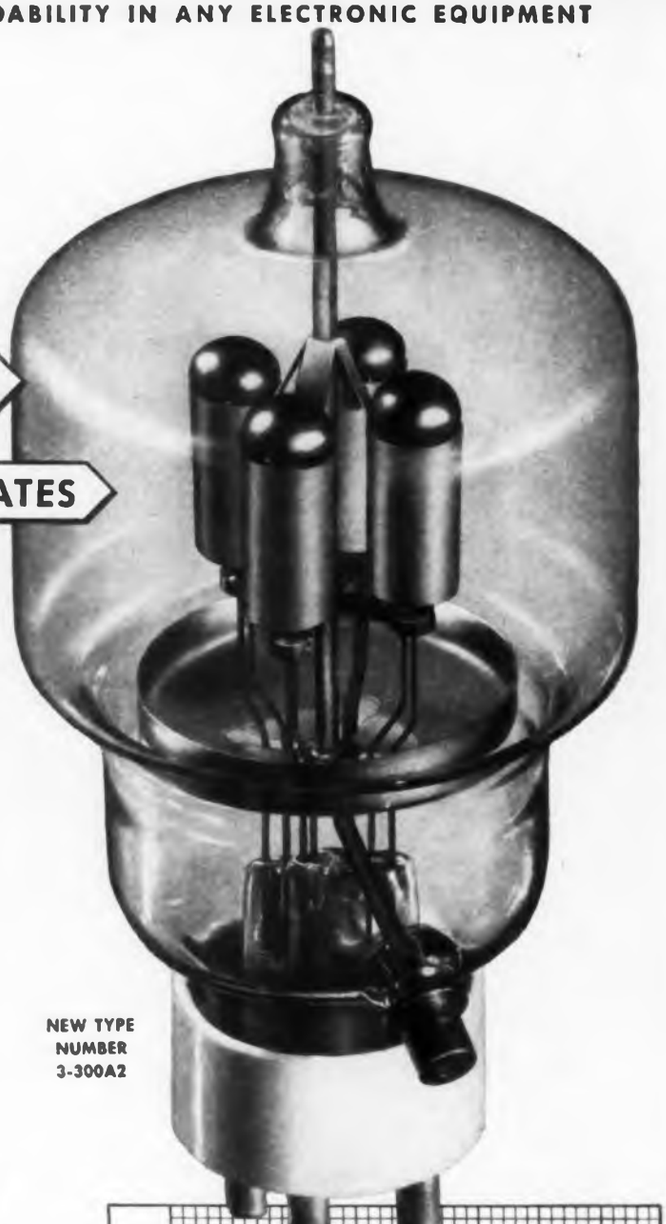
NEW NON-EMITTING GRIDS

NEW LOW-TEMPERATURE PLATES



NEW TYPE NUMBER 3-300A2

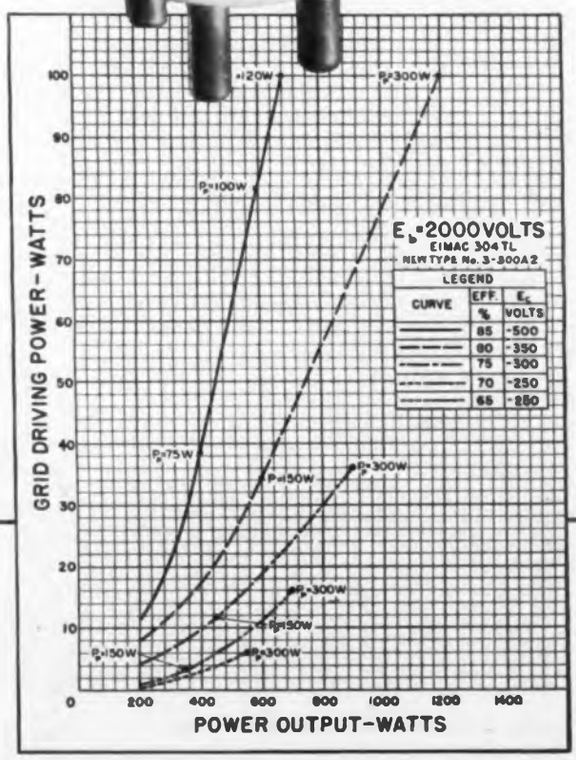
The Eimac Multi-Unit triode 3-300A2 pictured above is a radically improved version of the original 304TL which has been establishing outstanding performance records for a number of years in both civilian and military equipment.

The use of Eimac developed, non-emitting grids, contributes greatly to its already high stability, efficiency and long life, and the new type plates enable it to operate at much lower temperatures.

One of its outstanding characteristics is its ability to handle high current at relatively low voltages. For example: as a class-C amplifier the Eimac 3-300A2 will handle 1200 watts plate input with only 2000 volts on the plate. Under these conditions, the tube will deliver a power output of 900 watts, with a driving power of only 36 watts. The chart at right shows driving power requirements vs. power output. The symbols P_p indicate plate dissipation. Further information will be promptly supplied without cost or obligation.

ELECTRICAL CHARACTERISTICS

Filament: Thoriated tungsten	
Voltage	5.0 or 10.0 volts
Current	25.0 or 12.5 amperes
Amplification Factor (Average)	12
Direct Interelectrode Capacitances (Average)	
Grid-Plate	9.1 uuf
Grid-Filament	8.5 uuf
Plate-Filament	0.6 uuf
Transconductance (I_b=1.0 amp., E_b=3000, e_c=—200)	16,700 umhos



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V. O. JENSEN, General Sales Co., 2616 Second Ave., Seattle 1, Washington. Phone: Elliott 6871.

M. B. PATTERSON (W5CI) . . . 1124 Irwin-Kessler Bldg., Dallas 1, Texas. Phone: Central 5764.

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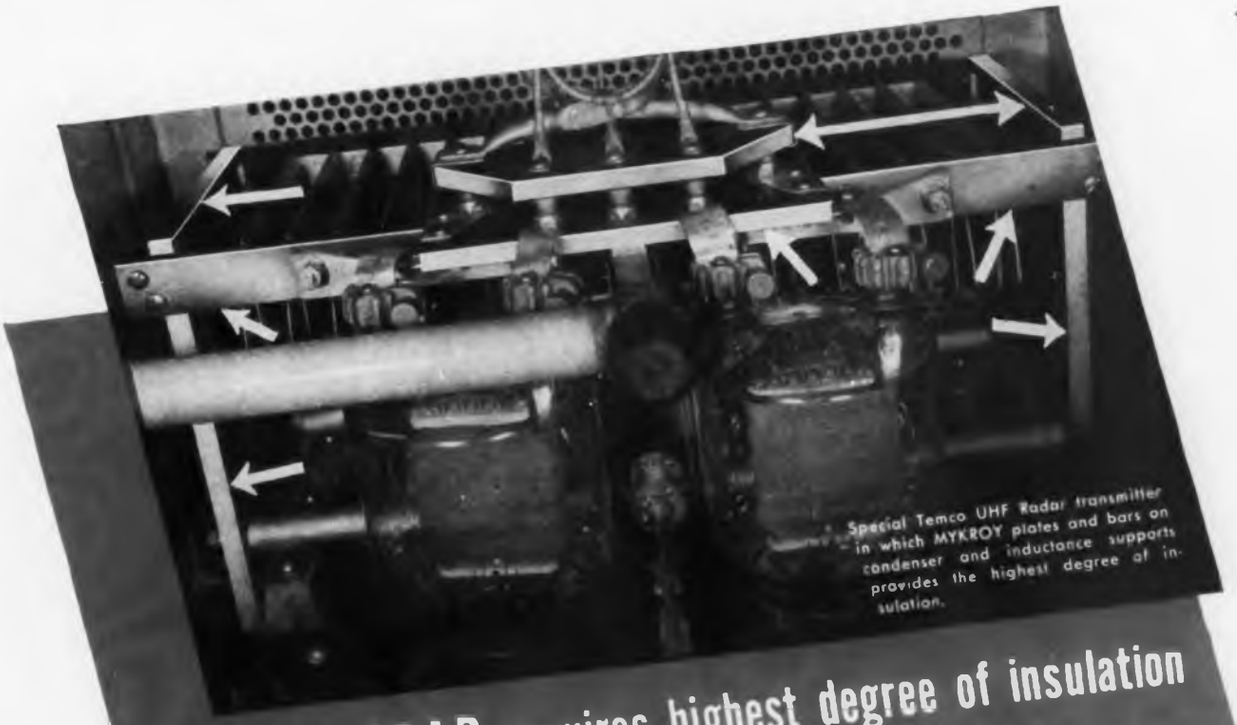
CAUTION! Look for the latest serial numbers on Eimac Tubes. Be sure you get the newest types.



Special Temco UHF Radar transmitter in which MYKROY plates and bars on condenser and inductance supports provides the highest degree of insulation.

Because RADAR requires highest degree of insulation is specified at TEMCO

MYKROY

PERFECTED MICA CERAMIC INSULATION

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Mr. Kahn's opinion is shared by leading engineers and manufacturers everywhere who have also discovered that MYKROY is one of the best and most usable insulating materials ever developed for general and high frequency applications.

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Although MYKROY is a new and superior type of insulation it costs no more than many standard dielectrics of lower electrical and mechanical properties. It will pay you, therefore, to investigate MYKROY now in planning your new products. Write for Bulletins 101-104.

High powered Temco VHF Radar unit operates over wide frequency range utilizing forced air cooled tubes. MYKROY is used at all points requiring maximum insulation.

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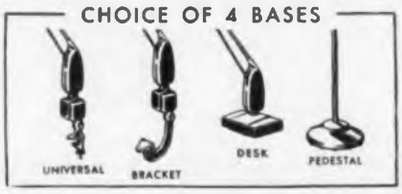

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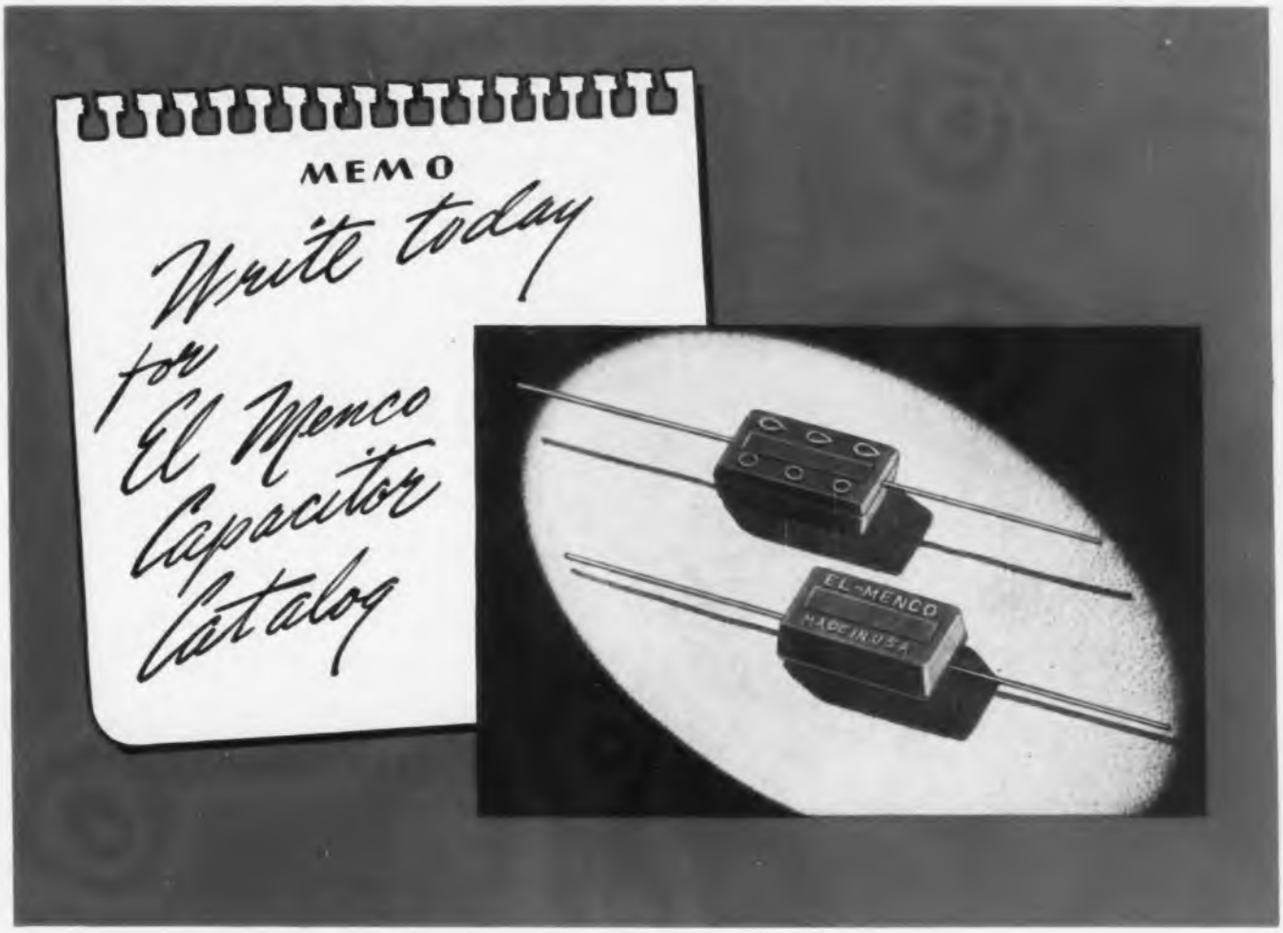

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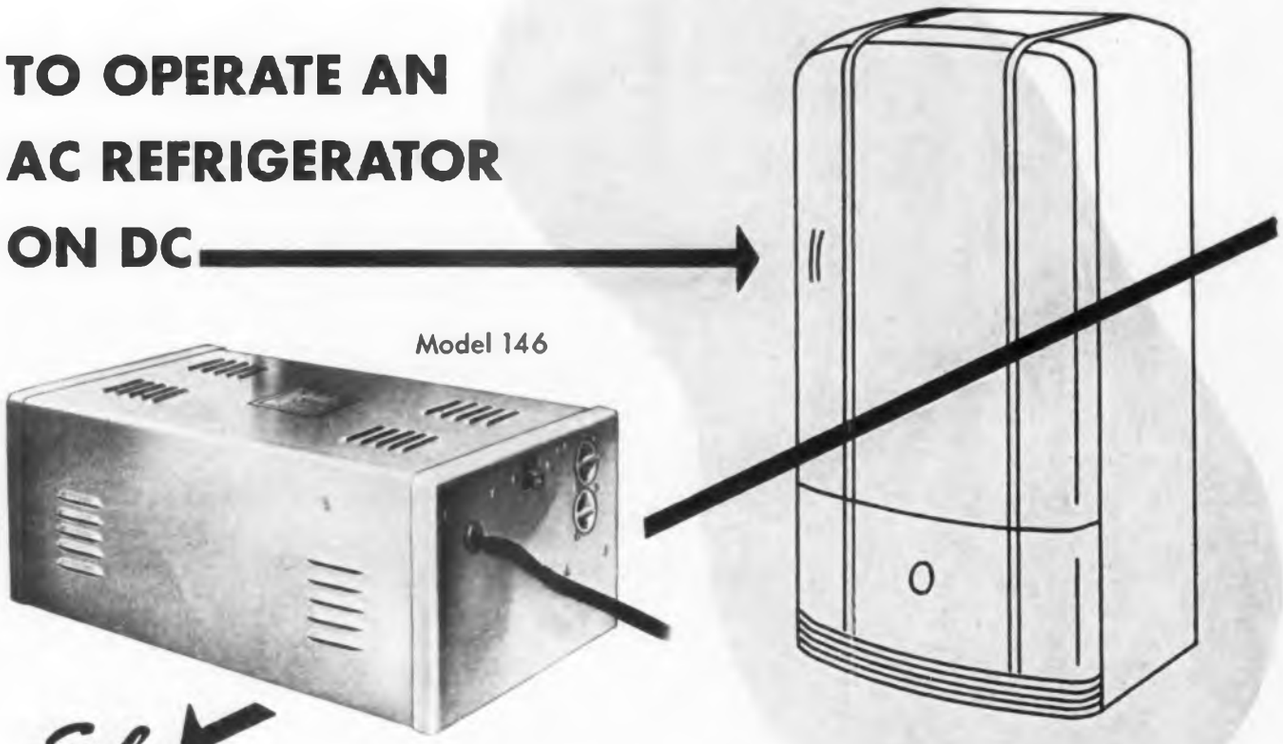

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507	12	115	150	80-100	10¾x7½x8¼	25	Radio Receivers, Transmitters, Appliances
146	32	115	350	80-100	16x10x8⅜	48	Receivers, Transmitters, Coin Phonographs
268	115	115	750	80-100	20½x11¾x7⅜	66	Motors, Communications, Equipment

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Excellence in Electronics

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Now ready at National Union is a group of new cathode-ray tubes capable of picture reproduction superior to anything television has yet offered. Here are tubes whose ultra fine grain screens* catch the most subtle gradations of light and shadow. Pictures are far more detailed, clearer, more brilliant. When enlarged by projection, they hold their distinct, high-definition quality and depth of tone. Here, too, ion burn, as a major television problem, is a thing of the past!

National Union enters the "Age of Television," ideally equipped to supply high-grade C-R Tubes at mass market prices. Here, is a large modern plant . . . an ultra-efficient production line . . . equipment designed for the most advanced manufacturing techniques . . . the highest standards of quality control . . . skilled workers . . . able engineers. All backed by one of this Industry's most extensive and fruitful Electronic Tube Research programs —assurance that N. U. will contribute its full share to future C-R Tube progress.

**So fine is the texture of the special florescent material developed by National Union Research Laboratories, it is calculated that a 10-inch picture on the screen of a National Union cathode-ray tube is reproduced on 10 billion crystals!*

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RADIO AND ELECTRON TUBES
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RAYTHEON

IONICALLY HEATED LOW VOLTAGE GAS RECTIFIERS

A major deterrent to the further size reduction of radio receivers and other equipment designed for universal operation from a standard 117 volt AC or DC line or internal batteries, has been the size and power dissipation associated with the rectifier tube. The advantages of an ionically heated tube for low voltage applications were recognized early by the Raytheon engineers, who have long pioneered in the field of gas tube development. However, considerable research has produced the OY4 and OY4G which start cold from no more than 95 volts DC. High rectification efficiency is realized from the low internal drop and high peak current ratings. Physically these types have the same dimensions as the familiar OZ4G and OZ4.

Where size is an important factor, use of the OY4G in place of the 117Z6GT, as extensively employed in the three way receivers, will result in a substantial reduction of the space requirements.

Even more important is the differential of approximately eight watts in favor of the OY4 and OY4G because of the ionic heating feature. This saving cuts the input power down by more than 50% for a normal receiver. Consequently, cabinet size can be decreased without danger of excessive heating. Furthermore, the time required for the set to become operative is the same whether on DC, AC or battery — that is, almost instantaneous.

These tubes have been engineered to produce a minimum of the radio frequency disturbances associated with a gaseous discharge. The simple filter circuit indicated below will generally reduce such interference to a negligible value.

If your product does not call for the ionically heated low voltage gas rectifier, there is a Raytheon type designed for your need. And all Raytheon tubes follow the same rigid pattern of advanced engineering with precision manufacture. To get continuing best results, specify Raytheon High-Fidelity Tubes.

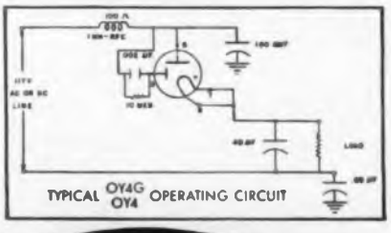
OY4G AND OY4 RATINGS

Half Wave Rectifier—Condenser Input to Filter*

Maximum Inverse Peak Voltage	300 volts
Maximum Peak Current	500 ma
Maximum DC Output Current	75 ma
Minimum DC Output Current	40 ma
Minimum Series Anode Resistance (117V line operation)	50 ohms
Approximate Tube Drop	12 volts
Maximum DC starting Voltage**	95 volts

*Pins 7 and 8 must be connected together. Rapid intermittent operation is undesirable.

**With starter anode network as shown in circuit.



Radio Receiving Tube Division

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Excellence in Electronics

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for High-Frequency Insulation

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G-E mycalex proved to be an excellent insulating material to meet exacting requirements of dimensional stability . . . rigidity . . . high-frequency insulation.

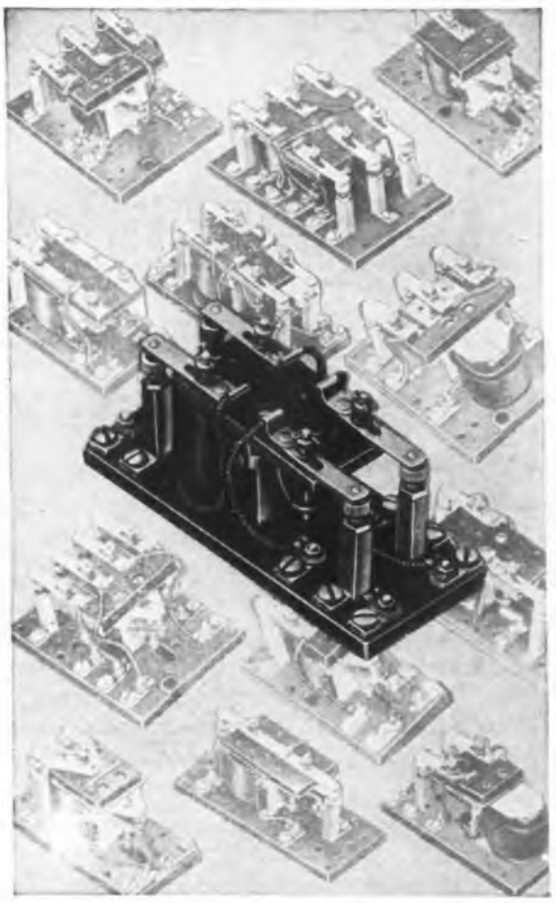
You, too, may find that molding G-E mycalex to your design will solve an insulation problem of yours. G-E mycalex is also available in standard sheets and rods. Write to Section T-7, Plastics Divisions, General Electric Company, 1 Plastics Avenue, Pittsfield, Mass.

GE MYCALEX

GENERAL ELECTRIC

CD46-M7

A NEW IDEA



BULLETIN 130 RELAYS

To serve the Electrical and Electronic Industries Ward Leonard has developed a relay capable of service in the widest possible variety of applications.

By designing a basic relay it was possible to produce a unit employing many interchangeable parts. With interchangeable components the broadest range of requirements as to voltages, currents and contact arrangements can be met.

By employing modern production methods embodying standardization of relay parts the greatest flexibility of individual relay assemblies of highest quality is provided. This standardization system, along with quantity production, fully assures the user of a better, more economical relay, utilizing the most modern features of relay design.

The Bulletin 130 relays offer the user the choice of one to four poles, 6 to 230 volts D. C. and 6 to 440 volts A. C. in single or double throw, normally open or closed, with or without blowout coils and a host of other options. With such flexibility of arrangement, custom requirements can be met without prohibitive cost or undue delay in delivery.

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"Modern railroad transportation systems cannot function to their maximum efficiencies without the use of modern communications networks. That is why the Santa Fe System maintains complete telephone and teletype, as well as telegraph systems along its entire thirteen-thousand-mile right-of-way. It is also the reason for Santa Fe's immediate and careful exploration of all new communications techniques, such as railroad radio, and accounts for the many 'firsts' contributed by the Santa Fe to the railroad communications art."

President
Atchison, Topeka and Santa Fe Railway

AM or FM? Which to use on railroad radio? This question has long troubled engineers in both the railroad and the radio fields.

To determine the comparative operating characteristics of AM and FM radio equipment, The Atchison, Topeka and Santa Fe Railway, in conjunction with the Farnsworth Television & Radio Corporation, recently conducted an exhaustive series of tests.

As a result, railway men the nation over have for the first time a thorough evaluation of both types of modulation for railroad service. Of equal importance is the fact that the information derived now enables Farnsworth to design better railroad radio equipment. Efficiency will be increased; the way has been opened to reductions in purchase price and maintenance cost.

Such tests add one more milestone to the development of railroad communications. The engineers of Farnsworth's Mobile Communications Division have pioneered many other important achievements. Backed by Farnsworth's ample production facilities, these engineers are now prepared to offer practical radio assistance to all the railroads of America.

The Farnsworth Television & Radio Corporation, Dept. EI-2 Ft. Wayne 1, Indiana.

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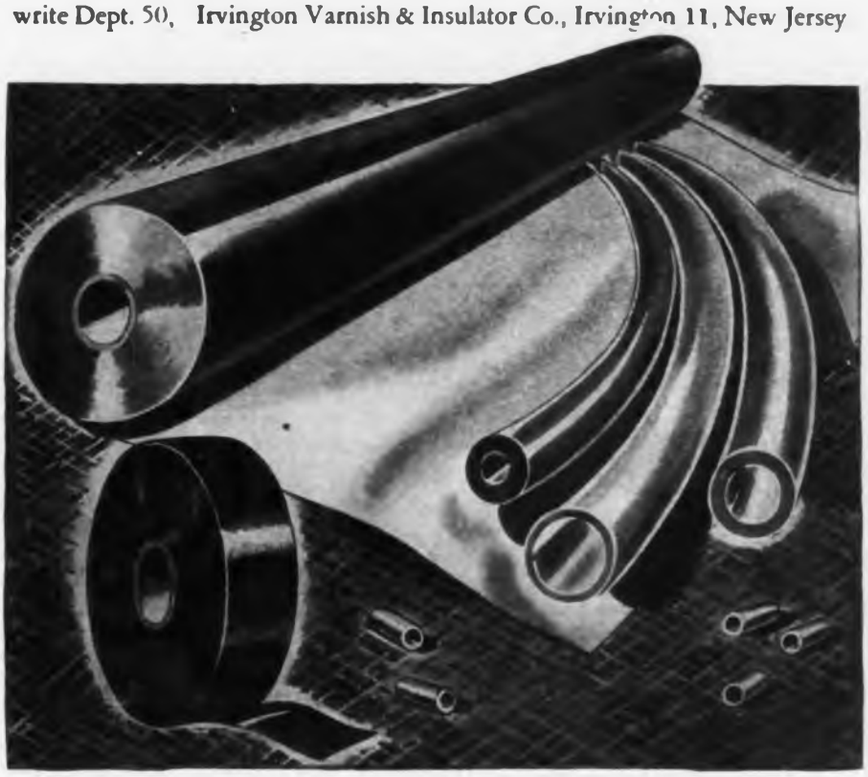
The varnished Fiberglas insulations you require in types, sizes and specifications, are all available at IRVINGTON. For samples, or full particulars, write Dept. 50, Irvington Varnish & Insulator Co., Irvington 11, New Jersey



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- TUBINGS
- SLEEVINGS
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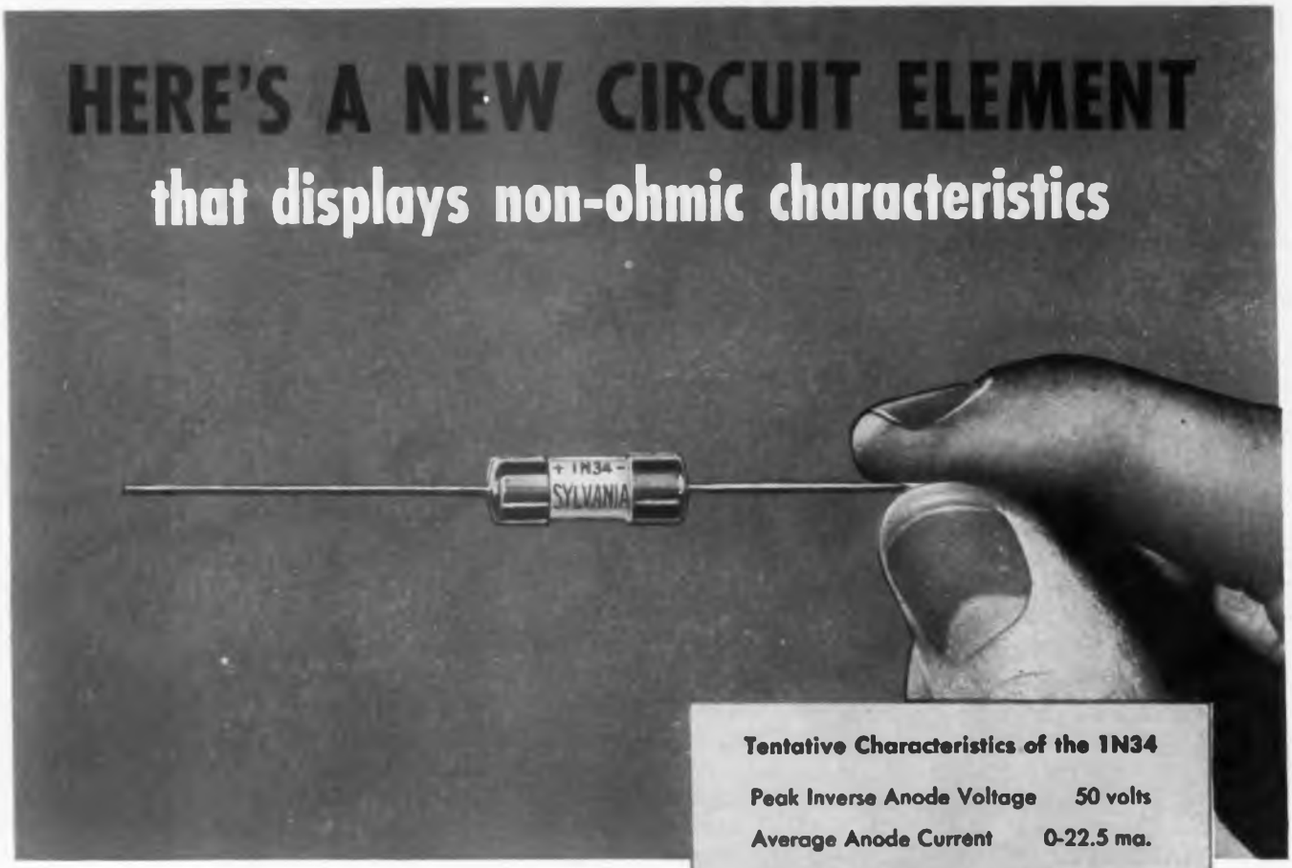
- SLOT

IRVINGTON VARNISH & INSULATOR COMPANY

IRVINGTON 11, NEW JERSEY

HERE'S A NEW CIRCUIT ELEMENT
that displays non-ohmic characteristics



Tentative Characteristics of the 1N34

Peak Inverse Anode Voltage	50 volts
Average Anode Current	0-22.5 ma.
Peak Anode Current	60 ma. max.
Surge Current	200 ma. max.
Back Conduction at 50 volts	2 ma. max.

(Surge current refers to transient values; peak current refers to the maximum value of an applied AC signal.)

IMAGINE a circuit element that *violates* Ohm's Law. One that exhibits *polarized* non-linear current-voltage characteristics.

Such an element has now been made commercially available for the first time . . . Sylvania Electric's 1N34 G_e metal Crystal Diode. This tiny unit (shown full size in illustration) opens up many interesting potentialities in circuit design. Withstanding relatively high voltages, it is extremely useful as a circuit element.

Light in weight and equipped with pigtail leads, it is conveniently soldered into place . . . no sockets required. No heater supplies are needed — eliminating hum and noise, permitting both terminals to be connected far above ground potential.

The 1N34 Diode gives superior performance at high frequencies and with low values of load resistance.

Where Can You Use an Element Like This?

Among the expected applications of the 1N34 Diode are: DC restorors in television receivers; frequency discriminators in FM sets; peak limiters; video detectors; meter rectifiers; bias rectifiers; modulators and demodulators.

Perhaps *you* can see many other ways in which you can put this revolutionary circuit element to work. We'll be glad to send you further technical information to assist you in planning applications, and to discuss specific uses with you.

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O. H. CALDWELL, EDITOR ★ M. CLEMENTS, PUBLISHER ★ 480 LEXINGTON AVE., NEW YORK (17), N. Y.

The Menace of "Power"

For most of the reception difficulties in radio—whether AM, FM, or television—transmitter power is the effective cure.

Yet "power" has always been a fearsome word in Washington. There the official attitude invariably holds to keeping power down, rather than letting stations increase their kw output to the limits which will insure good reception and best service to the public. Instead of regarding power increase as a merit, as something distinctly in the public interest,—radio power (along the Potomac, at least) is viewed as a kind of vice or plague to be held in check or resolutely slapped down!

Technical Gobbledegook!

Most of the official alarm about "power", we suspect, comes from our own lamented engineering use of this 5-letter word which (as engineers sometimes overlook) also has sinister political implications. If radio engineers from the beginning had only wiped the word "power" from their vocabularies when in Washington,—talking instead about "500 kilowatts" or "100 kilowatts", or even citing received field-strengths in terms of "microvolts per meter", the confused politicians would never have interposed any objection to letting engineers have what they wanted.

Something They Understood—and Feared

But when the engineers thoughtlessly lugged in the simple, understandable, one-syllable term "power", the political mind at last had a gleam of understanding—and fear!

And ever since, radio power has been something to be throttled and checked, instead of used and increased in the true public interest.

Yet high power at the transmitter is still the best insurance of good reception, at lowest cost, at the customer's receiver,—whether AM, FM or TV!

Mass Production

Rapid automatic output has always been the aim of manufacturing executives. Electronic methods fit well into such continuous processes, although tubes have not been used as much as might be expected. But the possibilities of automatic electronic production are shown by a new brazing unit using induction heating, soon to appear. Parts are poured in its hoppers twice a day; and twice a day cans of the finished joints are tucked away, ready for the next operation—each finished part exactly alike. We note this here not because this new equipment with its automatic features, is revolutionary, but because it is a logical combination of good electronic engineering and sound mechanical development.

Also it is a signpost that the industrial electronic field is going to have a place for small flexible engineering design groups who can develop equipment for highly specialized applications and also for mass production.

Market for New Ideas

A number of radio manufacturers are now busily engaged in trying to find products they can make in their idle plants. This is a nice idea but unfortunately it suffers from too much competition.

We think the best way to solve the idle plant problem is by new product development. New applications of known electronic art for public, commercial and industrial consumption, must be found and marketed. Original advances should be exploited! The engineering brains in the country have been enriched, not consumed by the many miraculous war inventions. The nation is in a buying mood. Let us bring the trained intellects to market. That is the road to business building!

Electronic Anticipation

The war has buried the old bugaboo about fragility and short life of electronic tubes. For tubes have been used by the millions under conditions thousands of times more strenuous than those in industry. Tubes today have no more glamour than a circuit fuse or a battery. Concerns that used to point with pride to a circuit with a photo-tube in it or a one-stage amplifier, will now have to compete with complete electronic systems that will combine effects of all kinds, compute the required control variation needed and then initiate the corrective factor instantly. Process lags will be reduced in many places, with a resulting improvement in the product, because of closer limits. This will be done largely by anticipating what will happen to the process by changes in flow, temperature, demand, etc., actuating complementary changes elsewhere. It will no longer be necessary to wait for these changes to show up in the output before making a correction.

In This Issue—UHF BLIND-LANDING SYSTEM—Page 60

MICROWAVE INSTRUMENT

Two beams, independently modulated, alternately turned on and off at 60 times per second, prevents interference

● The important advantages of microwaves in producing sharply defined beams and in permitting the concentration of nearly all available radiation energy in exactly the desired space regions have been applied to a new instrument landing system.

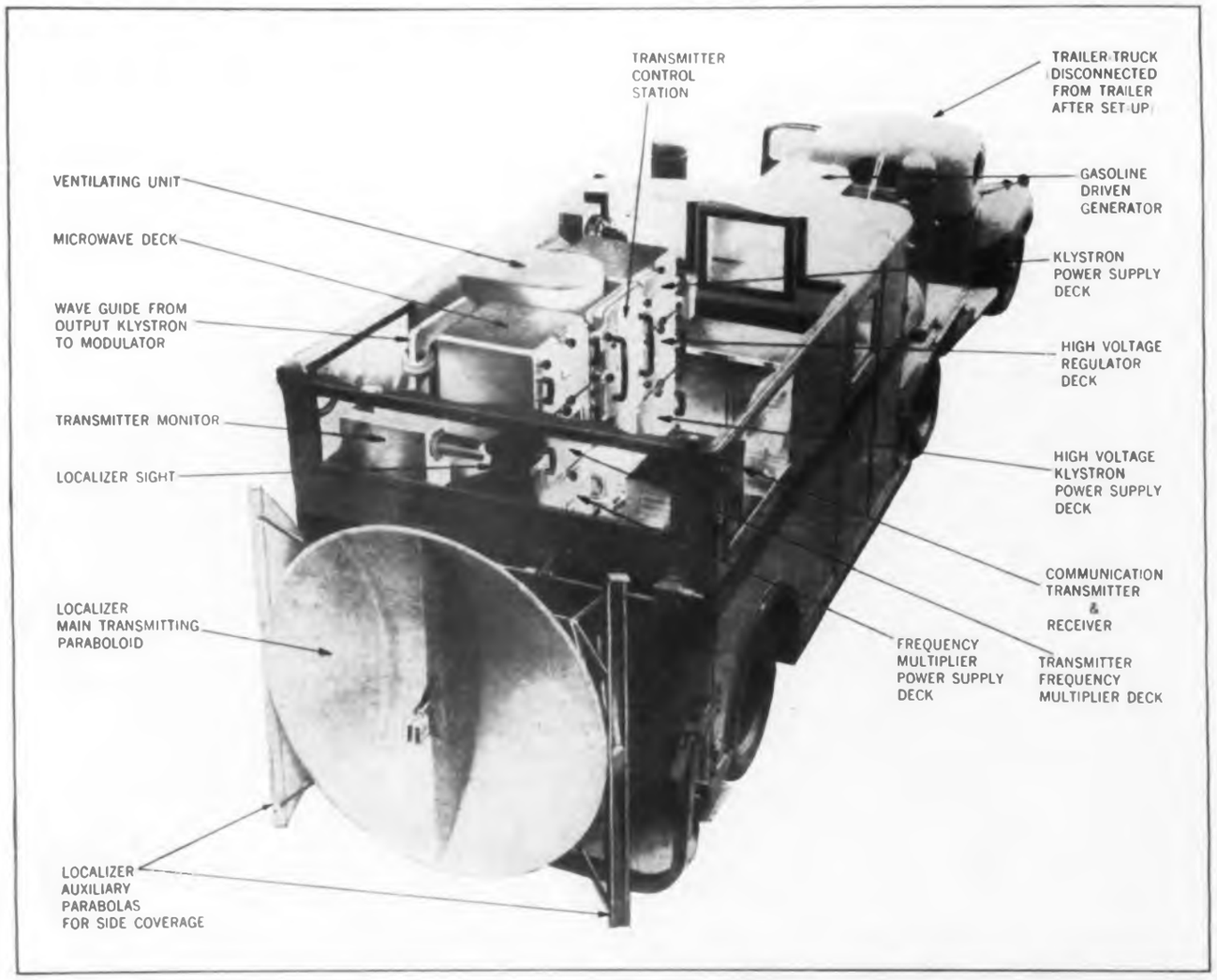
The general principle of operation is the same as originated by Diamond and Dunmore of the Bureau of Standards in 1928 and successfully applied at much lower frequencies.* Briefly a glide path is established in space at a glide angle of about 2.5 deg. by the plane of intersection of two beams of energy. These beams both originate at the same spot close to the landing runway and one is directed upward at a slightly greater angle than the other. In the new system developed by engineers of the Sperry Gyroscope Co., the two beams are identical and the lower edge of the bottom beam is ½ deg. above ground at the half power point while the upper edge is 3 deg. higher. The beam center lines being 2 deg. apart, the plane of intersection is 2½ deg. above level ground.

Position in azimuth is determined by a similar beam intersection. This one, called the localizer beam, is produced in a vertical instead of a nearly horizontal plane.

The intersecting beams are audio modulated, in the glide path, the lower being sine wave modulated 70% at 600 cycles and the upper at 900 cycles. The same scheme is used for the right and left beams of the localizer. At the receiver, preponderance of 900 cycle signal causes

*Latest type AAF Blind Landing Equipment, M. E. Montgomery, Federal Telephone & Radio Corp., Electronic Industries, Jan. 1945, pp. 100.

Phantom view of localizer trailer showing the disposition of equipment and the radiating surfaces, the paraboloid and the half-cheeses



BLIND LANDING SYSTEM

the needle on a pointer to move to one side, while a stronger 600 cycle signal has the opposite effect.

The pilot, watching a two-movement meter, flies his plane so as to bring the center of the meter toward the interesections of the two pointers. These are at right angles to each other, one being associated with glide path signals and the other with localizer signals. The meter used is different from that in general use as the needles are mutually perpendicular regardless of the signals applied. In the common meters this condition exists only when "on course", and as a result erroneous interpretations of the indications can be made.

The glide path is established by 2617 mc radiations from a half-cheese antenna mounted on the back of a special mobile trailer. The high frequency energy is fed to the antenna by a pair of wave guides terminating at the focus of the parabolas. Only one parabola is used in the glide path. Two beams are formed because two points of introduction of energy are used.

Thence the radiation irrigates the reflecting surface which forms it into beams of the desired shapes.

The parabola being many wavelengths long in the vertical plane forms a sharp beam with the slight vertical thickness of 2.2 deg. In the horizontal plane however the reflector mouth shape is such as to produce a very broad beam.

It should be noted that the two wave guide openings feeding the antenna are respectively immediately above and below the parabolic focus. The effect of such a displacement of the radiation source is familiar to every automobile driver who has a low and a high headlight beam at his command. It is this displacement

Compact receiver installed in plane

The recently developed Sperry microwave instrument landing system operates at a wavelength about 11½ cm and gives extremely sharp and well-defined beams both in the horizontal and vertical planes. The scheme used is to produce an intersection of radiated energy in two planes at right angles to each other and to have a meter in the airplane which indicates position to right or left, above or below the track.

which is used to produce the upper and lower beams.

Modulator

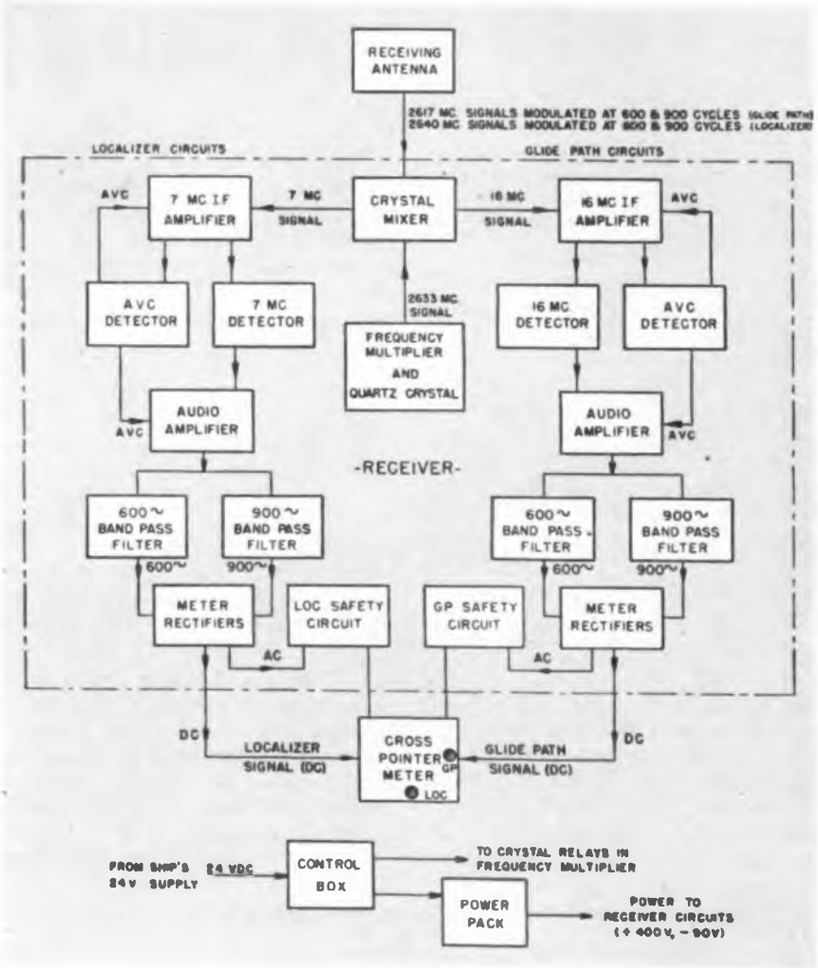
A feature of this system is that the upper and lower beams are turned on and off alternately 60 times per sec. to prevent any interference patterns between the two. This is accomplished in the modulator which is a purely mechanical device.

Energy in the transmitter output wave guide is split into two parts. Immediately beyond the split each guide is cut and the edge of a motor-driven metal disk passes through the cut. The disk is slotted and when the slots appear in the cut, energy is radiated. At other times it is interrupted. The slot width determines the modulation frequency (600 or 900 cps) and the slots are disposed so that the upper and lower wave guides are excited alternately. The shape of the slots is such as to produce sine wave modulations.

To prevent leakage at the cuts in the guides and in fact at all guide connections, flanges are mounted on the guides. These have an annular slot whose depth is ¼ of a wavelength. This slot, called a choke in wave guide practice, presents infinite impedance to the radial flow of surface currents across it and hence effectively stops energy leakage.

The glide path antenna is fixed

View of rear of glide path trailer showing half-cheese antenna fed by wave guides



Block diagram showing the general arrangement of the circuits in the receiving set

to the body of the trailer, but the latter is adjustable to provide a change of glide path angle up to 4 deg. by means of screwjacks. The trailer is a self-powered unit containing its own generator and all equipment required to produce the ultra high frequency energy.

The localizer is also housed in its own self-powered trailer. In this trailer, in view of the importance of having the beam coincide exactly with the centerline of the runway, an optical sighting telescope is provided. This telescope is accurately aligned with the electrical course and is used in installation of the equipment. Also a traversing screw is provided whereby the whole trailer can be rotated slightly in azimuth for final precise adjustment.

In this case the rf energy is split into four parts which are turned on and modulated seriatim by the same method as the glide path beams. As may be seen in the illustration, the paraboloid is partitioned down the center and each half is wave guide fed, the guides passing out through the thickness of the partition and then making 180 deg. turns so as to direct their openings toward the reflecting surfaces.

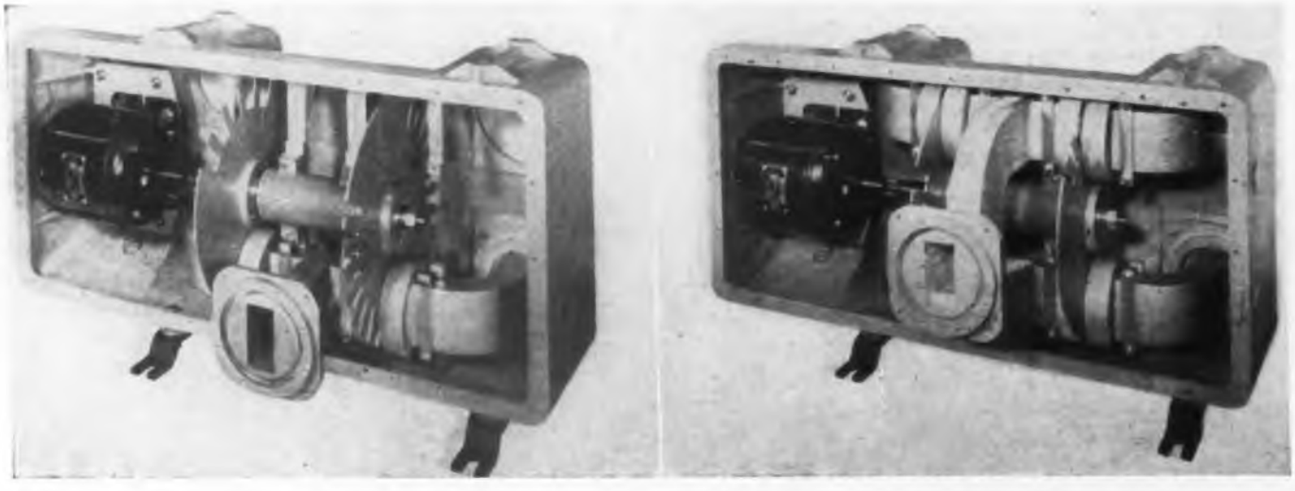
The two separate half-cheese antennas at the sides produce wide side beams whose function is to provide an energy field to catch planes seriously off course. This gives a 180 deg. coverage out to 20 miles (40 deg. to 50 miles).

The localizer frequency is 23 mc higher than that of the glide path, being 2640 mc. As a consequence there are no interference problems between the two. In cases where there are nearby airports, the system provides frequencies for them called B and C frequencies which are ½ mc lower than the standard glide path and localizer frequencies.

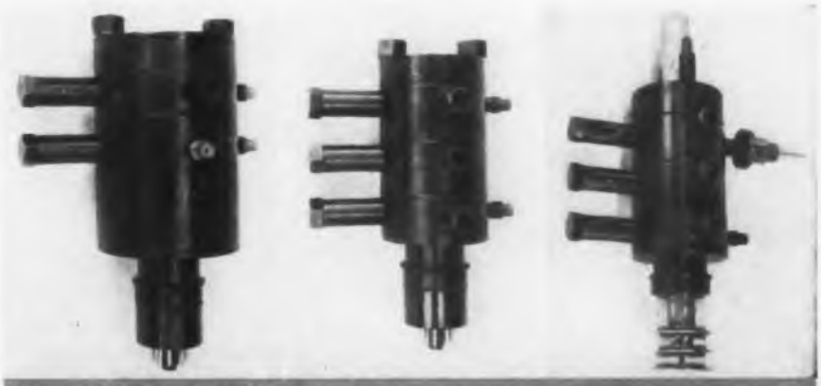
As the plane approaches a landing the angular width of the beams producing maximum deflection on the meter pointers is so slight (glide path ± 0.3 deg., localizer ± 1½deg.) that the flier would have difficulty in preventing the pointer from flopping suddenly from top to bottom or right to left. To make it easier for the pilot, the sensitivity of the meter response is halved gradually as the beam signals build up to high intensity, thus "softening" the course.

Noteworthy is the heavy cast

Mechanical modulators used to apply 600 and 900 cycle tones to the carriers. Left is for the glide path, right for the localizer beams



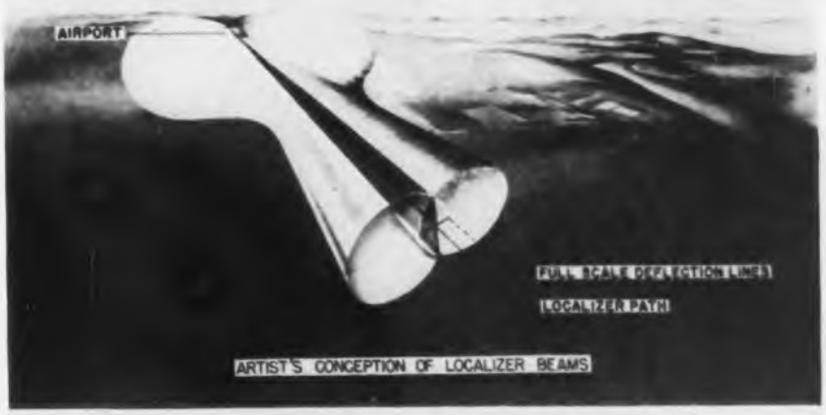
Antenna structure mounted on airplane



Klystron multipliers and amplifiers used in the microwave instrument landing system

Drawings showing the glide path and localizer beams as they would appear in space

ARTIST'S CONCEPTION OF GLIDE PATH BEAMS



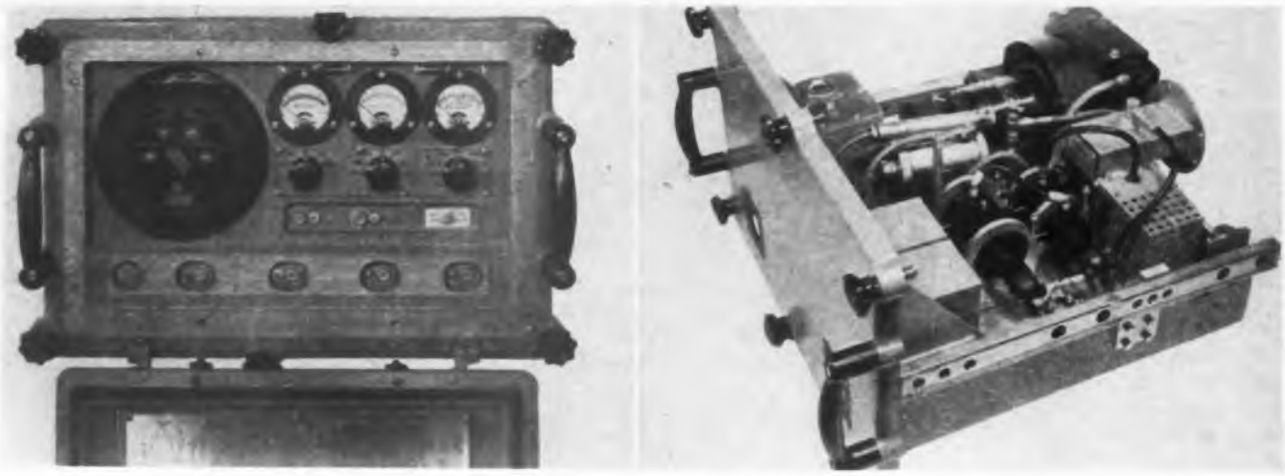
ARTIST'S CONCEPTION OF LOCALIZER BEAMS

STRAIGHT LINE LANDING PATH
(FORMED BY INTERSECTION OF GLIDE PATH & LOCALIZER PLANES)

"marine" type of construction used in housing the transmitter chassis. Reasons are durability and prevention of rf leakage—a matter of extreme importance in this type of work. The chassis slide in and out on file drawer type roller slides, and the entire chassis, when extended, can be pivoted for easy bottom access.

Heart of the transmitter is the crystal maintained in a temperature controlled oven. The "A" frequency crystal resonates at 4,846.296 kc. and controls a 6SG7 oscillator. This is followed by a 1614 buffer stage. Then the frequency is raised to 10 mc in a T-21 doubler, to 30 mc in a T-21 tripler and to 90 mc in a push-pull tripler using an 829 tube. A third tripling to 270 mc in a push-pull stage having a pair of 826 tubes provides energy to feed a klystron multiplier in the microwave deck. For operational supervision and trouble tracing, meters are provided together with multipoint switches.

In the microwave deck there are three liquid cooled klystrons. The first one, Type XE 8531, raises the frequency exactly 10 times, while the second, an X2F8534, amplifies the carrier to about 2 watts, and the third power cascade amplifier Type X2F8529 raises the power to an output level of about 70 watts. The output X2F8529 couples directly into the output wave guide



Oscillator deck (left) showing crystal oven and microwave deck at right

whence the energy is piped by rectangular tubing to the mechanical modulator described previously.

The generating equipment is identical for the glide path and localizer. Operation is completely automatic, one button starting the ac gasoline driven generator and a bat handle switch the transmitter.

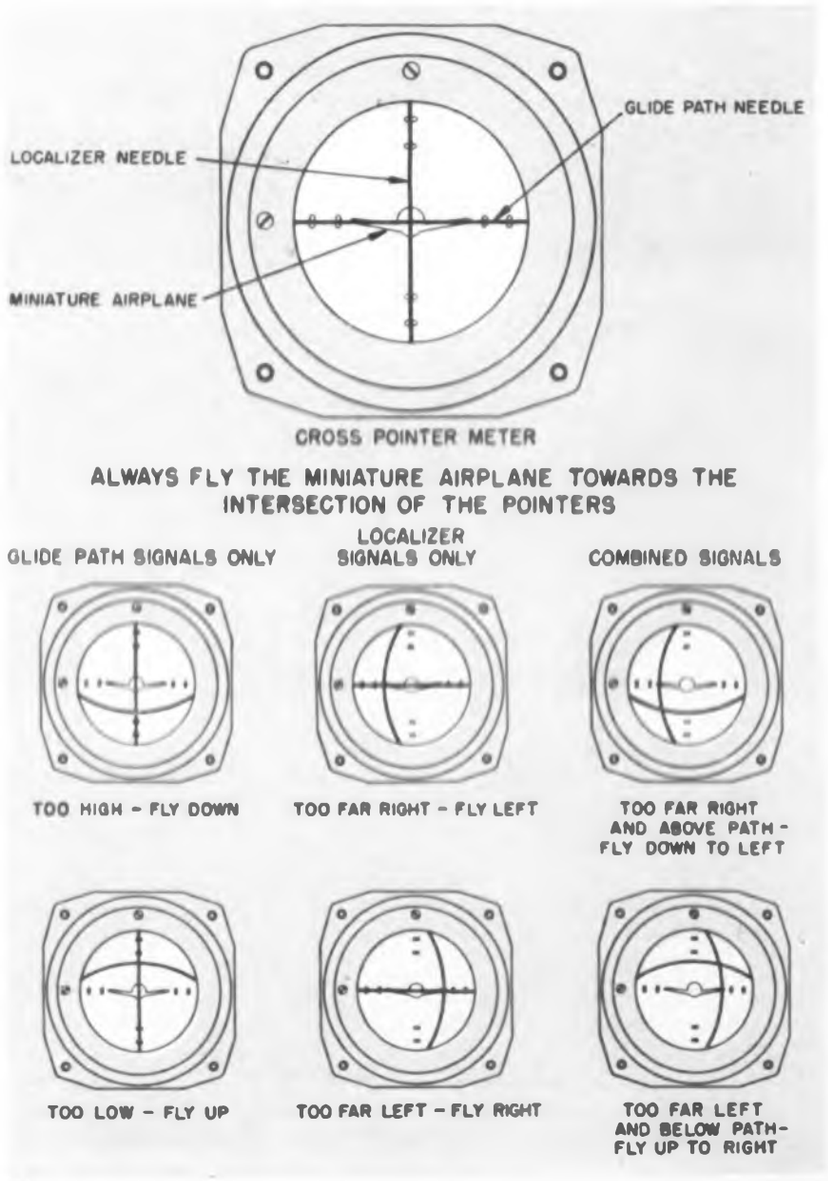
A 2K46/416 klystron multiplier is the last tube in a crystal controlled multiplier chain which serves as a local oscillator in the airplane receiver. This provides 2633 mc which combined with the transmitted signals in a crystal mixer delivers 7 mc intermediate frequency to the localizer and 16 mc to the glide path circuits.

The rest of the circuit is clearly shown in the appended block diagram. The pilot has no adjustments to make and for operation needs only to turn the receiving equipment "on" and to select the proper channel depending on the transmitting channel at the desired airport. Neon bulbs are connected to each of the meter circuits and glow when the set is functioning. Any failure in transmitting or receiving causes the bulb to go out giving warning to the pilot.

The reception antenna is a triple triple dipole in a streamlined housing on top of the plane. It has a 6 db gain over a plain dipole. The aircraft equipment has a total

(Continued on page 136)

Indications observed by pilot. Due to their design, needles are always at right angles



Face of course indicator in airplane

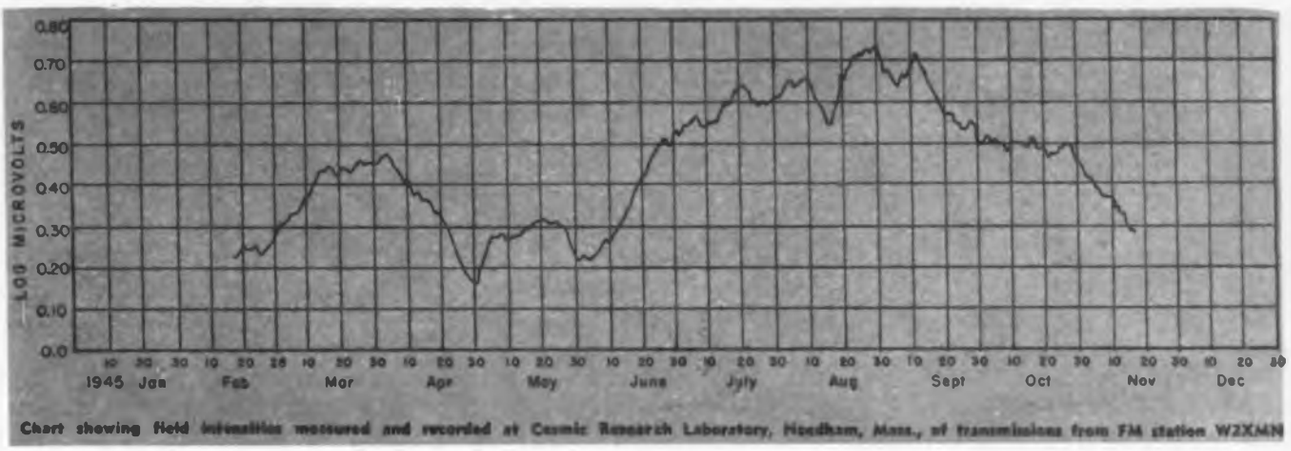


Chart showing field intensities measured and recorded at Cosmic Research Laboratory, Needham, Mass., of transmissions from FM station W2XMN

PROPAGATION EFFECTS

Scientists report on ionospheric and tropospheric transmissions and their relation to reception of FM broadcasts

● **The relative merit of FM transmission on the 40-50 mc band and the 90-100 mc band was one of the topics discussed at a conference on the ionosphere and radio wave propagation held at the Cosmic Terrestrial Research Laboratory at Needham, Mass., on December 11th. Evidence was presented to indicate that the new allocations may prove less satisfactory from the listener's point of view than the 40-50 mc band now destined to become obsolete.**

The conference was called by Dr. Harlan True Stetson, Director of the Laboratory, a member of M.I.T.'s staff of researchers and also Chairman of the Special Committee on Cosmic Terrestrial Relations of the American Geophysical Union, under the National Research Council. The purpose of the meeting was to bring together experts from universities, communication companies, radio industries, the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, the National Bureau of Standards, and the Federal Communications Commission for an informal discussion of cosmic effects influencing radio wave propogation. Among those participating in the discussions were: Major E. H. Armstrong, Dr. H. H. Beverage, C. F. Brooks, C. W. Carnahan, P. A. deMars, H. B. Marvin, F. A. V. Meinesz, H. R. Mimno, Dr. G. W. Pickard, V. Regener, Dr. H. T. Stetson, J. A. Stratton, O. G. Villard, H. W. Wells, G. Worsley, and others. Dr. Meinesz, noted Dutch geophysicist, represented the interests of his government in an "all out" post-war program for the development of the sciences in the Netherlands.

The topics for discussion, which was informal, were grouped into two general classifications, ionospheric transmission gaining attention for the morning session, while tropospheric or short wave transmission beyond the line of sight occupied the program in the afternoon. Those attending were guests of the Laboratory at luncheon.

Cosmic factors in the ionization of the atmosphere, from sunspots to meteors, introduced the morning session. The importance of the relationship between critical frequencies and the sunspot curve is well recognized in predicting wavelengths in world-wide communications. The importance of field intensity measurements made over a long period of time as a test of performance and a check on the success of predictions was made evident from exhibits presented.

The attenuation factor in long distance communications is a function of both ionic density at the reflection layer and the integrated ionization throughout the wave

(Continued on page 140)

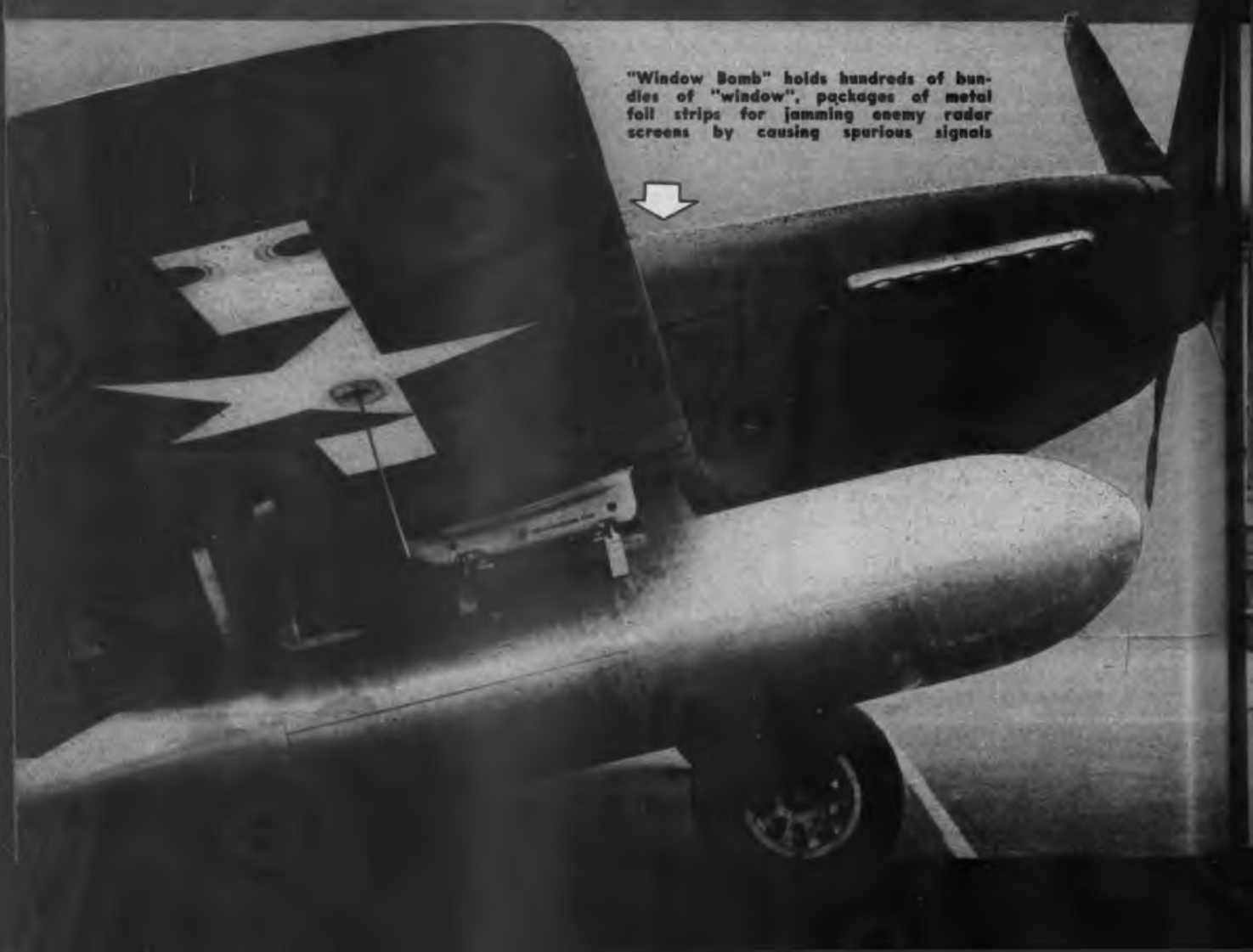
One of the field intensity recording equipments at the Cosmic Terrestrial Research Laboratory of the Massachusetts Institute of Technology used in making the measurements recorded above

Antenna for radar jammers, known as a "fishhook", radiates circularly polarized wave required to counter enemy gun-laying radar with spinning dipole

Radar search receiver picks up enemy radar signals before echoes become visible. Pilots frequently changed course, to avoid detection. Receiver covers 38-3000 mc.

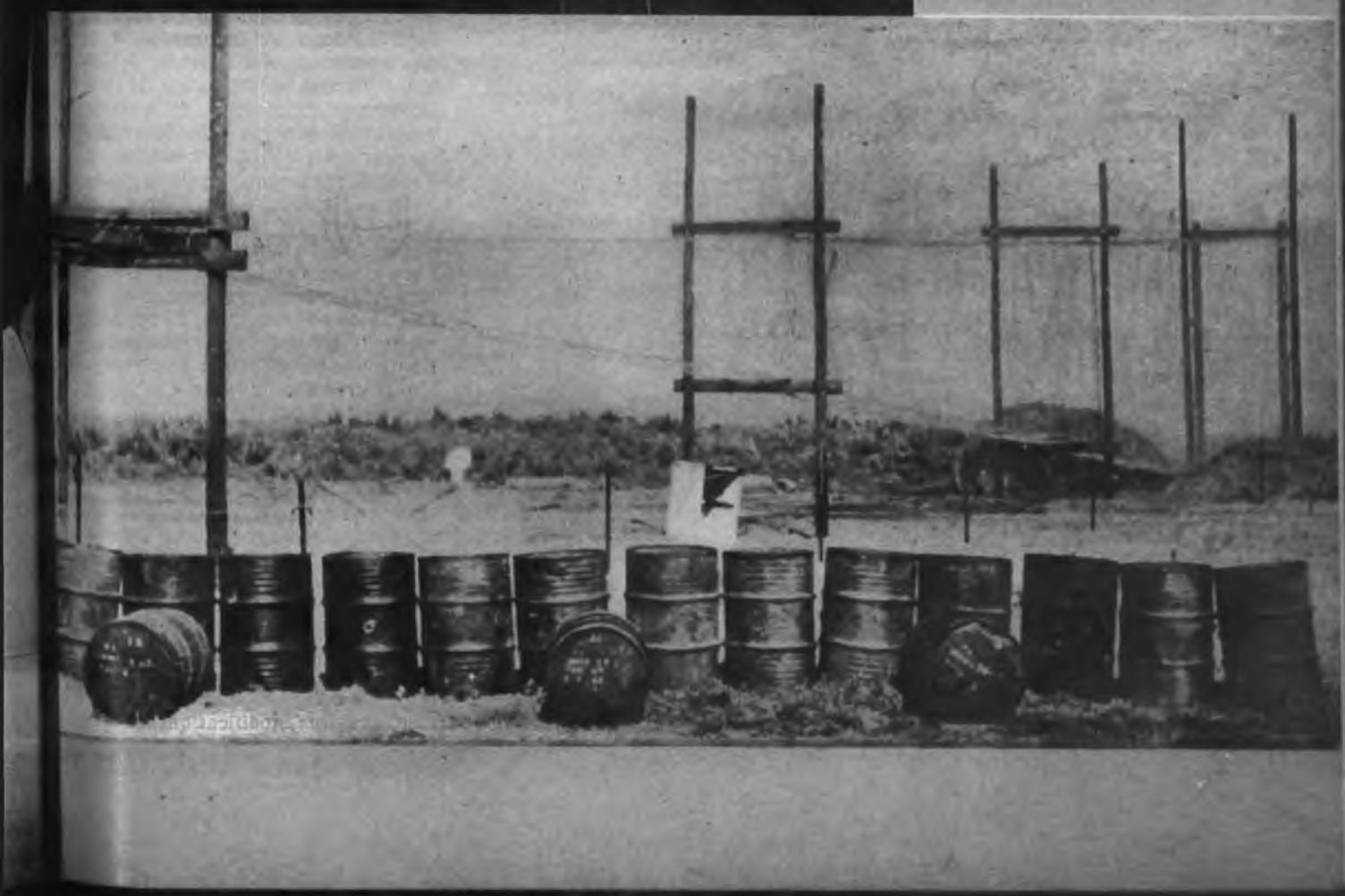
RADAR COUNTERMEASURES

"Window Bomb" holds hundreds of bundles of "window", packages of metal foil strips for jamming enemy radar screens by causing spurious signals



Packets of "window" are ejected by B-17 crewmember from a specially designed chute in the radio room of his plane. Packets opening in the slipstream, release thousands of thin strips of aluminum, jamming the German antiaircraft fire-control radars by creating false indications. Scientists at Harvard University Radio Research laboratory developed the device

Largest horn-type antenna ever built was improvised at an operating location in England for "Tuba" (see foregoing), giant jammar used by RAF to protect their bombers by blinding the radars of German night fighters. It is constructed of wire netting supported on telephone poles; the horn is 150 feet in length, with a mouth 6 x 18 feet. Birds accidentally flying into this horn were killed and cooked by the radio-frequency power



POWER MEASUREMENTS

By D. L. WAIDELICH
Naval Ordnance Laboratory
Navy Yard, Washington, D. C.

Development of two simple laboratory methods for the measurement of audio frequency power

• Power may be measured at audio frequencies by means of uncompensated commercial wattmeters within the limits of 15 to 133 cycles per second; compensated wattmeters may be obtained now that are usable in the frequency range of 25 to 3000 cycles per second. Below 15 cps and above 3000 cps, there are no commercial wattmeters available, and it is the purpose of this paper to describe two methods of measuring power that are usable down to 1 cps and up to at least 20 kilocycles per second.

The first method of measurement is the three-voltmeter method as given by Laws,[1] and it has been changed to make it more accurate and convenient. The circuit diagram used is shown in Fig. 1 where

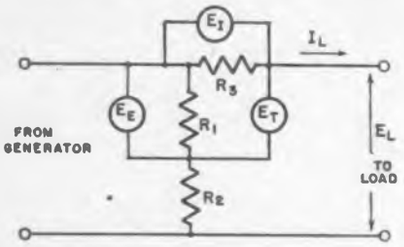


Fig. 1—Schematic diagram of the three voltmeter method

E_E, E_I and E_T are the three voltmeters. If simultaneous readings are not necessary, one voltmeter will serve to make all three readings by means of a simple switching arrangement.

The resistor R_3 is chosen to be much smaller than the impedance of the load so that the series voltage drop is small. Similarly R_1 and R_2 in series are chosen so that they are a good deal more than the impedance of the load and so that the current in R_1 and R_2 is very small compared to the load current.

The relative values of R_1 and R_2 should be so selected that the three voltages E_E, E_I and E_T are of approximately the same magnitude because this will produce the best accuracy. The voltmeters are assumed to have a high enough impedance so that the voltmeter current is negligibly small in every instance. Vacuum tube voltmeters are very useful in this connection, and it was found to measure power at one cycle per second that a new low frequency vacuum tube voltmeter incorporating the slide-back principle was quite advantageous.

[1] "Electrical Measurements", by F. A. Laws, McGraw-Hill Book Co., Inc., 1938, page 328.

Sinusoidal waveform

It is essential that the waveforms be sinusoidal, and to this end, the load voltage and perhaps the load current should be monitored by means of a cathode ray oscilloscope. If it is assumed that the series voltage drop in R_3 is small, the load voltage E_L is

$$E_L = \frac{R_1+R_2}{R_1} E_E, \qquad (1)$$

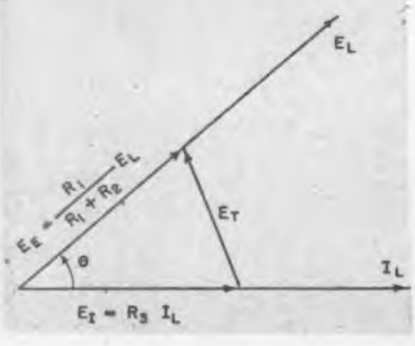
and the load current

$$I_L = \frac{E_I}{R_3}. \qquad (2)$$

The vector diagram of these voltages and currents is drawn in Fig. 2, in which θ is the power factor angle, i.e., the angle between the voltage and current. The power factor, cos θ, is then

$$\cos\theta = \frac{E_E^2+E_I^2-E_T^2}{2E_EE_I}, \qquad (3)$$

Fig. 2—Vector diagram of the three voltmeter method



and the power P is

$$P = \frac{R_1+R_2}{2R_1R_2}(E_E^2+E_I^2-E_T^2). \qquad (4)$$

By the use of an algebraic manipulation, it is possible to change the equation of the power into the form:

$$P = \frac{R_1+R_2}{R_1R_3} E_E E_I \left[1-2\frac{(S-E_E)(S-E_I)}{E_EE_I}\right] \qquad (5)$$

where

$$S = \frac{E_E+E_I+E_T}{2}.$$

As an example, a circuit was set up using the resistances, $R_1 = 100$ ohms, $R_2 = 9900$ ohms, and $R_3 = 0.5$ ohm. At a frequency of 25 cycles per second, the following readings were taken: $E_I = 0.57$ volt, $E_E = 1.09$ volts, and $E_T = 0.70$ volt. From (1) and (2) the current into the load is 1.14 amperes, and the voltage across the load is 109 volts. By the use of (4) or (5), the power was found to be 101.2 watts, and this compares with 100 watts measured on a standard wattmeter. From the calculated voltage, current and power values, the value of the load impedance and phase angle may be obtained, and these are 95.7 ohms and 35.6 degrees. The sign of the impedance phase angle can not be determined by this method without further information or tests, although in the example used the impedance actually was capacitive.

This method has its greatest accuracy at power factors approaching zero and its least accuracy near unity power factor. A modification of this method can be used if high accuracy is wanted at or near unity power factor. This modification consists of replacing the resistance R_2 with a capacitor of about the same reactance. A different vector diagram and a new equation for the power are necessary in this case, and this modification has the

AT AUDIO FREQUENCIES

disadvantage that it is suitable for use only at one frequency.

The second method of power measurement is the thermocouple wattmeter method. Sharpe[2] describes a partly compensated wattmeter that is usable at frequencies well above audio frequencies. Other thermocouple wattmeters[3] have been built for use at radio frequencies.

The circuit of the wattmeter to be described here has been changed from the ones used in these references so that complete compensation is achieved. Compensation becomes necessary in some cases, particularly at low voltages, low currents or low power factors.

The basic circuit used is shown in Fig. 3 where R_x and R_y are the two compensating resistances. The resistance R_y was used by Sharpe,[2] but for complete compensation R_x must also be used. In the following analysis of this circuit a sinusoidal waveform will be assumed throughout, although this same analysis can be carried through without this assumption. The thermocouple constant will be defined as the ratio of the output dc generated voltage from the couple to the square of the rms current in the heater.

For all practical purposes this quantity is constant except for currents above the rated values of the thermocouples. The equivalent circuit of the wattmeter is given in Fig. 4, and the currents indicated in the figure are solved for in terms of the load voltage and current, E_0 and I_0. If r_1 and r_2 are the heater resistances of No. 1 and No. 2 thermocouples, respectively,

$$I_1 = \left(\frac{R_c + r_2}{A}\right) E_0 + \left[\frac{R_c(r_2 + R_y)}{A}\right] I_0 \qquad (6)$$

where

$$A = (r_2 + R_y)(R_y + r_1) + (R_c + r_2)R_y \left[1 + \frac{R_y + r_1}{R_x}\right], \qquad (6A)$$

and

$$I_2 = \frac{R_y + r_1}{A} E_0 - \frac{R_c R_y \left(1 + \frac{R_y + r_1}{R_x}\right)}{A} I_0. \qquad (7)$$

Let K_1^2 and K_2^2 be the thermocouple constants for No. 1 and 2 thermocouples, respectively, and then

$$E_1 = K_1^2 |I_1|^2; \; E_2 = K_2^2 |I_2|^2 \qquad (8)$$

where E_1 and E_2 are the dc generated output voltages of the couples. Assume now that the load has the power factor angle θ and that the vector load voltage and current are

$$\bar{E}_0 = E_0 \cos\theta + jE_0 \sin\theta; \quad \bar{I}_0 = I_0 + j0 \qquad (9)$$

By the use of (6), (8) and (9) it can be shown that

$$E_1 = \frac{K_1^2}{A^2}[(R_c + r_2)E_0^2 + R_c^2(r_2 + R_y)^2 I_0^2 + 2(R_c + r_2)(r_2 + R_y)R_c E_0 I_0 \cos\theta] \qquad (10)$$

and from (7), (8) and (9)

$$E_2 = \frac{K_2^2}{A^2}\left\{(R_y + r_1)^2 E_0^2 + R_c^2 R_1^2 \left[1 + \frac{R_y + r_1}{R_x}\right]^2 I_0^2 - 2(R_y + r_1)\left[1 + \frac{R_y + r_1}{R_x}\right] R_c R_y E_0 I_0 \cos\theta\right\}. \qquad (11)$$

From Fig. 3 it may be seen that the two couples are connected in opposition and that the generated voltage available to actuate the microammeter is the difference of (10) and (11). This difference should be proportional to the product (E_0 I_0 cos θ) which is the power consumed by the load. This difference contains terms in E_0^2 and I_0^2 unless the following two conditions are satisfied:

1. For the term in E_0^2 to be zero

$$K_1^2(R_c + r_2) = K_2^2(R_y + r_1) \qquad (12)$$

2. For the term in I_0^2 to be zero

$$K_1^2(R_y + r_2)^2 = K_2^2 R_y \left[1 + \frac{R_y + r_1}{R_x}\right] \qquad (13)$$

With these two conditions satisfied, the generated voltage for the meter is

$$E_{meter} = E_1 - E_2 = \frac{K_2^2 R_c E_0 I_0 \cos\theta}{(R_c + r_2)(R_y + r_2)} \qquad (14)$$

and

$$A = 2(K_1/K_2)(R_c + r_2)(R_y + r_2).$$

The current flowing in the meter is equal to this generated voltage divided by the sum of the resistances of the two couples and of the meter itself.

Using the design equations given above an actual 300-watt full scale wattmeter was designed with commercially available thermocouples. The thermocouples used had a nominal heater resistance of 15 ohms, a couple resistance of 12 ohms and gave 10 millivolts dc for a current of 22 milliamperes ac with a maximum heater current of 44 milliamperes. This corresponds to a thermocouple constant of 20.6 which was found to hold up to the maximum current.

The wattmeter was rated nominally at 2 amperes and 150 volts.

[3] "Note on the Construction and Use of the Thermal Wattmeter" by B. A. Sharpe, Journal of Scientific Instruments, Vol. 10, pages 318-321, October 1933.

[2] "Direct Reading Wattmeters for Use at Radio Frequencies" by G. H. Brown, J. Epstein and D. W. Peterson, Proceedings of the Institute of Radio Engineers, Vol. 31, pages 403-410, August 1943.

Fig. 3—Schematic diagram of the thermal wattmeter

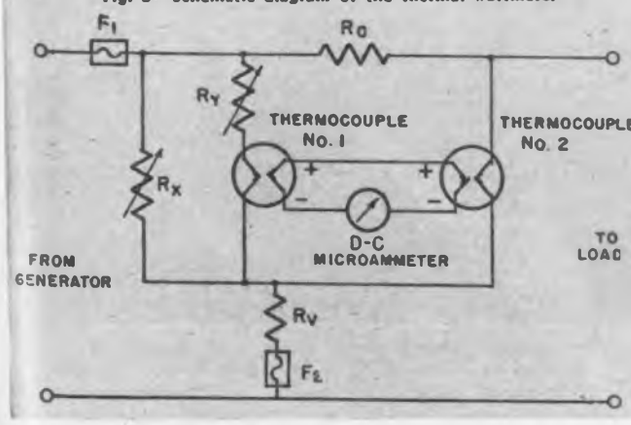
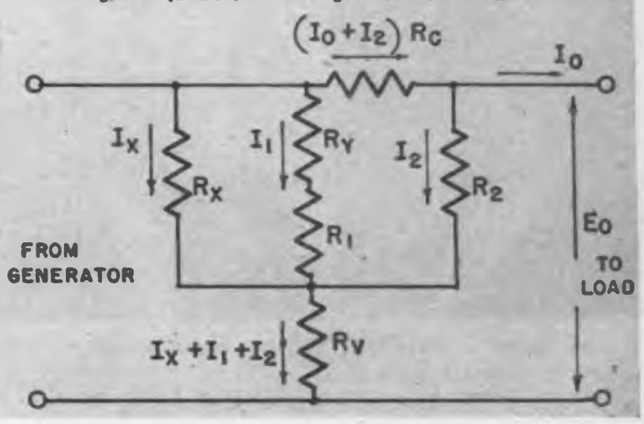


Fig. 4—Equivalent circuit diagram of the thermal wattmeter



With a current of 2 amperes flowing through R_c and no voltage across the load, the current through the thermocouples should be one-half the maximum value or 22 milliamperes. This corresponds to a resistance $R_c = 0.33$ ohms which was found experimentally to be higher than needed. The value used was $R_c = 0.15$ ohm and consisted of a length of resistance wire.

Similarly if the load current is zero, but the rated voltage of 150 volts is across the load, the current through each thermocouple should again be 22 milliamperes corresponding to $R_v = 34{,}200$ ohms. This was a precision wound resistor and had approximately this value of resistance although it was adjusted slightly to make the meter scale read exactly 300 watts full scale.

The thermocouples should be insulated for best results, although it is possible to use one insulated and one uninsulated thermocouple. From the analysis it may be noted that neither the heater resistance nor the thermocouple constant need be matched, and hence it is possible to use any two unmatched thermocouples providing that their ratings are approximately the same. The thermocouples having the smaller heater resistance should be chosen for $\sqrt{1}$ since the compensating resistance R_y is approximately equal to $(\sqrt{2} - \sqrt{1} + R_c)$. This was chosen to be a wire wound rheostat of 10 ohms. The other compensating resistance R_x was practically equal to R_v and was chosen as a 200,000 ohm rheostat.

The microammeter used had a 30 microampere full scale and 50 ohms resistance. The selection of this meter was dictated by the voltage available as calculated from equation (14) and the combined resistance of the two couples and of the meter itself. Two fuses were used to protect the thermocouples from overloads as shown in Fig. 3. Fuse F_1 was a three-ampere size, while F_2 was a $\frac{1}{16}$-ampere instrument fuse.

To satisfy the two conditions (12) and (13) so that the microammeter reading is proportional to the wattage taken by the load, it is necessary to adjust R_x and R_y. The resistance R_y should be adjusted first, and this is done by open-circuiting the load, applying rated voltage, and adjusting R_y until the microammeter reads zero. If it will not reach zero, the trouble may be that R_y is not large enough or that the thermocouple with the larger heater resistance is in the No. 1 position rather than the No. 2 position.

Next, to adjust R_x, the load should be short-circuited and only enough voltage applied to the input terminals of the wattmeter to cause rated current to flow in the load. The resistance R_x should then be adjusted until the microammeter again reads zero. Adjusting R_y to satisfy the first condition is particularly important for a high voltage, low current wattmeter, while for a low voltage, high current wattmeter, satisfying the second condition by adjusting R_x is more important.

The wattmeter was tested on a variety of loads with leading, lagging and unity power factors, and the errors were always less than two per cent. It is believed that with more care in the selection of the components, maximum errors under one per cent may be achieved. Frequencies between one and 20,000 cps were employed, but it is believed that the wattmeter would be usable at much higher frequencies limited principally by the inductance and capacitance of the various circuit elements.

This wattmeter has the advantage that it may be made into a recording wattmeter through the use of a suitable amplifier and recording voltmeter or milliammeter.

The advantages and disadvantages of the two methods may be summarized as follows:

Three voltmeter method:

Advantages

1. Usable at all frequencies.
2. Can be improvised easily.
3. Stands overloads well.
4. Measures voltage, current and power at the same time.

Disadvantages

1. Three readings plus a calculation necessary.
2. Not direct reading.
3. Lowest accuracy at unity power factor.

Thermal wattmeter method:

Advantages

1. Direct reading.
2. Usable over wide frequency range.
3. Thermocouples need not be matched in any way.
4. Can be used as a recording wattmeter.

Disadvantages

1. Sluggish response.
2. Microammeter used is not rugged.
3. Will not stand overloads well.

ENGINEERS WHO ADDRESSED IRE WINTER TECHNICAL MEETING

DR. FRANK B. JEWETT
President National Academy of Sciences

EDGAR KOBAK
President Mutual Broadcasting System, Inc.

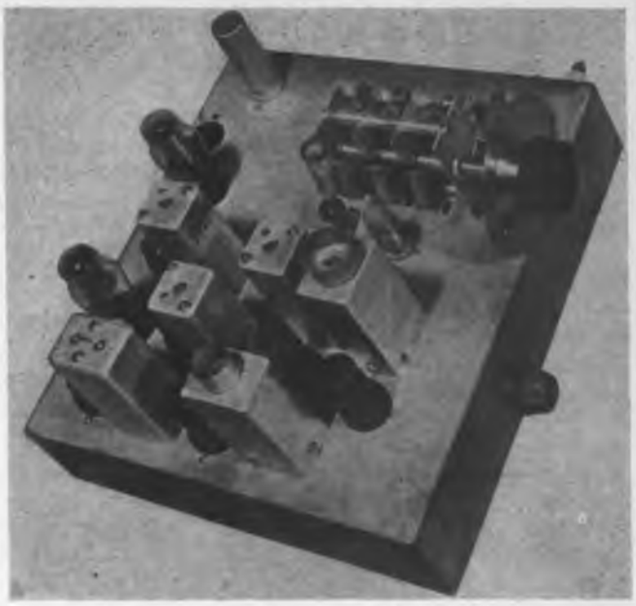
LEWIS CLEMENT
Research-Engineering V-P Crosley Corp.

PAUL PORTER
Chairman Federal Communications Commission

LABORATORY RECEIVER

By **WM. F. FRANKART**
Radio Design Engineer
1429 East 125th Street, Crompton, Calif.

Providing extreme stability and sensitivity for rapid and accurate checks of high and low frequency FM and AM



Top view of the AM-FM high stability receiver showing arrangement

• The purpose in building this laboratory receiver was to have on hand a receiver that could be used for a number of purposes. A receiver was needed in the VHF range that was suitable for the determination of maximum frequency and maximum phase deviation and of the mean carrier frequency tests as suggested by Crosby.* Since no commercial combination AM-FM communications receiver is selective enough on the AM side to be useful in determining maximum frequency deviations this receiver was built.

A receiver was needed for field tests in conjunction with transmitting equipment. This receiver had to be stable, that is, no frequency drift, of known sensitivity, selectivity, and provide for rapid changeover from FM to AM for communications reliability comparisons. That is, tests were being conducted to directly compare FM and AM for reliability of communications over actual operating conditions.

A receiver was also needed to receive WWV on 15 mc for frequency measurement purposes. This accounts for the low frequency receiving end of this design.

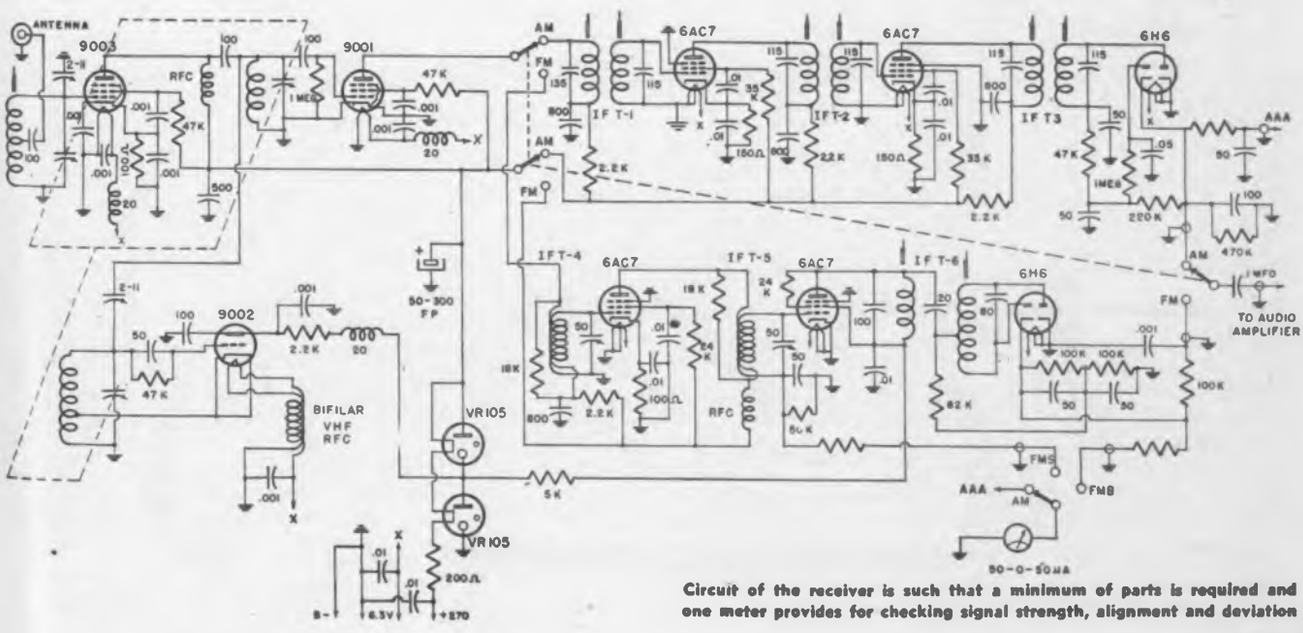
This receiver was used in field tests over the Los Angeles area. Its performance was satisfactory and much was learned as to the AM-FM question. The purpose of this article is not to discuss the relative merits of the two types of modulation but to give a little data on a receiver that proved its worth and in this way, it is hoped, bring about some good ideas.

As cost was no item, all capacitors possible were either silver mica, or mica, plug-in coil forms were polystyrene, sockets were ceramic and some were mica filled bakelite. All insulations were at least equivalent to mica filled bakelite. Along with these high quality parts, proper circuit isolation was obtained as can be seen from the schematic. The above reasons were largely responsible for the stable characteristics of this unit.

The FM-if transformers are of particular interest. The first two are bifilar wound. By using this type of winding certain advantages

(*Continued on page* 144)

*Pages 85-87 Hund, Freq. Mod.



Circuit of the receiver is such that a minimum of parts is required and one meter provides for checking signal strength, alignment and deviation

PROGRESS DEPENDS ON

By DR. JOHN ALBERT STOBBE
Electronic Consultant
63 Wall Street, New York

The coming race for the survival of the fittest emphasizes the importance of putting engineering up at the head

● Engineering can make or break a company. Any electronic manufacturer's management will agree with that statement. I sometimes wonder, though, how well most of them have thought it through. Before the war different companies paid varying degrees of attention to engineering and, although the operating results of any particular company did not always show profits directly in proportion to its engineering budget, it usually was found that a company's permanency was related to the wisdom of its engineering expenditures.

Engineering in our industry covers a lot of ground. Of course, prewar, wartime and postwar conditions differ sharply. I believe they differ even more sharply in more ways than most people realize. For instance, a man used to go out and hire a secretary and an "engineer" and start to make radio sets. While he was doing this—and quite often profitably — another company was doing its engineering job all the way through from physical and pure research to sales engineering and field technical assistance.

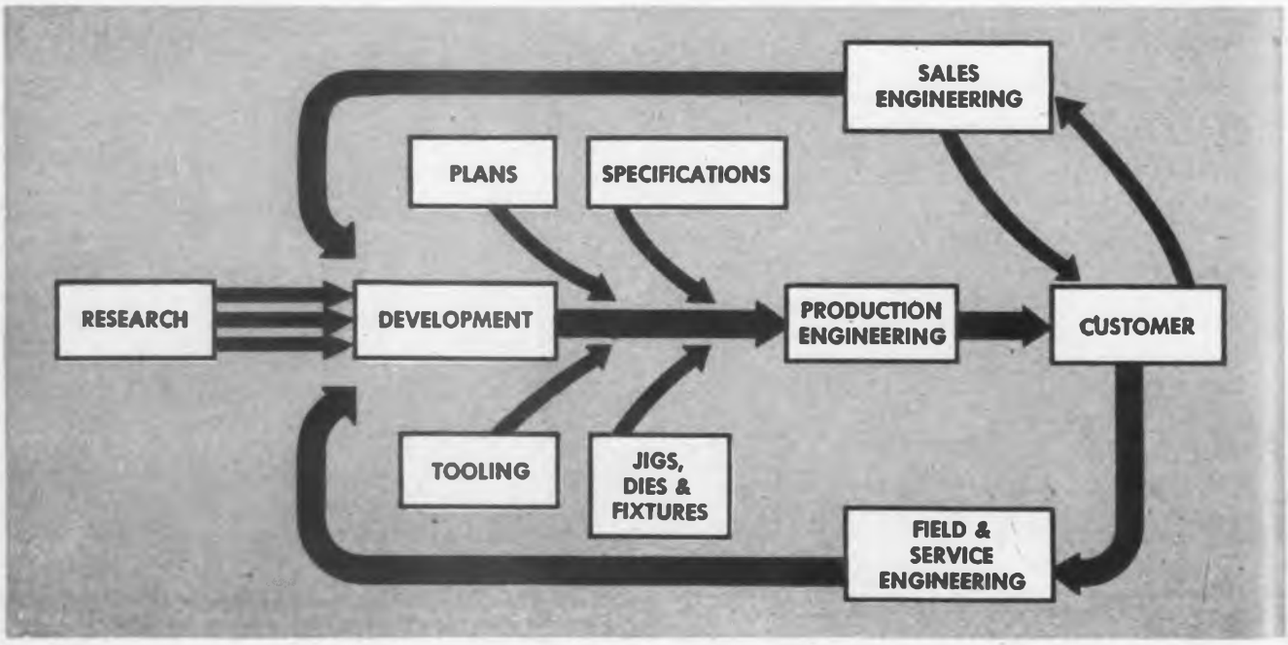
A full study will show that business mortality in our industry, barring dishonest practices and quasi-insane expansions, of which we have had enough of both, occurred quickest in those enterprises which had inadequate, faulty or unbalanced engineering. The few instances of survival among the "hole in the wall" units were the result of special abilities and talents.

The rules change

Now when the war came along the rules were changed. Certain laboratories did basic design work. The team of university laboratory, industrial research and development section, and government or service branch technical group has been basically a new method of attack. The designed equipment, reasonably completely specified and turned over to a production company, has provided an opportunity for a manufacturer with only "production engineering" to prosper greatly. But this situation is a war time phenomenon and cannot last except in specialized fields such as Civil Aeronautics Authority equipment, etc. It is not the postwar high road to profits in our industry.

For example, before the war a few companies made a few quartz crystals. Airlines, broadcasting stations and some amateurs were the customers. The amateurs with their advanced stable variable frequency oscillators had all but abandoned the piezoelectric control method. Came the war with its heavy crystal demands and the expansion measured in thousands of per cent. The Signal Corps and a few notable old line manufacturers produced, by detailed guidance and specification work, an industry of more than one hundred companies grossing in the $100,000,000 region.

Some of these companies now



SOUND ENGINEERING

think they have engineering, but have they? More important, will a dozen or twenty survive and, if so, what can be their market unless they become engineering conscious? This is an example. We could add on and on—for instance, transmitting tubes, cathode ray tubes, patented connectors—all to show the abnormalities existing and as any thinker knows, much plunging ahead heedless of the danger signs.

As the saying "a better mousetrap" so goes our future. No one is going to play Santa Claus in postwar competitive markets. What a company builds and sells must be better to give its seller a permanent future. A big bass boom and lots of advertising flash and sales drive may sell sets for a few years, but unless sound thinking exists underneath, the newcomers with the wonderful plans will go broke just as quickly and completely as the big bass booms of the late '20s fared by the cold appraisals of the '30s. And that was only a repetition of '24-'25.

Base for permanency

The radio names of the teens are as completely gone as the automobile names of a decade earlier. Even the big names of '20, '21 and '22 are dead. Only one real base for permanency exists and that is sound, realistic and advanced engineering. That, all other things being equal, will make or break any company.

It would be impossible in an article even to outline what engineering should do for a medium-sized company. That would take a book with divisions and chapters, such as, the broad objective, the budget, pure and applied research, development, pre-production, production, field, sales, management, and interdepartmental cooperation. What can be done in an article is to stimulate thinking and to hit a few neglected broad ideas.

To me, the two biggest things that an engineering department in one of our companies should do are to keep ahead of the parade and to design for low cost manufacture. If we take each of these objectives apart a little it will be worthwhile.

How simple it sounds to say "to keep ahead of the parade." It isn't simple to do but the more you try the closer you come. It is all right to study the competitor's product, but if you have to copy—even one little screw—you have been lagging. Your customer, not your competitor should design your product!

Right here we stand at the point where management of the largest companies can take one direction, but medium and smaller companies must plan differently. The largest companies sometimes can afford to design a product and then let the customers see it. This is because enough advertising and sales razzle-dazzle actually can cover inferior engineering. But it is an expensive and dangerous gamble at best as any honest advertising agency will attest.

Development lags demand

The medium or smaller company must avoid this sort of thing or share the fate of the phonograph companies of two decades ago. The very thing we are writing about, then was neglected—not only by a company but by an industry, to its wrecking. There is no basic reason why today's radio phonograph could not have been developed by one of the big phonograph companies of the early twenties. They were designing what they wanted to sell and not what the public wanted—each being very careful not to get too far ahead of competition. Engineering content of a spring-wound diaphragm type phonograph was ludicrous in its absence. And the industry—and public security holders—paid.

The approach must be different for a producer of components for use in further manufacture than for a producer of consumer goods sold directly—or through jobbers and dealers—to the public.

The producer of components should have his engineering group practically haunt his present or potential customers. The producer knows what he can or maybe can't make and can guess what it will cost. The assembling company customer's engineers know what they want but sometimes—often—by ignorance or bliss don't seem able to realize about things like standardization, costs and efficiency of adaptation. The producer plus customer engineering team can't be beaten by an ivory tower dreamer.

Build on quality

Get your engineers out in circulation and see how fast they learn some production practicalities and see how much less they know than before they talked it over with George out in Chicago. If you have the kind of engineers who know too much or too little to do that then hire some more quickly—because life and the hereafter depend on it.

The old line producer for the consumer knows all about customer reaction from what his advertising agency with its "test area" technic tells him. The new aspirant for the "rainbow" market does, too. The difference is that the old line man did a lot of dumping in the "thirties" and believes less than half of what he is told. Maybe that's why he survived. Anyway get around and look, and at least get one or two sales engineers who have been through the mill. Distributors and dealers are coyly cute when things that look like shortages exist. Only a firm base of quality will ride the inevitable storm. Unless building on that base begins now, it may be too late.

"Design for low cost manufacture" is the other part of it. Do it yourself, the work I mean. Industrial designers and engineers may look like a happy solution because "we're too busy" but how many times do they turn out even as good a job as half the cost spent on in-plant engineering.

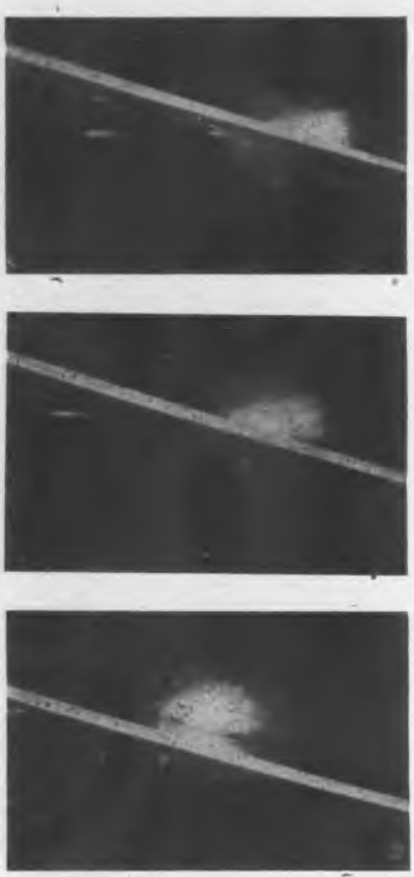
SEVEN ENGINEERING STEPS TO WATCH

1. Look your engineering over.
2. Strengthen it even if you have to go to extremes.
3. Bring in trained ex-service men.
4. Get your engineering together with your customers and distributors.
5. Get after those cost reduction programs now.
6. Standardize with and for your customers and not your competitors.
7. Work hard and be honest—and survive.

ELECTRONIC TIMING OF

By CHARLES H. COLES
Captain, Air Corps, Wright Field, Dayton, Ohio

High intensity flashes of 2 microseconds duration are triggered in sequence by unblocking amplifier tubes



Sequence of flashes of a .50 cal. projectile stream being fired from a machine gun through a plate mounted at an angle. The extremely short time of the flash effectively "stops" the motion so that a clear picture is obtained. In 2 microseconds a projectile going 2,400 ft./sec. only travels .058 in.

● In an effort to measure velocity changes in projectiles, the necessity for a flexible and rapid sequence timer arose. This was required to trigger flash lamps for a series of photographs which show the position of a flying bullet at known intervals of time. A device was required that would produce pulses in a set of six circuits in rapid sequence. At first a high speed commutator was built, but the inflexibility of this method led to the construction of an electronically controlled instrument.

The sequence timer as developed in the laboratory of the engineering division of the Army Service Forces Material Command is capable of firing from two to six microflash lamps. The time interval between the first and last flash may be adjusted from 0.57 seconds to 0.00035 seconds. During this time interval all six lamps may be fired in any kind of sequence desired with either equal spacing between flashes or irregularly spaced flashes. At the highest speed, the timer will permit six pictures to be taken of a 50 caliber projectile before it has moved more than four times its own length.

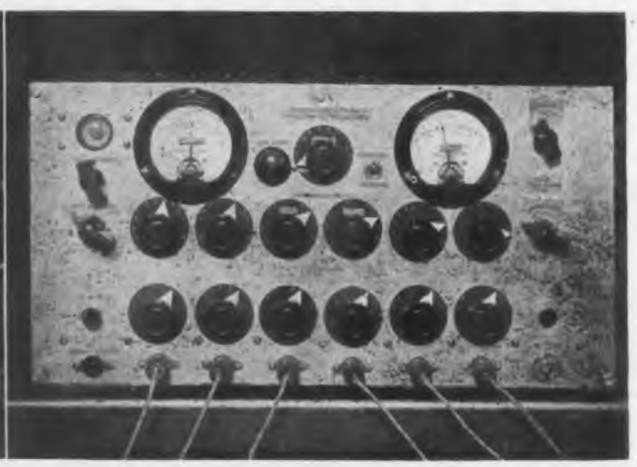
Microflash units are vacuum-tube flash lamps which produce a flash of light of extremely short duration by means of a condenser discharge. The flash is used as a light source to photograph bullets in flight or any other high-speed mechanical action. While a single flash will show any particular stage of an action, such as a projectile entering armor plate, several successive photographs are essential when determining the velocity of a projectile, before and after penetrating the armor plate. Successive stages of the bursting of a turbo-supercharger rotor are also within the range of possibilities of such a sequence picture apparatus.

The circuit that was used as a basis for the timer was published in the Review of Scientific Instruments, February, 1941, by R. G. Loeffel of Washington University. The relaxation oscillator used a neon lamp in the original circuit as published, but this was changed to use a strobotron, a more controllable form of discharge tube. For purposes of calibrating the dial settings, a vacuum tube voltmeter was added to measure the grid bias applied to the first tube of each of the amplifiers. Six channels were built into the timer to trigger six microflash units.

The basic circuit is essentially a triangular wave generating circuit connected to six amplifiers whose sensitivity can be adjusted by grid bias control. When each amplifier is set to a successively lower voltage response, the outputs will be activated in turn as the triangular wave voltage rises across the input grids.

The output of each amplifier

Set up used by the author in making pictures in rapid sequence. The six microflash lamps are shown at the left and the panel at right



SEQUENCE PHOTOGRAPHS

feeds into the thyratron control grid of a microflash unit. These units produce a flash of light with a duration of about two microseconds. The flash is used to photograph a bullet in flight. By making one flash from each of six units, a bullet may be photographed in six successive phases of its flight. If the time between the flashes is known, measurements of distance on the photographs will determine the velocity of the bullet between images.

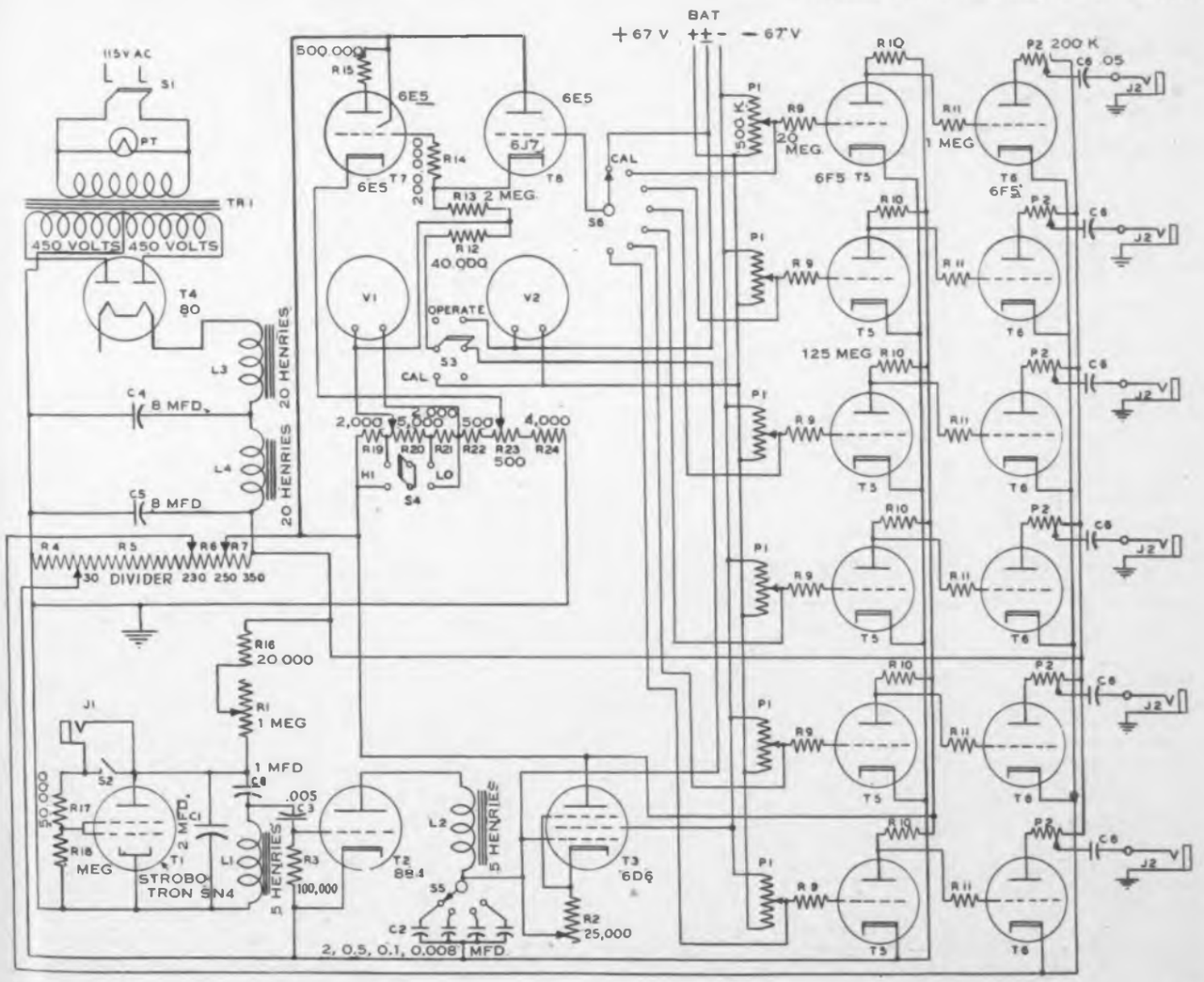
To make the photographs, the units are grouped near the target. An ordinary press camera is set up near the target and focused on the position where the bullet is to be photographed. When all is in readiness, the lights are extinguished on the enclosed gun range and the shutter of the camera opened. When the gun is fired, the bow wave of the bullet crossing a microphone initiates the action of the sequence timer. The timer fires the lamps in succession, six flashes of light illuminating the bullet in six successive positions.

Referring to the circuit diagram, a capacitor C_2 is charged linearly through the pentode T_8 to a voltage dependent upon the plate voltage applied to the pentode. When the capacitor is charged, it remains so until the strobotron T_1 fires, whereupon the grid of the gas triode T_2 is made positive, causing the tube to become conducting and discharging the capacitor C_2. The capactor C_2 starts to charge again, causing the voltage across it to rise at a rate determined by the resistance R_2 and the size of the capacity C_2. The same voltage is applied to the grids of the six amplifiers.

These grids are biased negatively at various voltage levels by means of the batteries connected to —±+ and the potentiometers P_1. When the rising voltage reaches the critical point where it causes a particular amplifier tube T_5 to become conducting, the amplifier produces a pulse in the output circuit to its microflash unit. By imposing a different grid bias voltage on the tube of each amplifier, the amplifiers will produce pulses successively as the voltage rises.

When making pictures of high speed mechanical action, the equipment must be used in a darkroom or out-of-doors at night because the camera shutter is left open during the action. The exposure time is determined by the duration of the flash which is fixed at 2 microseconds. Only one flash from each unit is utilized because it

Circuit diagram used for controlling six lamps. Rising positive voltage across C_2 as it charges successively fires differently biased 6F5 tubes



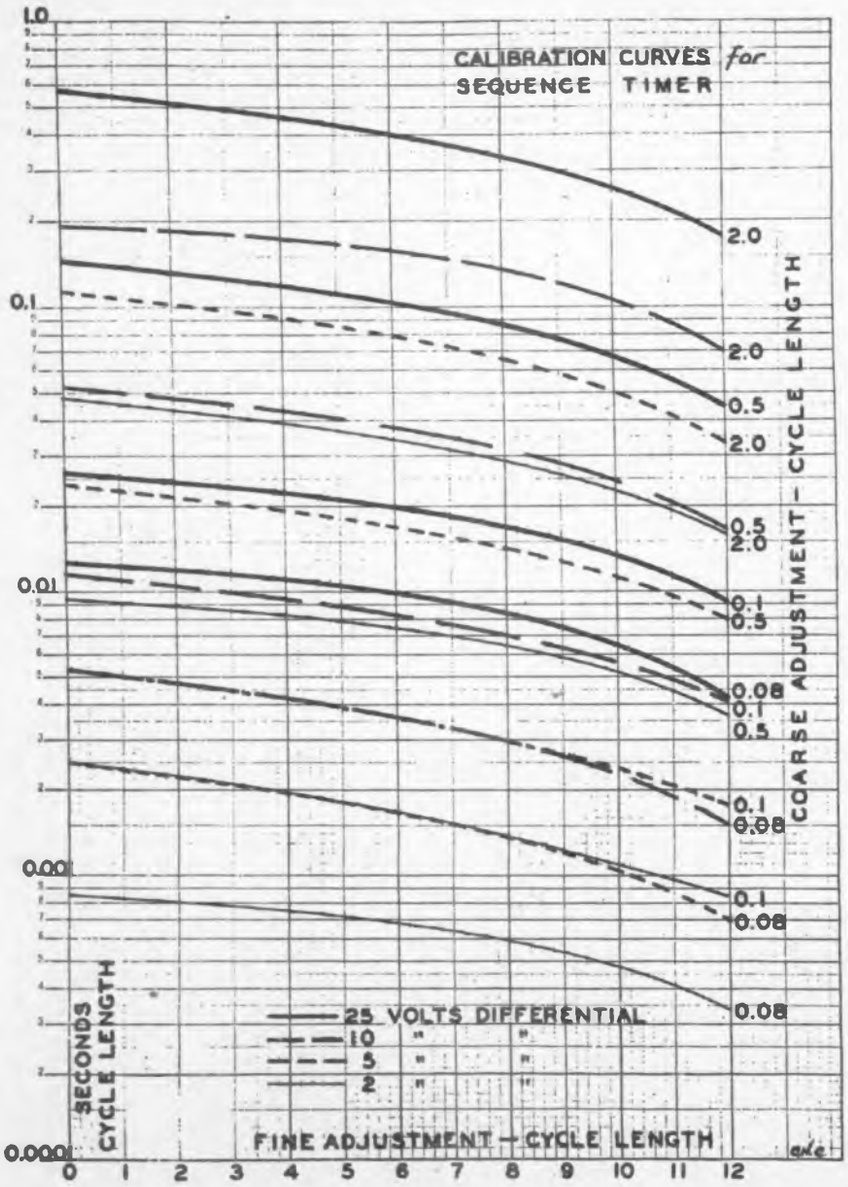
By taking pictures on one film of a rapidly revolving wheel the unit can be calibrated

takes two or three seconds for the microflash units to recharge, a time usually far in excess of the phenomena being recorded.

The calibration curves of the sequence timer were obtained from experimental determinations. The flash units were directed toward a disk driven by an electric motor. The disk revolved at 1770 rpm and had an arrow painted near the edge. The stationary ring surrounding the disk was divided into 20 parts. By observing the position of the images as revealed by the flash, the time between flashes may be determined.

The curves were made by observing the time spacing between the first and last flash of the series of six. Five points were taken for each curve. The setting of the coarse adjustment — cycle length used for each individual curve is indicated at the right hand end of each curve as the size of condenser in the circuit. The time in seconds between the first and last flashes is indicated along the left side of the chart.

Calibration curves can be drawn for a unit based on information obtained with the disc



After the time interval required between the first and last flash has been decided upon by reference to the speed of the phenomenon to be photographed, this figure is found along the left side of the chart. Following this horizontal line to the right to where it intersects a curve, the number at the end of the curve is noted for the setting of the coarse adjustment — cycle length. By dropping down at the point of intersection to the bottom of the chart, the setting of the fine adjustment— cycle length may be read. Usually more than one combination may be set up, but it is advisable to use those in the mid-range of voltage differentials: i.e., 5 or 10 v. These settings produce more easily controllable results.

By means of the vacuum tube voltmeter, the various grid voltages of the amplifiers are set at successively higher voltages as indicated by the calibration curve in use. With the setting of the cycle length adjustments, the sequence of flashes within the required time will follow upon the closing of the initiating contact.

The disk pictured is 12 in. in diameter but there is actually only one arrow-head painted near the edge of the disk and one radial line painted from the center. The disk, a camera pointed at it, and the lamps also directed at the disk, were set up in a darkened room. After the disk started revolving, the camera lens was held open while the sequence timer was set into operation. The successive flashes of the microflash lamps recorded six images of the single arrow-head.

The disk is revolved by an electric motor at 1770 revolutions per minute. Each revolution represents $\frac{60}{1770}$ or 0.0339 second. Each of the 20 divisions represent $\frac{0.0339}{20} =$ 0.0017 second.

In the photograph the first and last flash are 2½ divisions apart or 2.5 x 0.0017 = 0.0042 second. The time interval between flashes is 0.5 x 0.0017 = 0.0009 second. For the shortest time spaces, a 10,000 rpm motor may be used.

The greatest difficulty encountered with the operation of the instrument was not with the timer but with the excessive sensitivity of the microflash lamps. The negative grid bias on the thyratrons was increased considerably before stable operation was obtained.

REMOTE TUNED ANTENNA

Motor-operated extensible members of rotatable dipole provide for covering range between 46½ and 215 mc

Television receiver engineers know that installation of antennas in metropolitan areas presents difficult problems, which are daily becoming more complex.

Technical opinion is largely agreed upon the conclusion that it is not possible to set up a dipole antenna in mid-town New York which will receive satisfactorily from more than one station without adjustment. However, if provision is made for orienting the antenna when desired, reception may be realized from the three stations.

A major complication encountered with fixed antennas is reflection, leading to ghost images, which can be largely eliminated by proper antenna orientation. It has been determined that in special cases, it is of advantage to tune the antenna for optimum reception.

Such an antenna, which may be both oriented and tuned by remote control has been developed, and is illustrated. It is a horizontally polarized assembly, containing two motors and associated mechanical trains.

In operation, the antenna is rotated in azimuth, and the dipole arms extended or retracted until the strongest direct signal is received with the reflected signals attenuated to the greatest possible extent.

The antenna has a three-section arm extension with a frequency range of two and one-half to one, from 46½ to 117 mc has been developed by Farnsworth Television and Radio Corp., Fort Wayne, Ind. Extensible members of the dipole are designed as three sections of telescopic tubes, controllable from 26 to 66 in.

Motor assemblies have been specially designed for the application, and mechanical details of the design of a two-section antenna are illustrated. Four push-buttons on a control board allow the operator to control motor rotation from a remote position. An automatic stop limits the angle of rotation to plus or minus 190°, so that the antenna cable will not be twisted beyond its elastic limit.

The smaller antenna has two sections of telescoping tubes, with a frequency range of 1.8 to 1, from 46½ mc to 85 mc. Length of the antenna may be varied from 36-in. to 66-in. Should a greater frequency range be desired, additional telescopic sections may be installed. A five-section antenna, for example, affords a frequency range of 3.6 to 1, from 46½ to 167 mc.

With N sections to the extensible member of length L, with mechanical overlap b, the approximate tuning range is to be:

$$R = NL/(N_b + L)$$

and substitution of values for the three-section antenna gives:

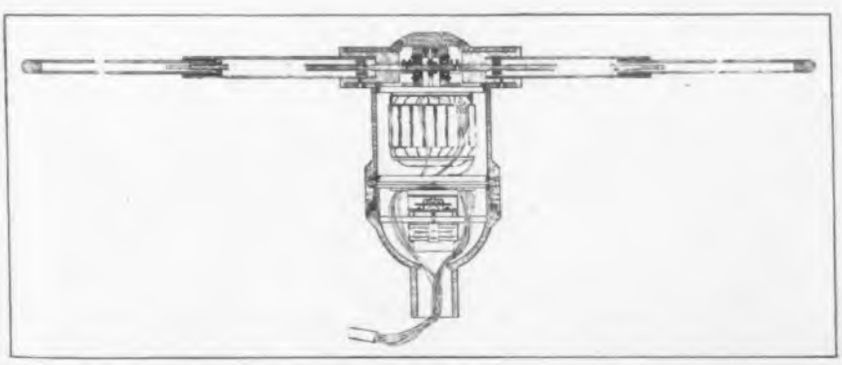
$$R = 3x26/(3x1.5 + 26) = 2.56$$

The number of sections required to cover a tuning range greater than this goes up quite rapidly with the range. The top frequency determines the value of the section L. For example, it requires four sections for a tuning range of three, if the top frequency is approximately 215 mc.

A simpler antenna design features orientation control alone, since the tuning control may constitute unnecessary complication in some installations.

The theoretical resistance of the antenna varies from 36 to 160 ohms, and works into a 95-ohm twinax line. Using 170 feet of line to the receiver, matching has been found satisfactory for all channels in group A.

Receivers having various input impedances not matched to the line have been used, with good results. Experiment shows that orientation is a far more important factor in "ghost-free" reception, than mismatch between dipole, transmission line, and receiver input.



Above is a cross sectional view of the tunable rotable antenna showing location and connection of the two motors. Right is a general view of the antenna as it appears when installed

CONCENTRIC LINE FM

Use of miniature tubes and push pull circuits simplifies frequency multiplication, stability and modulation problems

● First of the new FM transmitters, unveiled at a time when the engineers of FM stations all over the country are wrestling with problems involved in converting to the recently newly designated 88-108 mc band, reveals a number of features uncommon in such equipment and for which considerable advantage is expected:

1—In order to obtain efficient operation in all stages at the higher frequencies, linear elements of the concentric line type are used in tank circuits.

2—Easily obtainable miniature and other forms of high frequency tubes have been used.

3—An electro-mechanical means is provided to insure exact maintenance of center frequency control.

In designing the transmitter, which carries a rating of 250 w output, engineers of the Transmitter Equipment Mfg. Co., New York, have had in mind the difficulty of finding tubes which could be operated at about 100 mc and still would be capable of furnishing the desired power. Since 250 w tubes are available, this power was selected for the transmitter with the thought that it could serve as a driving unit for future larger tubes if more output were needed.

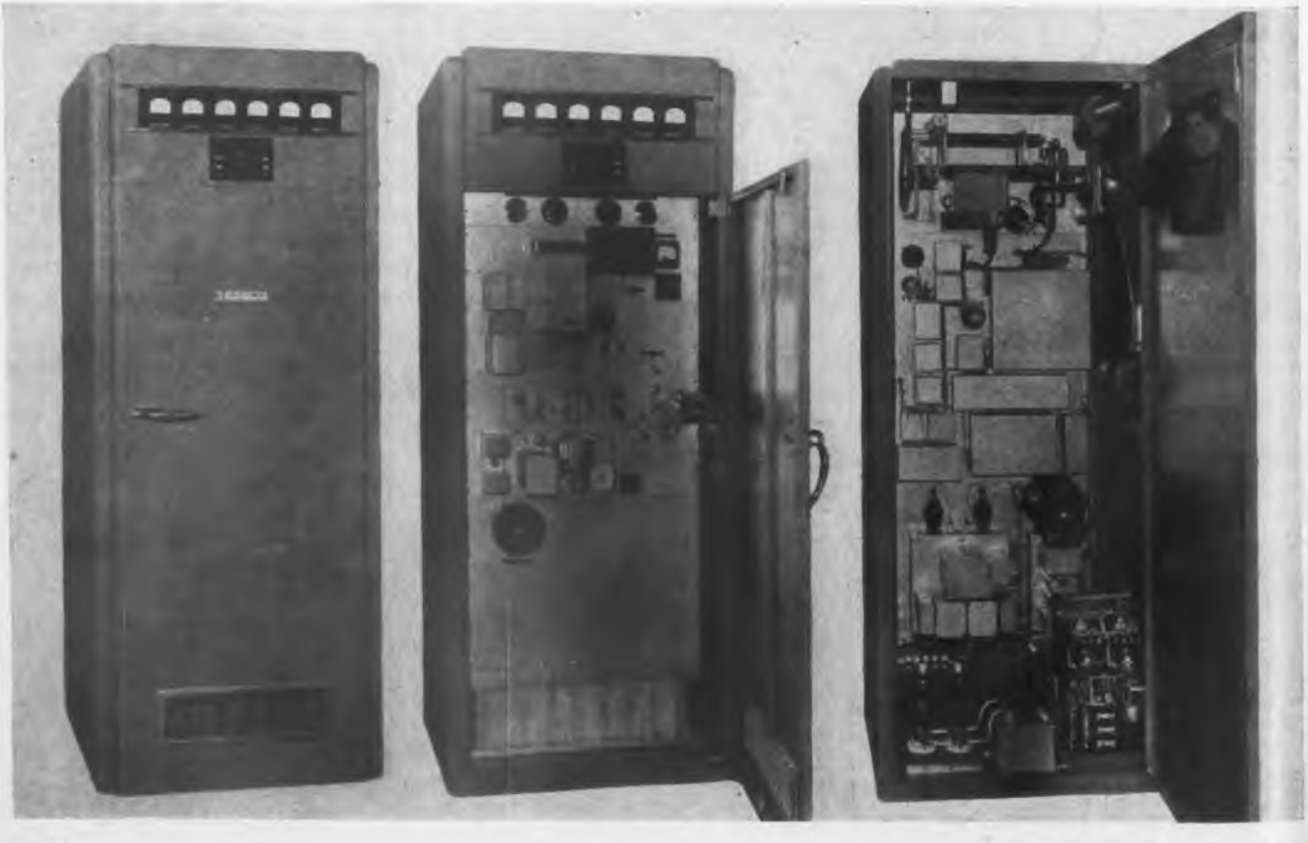
Consistent, stable, center-frequency control of the primary oscillator is a prime consideration. The method used is to incorporate in the set the usual crystal controlled oscillator as a reference standard. The primary working oscillator, the source of the frequency modulated carrier, is continuously monitored by the crystal oscillator.

This supervision of the center-frequency is effected by an electro-mechanical system which makes use of the fact that two carriers differing in frequency by a small amount may be considered to phase-modulate one another. The amount of phase modulation of either carrier is determined by the relative amplitudes of the two carriers, and the value of the beat difference between them.

Outputs of the primary oscillator and the standard crystal oscillator are fed to two mixer stages. One mixer yields the AM audio components; the output of the other mixer is fed through limiters and is followed by a discriminator from which FM audio components are recovered. These AM and FM voltages are applied to a phase detector.

Relative phase of AM and FM audio voltages depends upon the sign of the beat difference between the standard crystal oscillator ref-

These three views of the new Temco model 250BCF 250-watt FM transmitter for the 88-108 mc band show its appearance with the front door closed, with the door open revealing essential tuning controls, and from the back which gives access to the oscillator circuits, modulators, etc.



TRANSMITTER FOR 250 W

erence carrier and the primary oscillator carrier. The level of the dc output voltage from the phase detector is directly proportional to the beat difference between the two carriers, and the sign of that voltage is a function of the sign of the beat between the carriers.

Output voltage from the phase detector is applied to a dc amplifier, which in turn controls the grids of a pair of thyratron tubes. AC voltage of proper phase to operate a two-phase motor is obtained from the output circuit of the thyratrons; the motor is mechanically coupled to the primary oscillator tuning capacitor. In this manner continuous monitoring of the center-frequency of the primary oscillator is provided.

Direct indication of the primary oscillator frequency in cps with respect to the standard crystal oscillator frequency is also provided for. DC output voltage from the phase detector is used as a measure of the beat difference between the two carriers; a zero-center dc voltmeter having a high internal resistance is placed across the phase-detector output, indicating both the value of the difference frequency and its sign.

Grids of the modulator tubes have no correcting voltage fed back as a result of drift in the primary oscillator, which eliminates the possibility of distortion arising from operation on improper portions of their characteristics.

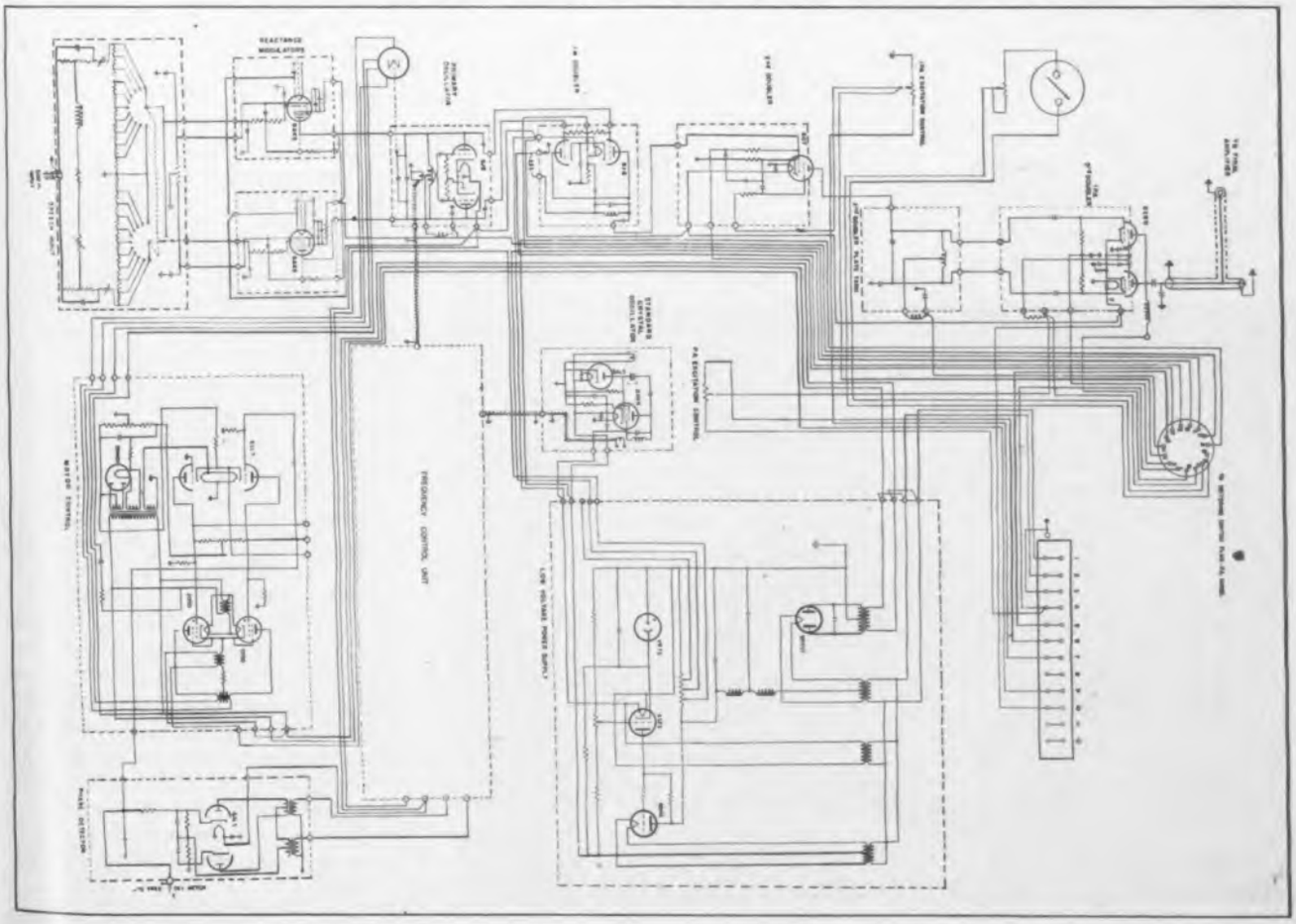
The power supply for the standard crystal oscillator, primary oscillator, and modulator was carefully designed for constant output voltage with respect to load changes and line variation. Undesired FM modulation of the primary oscillator would occur if the power-supply voltage should vary.

For the same reason, ripple must be kept within a few millivolts to avoid hum modulation of the carrier. A high degree of regulation of the voltage supply for the standard crystal oscillator is provided by means of the 6B4 high-G_m control tube; the amplifier tube is a high-mu 6SF5 triode, the cathode of which is maintained at a constant reference level with a VR-75 voltage-regulator tube.

The primary oscillator operates within the frequency range of 11-13.5 mc. Use of balanced modulators and a push-pull oscillator provides twice the FM swing of oscillator frequency that is obtainable with a single modulator, and permits use of a multiplication factor of only eight to raise the oscillator frequency to the carrier frequency. Since the push-pull circuit eliminates even-order harmonics which would otherwise arise due to curvature of the transfer characteristic, this further advantage is afforded.

Reference to the schematic diagram shows the potentiometer circuit for balancing the cathode cur-

Schematic diagram of the Temco 250-watt transmitter showing arrangement of the frequency stability control equipment and linear tanks



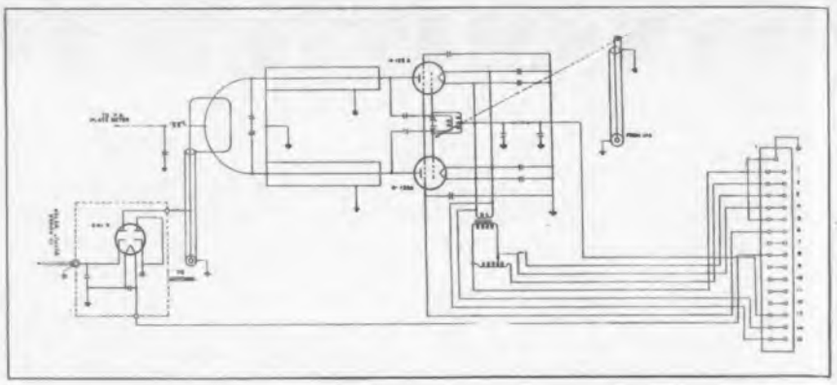
rents of the 6AK5 modulator tubes; variable capacitors are provided for adjusting the value of the quadrature voltage fed back to each grid. Quadrature voltages fed to modulator grids are in phase; if the grids are connected together and a modulating voltage of the same phase is applied, reactive currents flowing through the push-pull oscillator tank as a result of modulator plate currents, will be effectively zero.

Means are thus provided of adjusting the cathode currents of the modulator and values of quadature voltages fed to each grid so that no FM modulation of oscillator frequency takes place when modulating voltage is applied to modulator grids. Balancing of the modulators can then be carried out at various input levels of modulating voltage, insuring that both modulator tubes are operating on the same portion of their G_m characteristics; with this condition a symmetrical shift of oscillator frequency about its center value results.

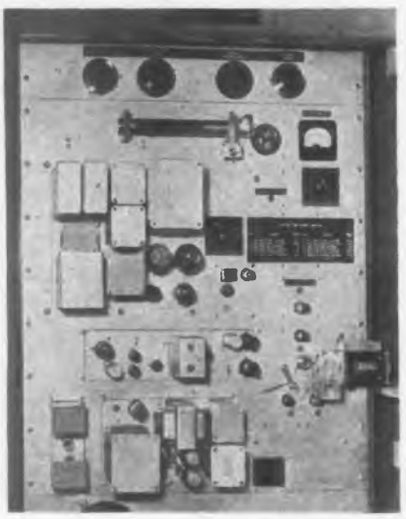
With modulating voltages of opposite phase applied to each modulator grid, reactive currents now flowing in the oscillator tank coil will be of the same sign and opposite phase, resulting in a double total net effect on the oscillator frequency.

Type 6AK5 miniature pentode tubes were purposely selected as modulators because of low internal capacitances and high G_m. Grid and plate circuits of each modulator tube are separately shielded to avoid relaxation oscillation.

Audio modulating voltage fed to modulator grids is carried through a 500-ohm line, across which is placed a series RL network having a high-frequency pre-emphasis characteristic; its slope may be adjusted to lie between the FCC specified limits. The time constant of the pre-emphasis network is 75 microseconds; its frequency characteristic is within ±1 db of the normal curve of the circuit.

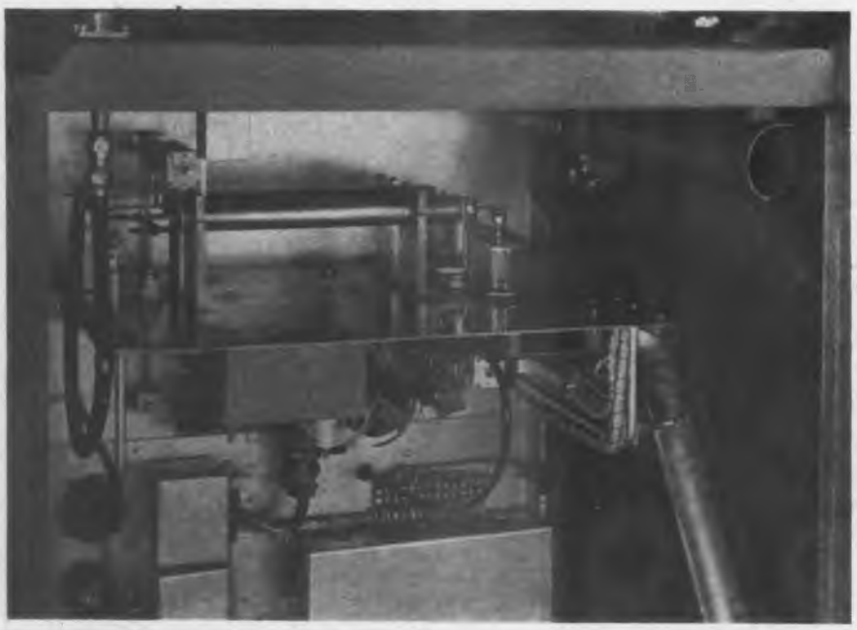


Schematic of the concentric line final amplifier for the 250-watt FM transmitter



Close-up view of front of the exciter units

Close-up view of the rear of the final amplifier showing mounting of the 4-125A Eimac tubes



Plates of the modulator tubes are connected directly to the plates of the 6J6 dual miniature triode used in a push-pull Hartley circuit; it is required that the oscillator tube have low C_{gk}, low C_{pk}, and high G_m. The low interelectrode capacitances are necessary to keep the shunt capacitance of the tank down; high G_m is required to enable the tube to oscillate readily at 11-13.5 mc.

To obtain a minimum deviation of ±10 kc, it is necessary that the reactive currents developed by the modulator constitute a considerable portion of the total tank current. Thus, constants of the tank circuit have to be chosen to insure stable oscillator operation, while permitting specified modulation of the oscillator frequency.

Sufficient power is likewise developed by the oscillator to drive the first doubler; approximately 3½ watts are available. The grid-cathode capacitance of the doubler tube is effectively in shunt to the oscillator tank, which requires that it be kept low. A 6J6 miniature twin triode is used as the first doubler for this reason, in a push-push circuit. Three watts of second-harmonic power are developed.

Considerable power must be developed from the second doubler to insure saturation of third-doubler grids; an 807 tube is used for the purpose. Its input capacitance of 11 mmf, while relatively high, is not prohibitive since plate-cathode capacitances of the parallel-connected 6J6 are only of the order of 0.8 mmf.

Use of lumped parameters in the first doubler plate circuit is still feasible, as it is operating in the 22-27 mc region. To obtain considerable second-harmonic voltage from the 807 plate tank, a large

(*Continued on page* 146)

GERMANY'S UHF TUBES

American engineers and scientists investigate and report on design of water-cooled klystrons and various magnetrons

• Along with other items, the UHF tubes developed during the war were investigated and a number of interesting items were turned up. For example: A water cooled Klystron[1], with a double internal resonator and inductive coupling between the two sections was developed. Using a voltage of 5 kv, an output of 100 w, and an efficiency of 10% was reported. Provision was made for modulating the accelerating grid of the tube (200 v modulation). Noise modulation (spectrum 1 to 3 mc/s) was used, variously a hexode mixer tube, a gas discharge tube, and a resistance as sources of noise. The few tubes made were used by the Luftwaffe in the Feuerball jammer, for jamming H2X, the frequency range being 8.6 to 9.3 cm.

A corona discharge tube for stabilization of voltages up to 10,000 v (mainly for Klystron operation) was started but was dropped in favor of neon stabilizers in production at Philips.

Some of the tubes developed by Dr. Oskar Heil[2] gave electron efficiencies of 50% (theoretical maximum 65%) and an over-all efficiency of around 25%. These tubes had magnetic focusing. A newer tube, using electric focusing, operated at 3 cm and gave 20 w average power when pulsed with 1/10 to 1/20 duty cycle.

The RoE/4 101 tube appears to have two especially interesting features: the cavity design and the electron focusing. The cavity of this tube can be operated at 3 cm, 4.8 cm, or at 7 cm with different drift times for each mode. The center discs for each mode actually are of different shapes, and the supporting legs are attached at different places. The disc and the legs are those used for the second mode at 4.8 cm. The tube will operate best with a particular shape of the disc, designed to give the shortest possible drift time for each mode. By altering the shape and position of the disc for a given mode, the the ratio of bunching to catching voltages may be controlled in design.

[1]Report Index Number, 78.
[2]Report Index Number, 95.

Some information on German equipment has been released by the U. S. Department of Commerce (Publication Board) based on personal reports by the members of the Combined Intelligence Objectives Sub - Committee, who are making studies of German industrial and military equipment and the status of research in the Axis controlled countries. During the next few months, digests of reports on the most interesting items relating to electronic matters will be published here. The complete reports are available from the U. S. Department of Commerce, Washington, D. C.—Editors.

Dr. Heil stated that the most desirable beam is one having a uniform charge density in cross section. In such a beam, although the electrons diverge, they appear at any point along the beam to be all diverging from the same point in space, giving a converging beam of uniform density and a uniform field at the surface of the cathode. A beam of uniform density avoids lateral oscillations which cause a reduction in useful beam current.

A cone-shaped electrode between the ring and the opening into the bunching space (called the "control space"), operated at 20 to 30 volts above the cavity potential, arrests the longitudinal drift of the positive ions before they reach the cathode. In practice, there are enough gas molecules present to permit the formation of a positive space charge. The geometry of the system is such that, neglecting space charge, the electrons would cross over at the position of this conical electrode. The positive space charge partially neutralizes the electron space charge and reduces the spreading of the beam.

The tube is so designed that the neutralization of the electron space charge is almost complete for the dc beam. This means that the neutralization is incomplete in a bunch, and that there is a net positive charge in the region between bunches. The limiting sine-wave modulation frequency at which this focusing effect can be observed is around 10 kc. This implies that about 100 microseconds is required for the positive ion space charge to form.

The beam at the entrance to the bunching region is about 1.9 mm in cross-section. With gas focusing it is 2.2 mm, at the exit from the space, and without gas focusing 4 mm. These beam measurements were made at dc. Because of the inexact space charge neutralization of the modulated beam the corresponding rf figures would not be as favorable, and were not. In the newest tubes, ratios of cathode diameter to diameter of the beam at its smallest point have been as large as 85, for 1,000 v 70 ma beams.

It was reported that for the greatest efficiency in a velocity-modulated oscillator the electron bunch should be disc-shaped although this ideal has not as yet been attained. There is an optimum charge density of the disc, above which the disc life time is too short to be useful.

An oscillator of this type could be tuned either by deforming the cavity or by inserting metal slugs through ceramic glass tubes. No mechanically tunable tubes were built, but tuning was accomplished by changing the accelerating voltage. A change of 1.2 mc at 2,000 mc was obtained on an older model as the voltage was changed from 975 to 1180.

Electron optics

Unusual technics were employed for studying electron optics. For example, Dr. Heil set up an electron gun in a vacuum tube, and placed a piece of carbonized filter paper in the beam. Where the beam strikes the paper, the paper gets hot and glows. This method was found necessary because the beams being investigated are so intense that fluorescent screens are burned very quickly.

The various components of the guns used in experimental tubes are mounted on wires in such a

way that they may be slid longitudinally along the tube in order to alter the spacing between components. They are made to slide simply by tapping the tube; their positions are measured with a traveling microscope. The screen used to observe the cross-section of the beam may itself be moved in the same way. By making two components have different frictional resistances, a series of tests may be made in which one component has a fixed position while that of another is varied.

The carbonized screen is prepared by placing a piece of filter paper between metal plates and heating this assembly at fore-vacuum pressure. Next the metal plates are removed, and usable bits (of the order of 1 cm square) are clamped tightly between molybdenum plates and heated in an induction furnace in a high vacuum.

An oscillographic method of measuring the energy spectrum of the electrons in the beam was reported where a probe was placed in the collecting region of the oscillator tube, and an audio frequency voltage applied to it. The same voltage is applied to one pair of deflecting plates of a CR tube, while the other pair of plates is controlled by the current picked up by the probe, giving a trace which is a measure of the energy spectrum of the beam.

Transit time resonance

An effect which might be called transit time resonance (TTR) has been utilized in tube design. Suppose we have two parallel metal plates to which a high frequency voltage is applied, assuming that some free electrons are present in the space between the plates. At certain voltages and spaces, an electron starting from near one plate at an instant of zero voltage will be accelerated toward the other plate and arrive there at the next instant of zero voltage. The electron will then have acquired energy which it loses by collision with the second plate, from which secondary emission may be released. The latter is accelerated toward the first plate. Since they start at an instant of zero voltage they too acquire energy and release still more secondaries when they hit the first plate. The process is cumulative and relatively empty space absorbs energy.

This is of importance in the design of HF tubes, because a region in which the necessary conditions hold may easily be unintentionally built into a tube, causing, among other things, dead spots in tuning. Improved working efficiency of some of the tubes was made by discovering and eliminating such regions. The area over which we might have resonance at a given frequency can be reduced by using cone-shaped elements in the tubes. The amount of secondary emission may be reduced by cutting away the metal, leaving teeth having a net area not less than 1/10 that of the unmodified electrode. The effect may also be reduced by giving attention to the secondary emission characteristics of the surfaces involved although oxide-coated cathodes have the tendency for the oxide to evaporate and contaminate the surface. (This effect is similar to that used in the Farnsworth multiplier.)

In a tube which is built along the lines of these with which Heil first worked, in which the beam is projected across a coaxial line, electronic tuning may be obtained by projecting a second beam across the line normal to the first. The drift time of the tuning beam must differ by about one-half period from that of the working beam. The frequency is changed by altering the current in the tuning beam.

Magnetrons

Several magnetrons also were investigated.[3,4] For example the LMS 10 had a peak output power of 15 to 20 kw. In a circuit rf buildup time was reported to be 1/100 miscrosec. The frequency ranged 8.9 to 9.1 cms as the tube happens to come from production.

Thus the magnetron used in a 10 cm equipment, was a copy of the allied one. The 3 cm tubes produced were claimed to be their own development. The LMS 10 was 30% efficient.

The LMS 100 (up to 100 kw) also on 10 cm was 10% efficient and had a field of 1,500-2,000 gauss, 30% greater than critical. It was air-cooled and was suitable for space/mark of 1,000. The LMS 12 on 3 cm had 18 splits, the LMS 32 was 3 cm tunable, and water-cooled, with 2 kw loss. Small receiver magnetrons are the RD2MG (3 cm, 6 or 8 splits, 50 w output, short life), the RD2MH, and the RD4MG. This series contains about 10 other types. They have used copper magnetron anodes only, have had trouble with glass-sealing (usually nickel-iron soldered to the copper with silver-solder was preferred). Most of the tunable magnetron work was done on 3 cm, using a metal ring supported on a flexible membrane and moved towards the circle of gaps.

Tubes in the 2.0 to 1.6 cms range were in the experimental stage. A magnetron LMS 13 was used giving a peak power of about 1 kw with a 1-microsec pulse. For some reason, a waveguide feed was abandoned here, and a concentric used. The LMS 13 was a scaled down model of LMS 100. It used about 3000 Gauss at 15 Kv. In general, electromagnets are used to produce these fields as Germany has no cobalt to make good permanent magnets.

The modulation system was a copy of the British. The modulator is an LG 201 and later, an LG 201 A (a better model). A 1-microsec pulse is used, at a pulse rate frequency of 1500. The antenna system used 4 to 8 dielectric rods giving a beam width 10° (total to half amplitudes). This antenna had a scanning speed of 300 to 400 per minute, and was fed by a coaxial line. The standing wave tolerance allowed on the feeding line is 1.3 to 1, in amplitude. The receiver had an if of 30.5 mc, 2 mc wide. At the video stage output the leading edge of the pulse rises in 1/3 microsec, and the trailing edge falls in about ½ microsec. The crystal for the mixer is of "vapored" silicon.

The 3 cm technic—"Berlin-D"—was said to be almost an exact copy of the American H2X as far as the magnetron, antenna and mixer are concerned. All the rest was taken from the 9 cm Berlingeret. For Naval use a 1½ m parabola was used, stated to give a ¾° beam (total to half amplitudes).

Power measurement

In another research program magnetrons for use in search receiver design and in frequency measuring experiments were developed.[5] They claim to have operated magnetrons as high as 3.7 mm wavelength. They obtain a S/N ratio of 100:1 using horn antennas and crystal detectors at 3.7 mm. They can accurately measure power output down to 3 cm. Their frequency measuring apparatus permits measurement with the following accuracy:

Down to 5 meters	±2 parts in 100 million
Down to 8 cm	±20 parts per million
Down to 0.8 cm	±0.1%

A magnetron also was developed[6] which could be operated at any of several discreet wavelengths be-

(*Continued on page* 122)

[3]Report Index Number, 58.
[4]Report Index Number, 59.
[5]Report Index Number, 69.
[6]Report Index Number, 78.

LABORATORY KEYHOLE

Current Research that Forecasts Future Electronic Developments

WEATHER-SENSITIVE TUBE—J. Rothstein of the Belmar, N. J., labs has developed a microphonic electronic tube highly sensitive to external pressure changes. This tube may be calibrated to indicate static pressure, and used as a barometer. Because air pressure varies with altitude above the earth, it may be calibrated directly as an altimeter. Reinforced and made rigid, the tube may be used as a piezometer. Properly calibrated, it can be installed on submarines to give precise readings of depth. The tube also will measure and record temperature, measure wind velocity through dynamic pressure, record air speed and water flow, register pressure changes in a wind tunnel and measure minute changes in the stress of metals.

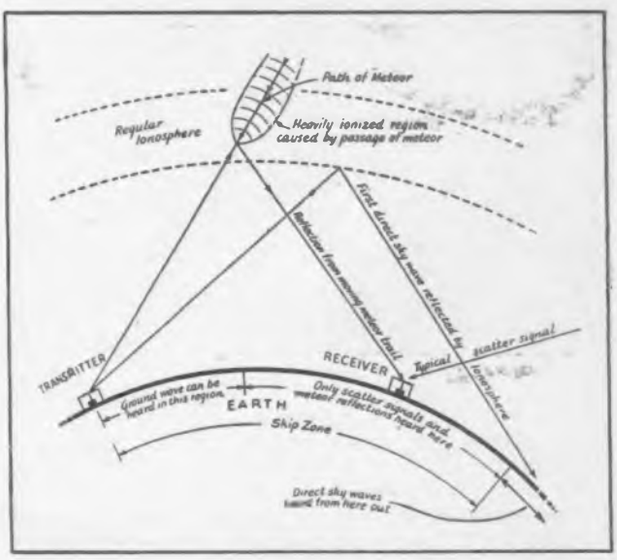
HIGH FREQUENCY HEARING—Using extended range audio systems in services where high fidelity is possible (FM and television), a certain research group has found that it was necessary to supress transformer lamination vibration, which in one instance occurred at about 15 kc and was annoying to a few people with unusually keen hearing response in these higher ranges.

FOLLOWING BULLET IN GUN BORE—In military science it is of considerable importance to study the movement of the bullet within the gun barrel. Suggestion has therefore been made that strain gages fastened to the outside of the gun barrel at various positions along its length might be used to indicate the passage of the bullet down the bore. According to a report by C. M. Slack, C. T. Zavales and E. R. Thilo, some preliminary work along these lines has been carried out at the Frankford Arsenal Laboratories in Philadelphia. An attempt was made to determine the reliability of the gages in recording the position of the bullet. Excellent pictures have been obtained.

CATALYSIS CONTROL BY X-RAY DIFFRACTION—The catalytic agent used in the Fischer-Tropsch process for the synthesis of hydrocarbons from H_2 and CO consists of Ni or Co or both, with activating materials such as alumina, thoria or other difficultly reduceable metal oxides; kieselguhr has been used as a carrier.

The particle size of the nickel can be determined from the width in X-ray diffraction pattern. The phase of MnO_2 present can also be identified and controlled by previous conditioning. The activator may possibly contain substances that would act as catalytic inhibitors; their presence may be detected by X-ray investigations and they can be eliminated by chemical methods. The kieselguhr carrier has to be previously prepared by suitable chemical and thermal treatments to achieve uniformity and the absence of harmful impurities. This treatment can be followed closely by X-ray powder diagnosis so that optimum conditions are employed. Extensive studies of catalytic processes indicate particle size to be of primary importance suggesting many further applications of X-ray diffraction controls in this field.

METEORS CAUSE RADIO WHISTLES, with tone indicating the speed component toward observer. Effect is analagous to that observed on television screen where illumination periodically brightens and blacks out, as airplanes fly overhead, reflecting waves alternately in phase with or opposing the regularly received waves. With meteor travelling at 40 kilometers per second and reflecting a 20-meter radio wave, says O. G. Villard, Jr., in QST, this results in meteor traversing 2,000 wavelengths per second, producing 4,000 complete cancellations and additions per second, which receiver reports as 4,000-cycle note. Changes in meteor speed are revealed by changes in tone.



ELECTRONIC DEPILATORY—Violet Arnold of Detroit has been granted a patent on an electronic depilatory unit consisting of a 65-kv X-ray tube, rays from which are filtered through a laminated filter consisting of spaced aluminum sheets with water between. Several treatments are required to remove hair, permanently, it is stated in the patent.

"WEATHER SLEUTH" was a wartime project of Signal Corps and Farnsworth laboratories, which measures the direction and velocity of wind aloft, and also provides information on humidity, temperature and pressure at altitudes up to 60,000 ft. With additional forecasting ability of instrument, device is expected to aid pilots in selecting levels which will provide helping tailwinds instead of delaying headwinds, explains Farnsworth's B. R. Cummings.

NOTE: *Please don't ask us for more details about any of the foregoing. We present here all the information we have. As soon as we get more about any of these situations, full details will be printed in Electronic Industries. Our editors run across many interesting tips, leads, and rumors, both well-founded and baseless. We thought you would be interested in hearing about them, even if we can't give all the details or vouch for their authenticity. Editors.*

RADAR ASSEMBLY AND

Production engineering of mass production of radar

Assembly and inspection line of the step-by-step converter associated with Mark XX Radar. Below: Intricate radars designed to be slung beneath night-fighters to pin-point targets through darkness. Bomb-shaped housings enclose the radars, shown on next page, lower left

Synchro-Step Converter in process of assembly. It operates searchlight controls through selsyns and automatically feeds location data supplied by radar searchlight controls. Frame is aluminum tubing

Testing the test equipment; a signal generator receives final operation test before going into the field to check radar performance. A radar is no better than its associated test equipment. When no target appears on the screen, either no target is within range or the electronic equipment is not functioning properly. Test sets tell the

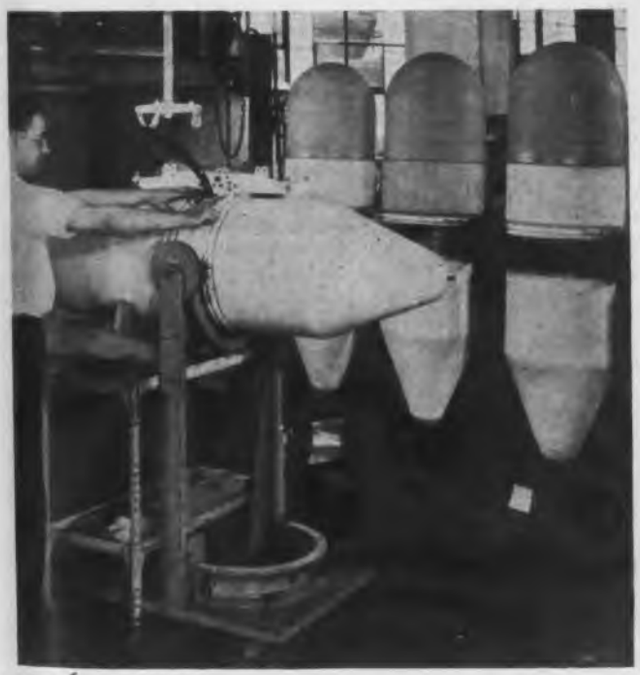
TESTING OPERATIONS

highest type is required in equipment on assembly lines

Radar elements which helped to aim big guns that mowed 'em down. With high precision test set, expert radar technician makes final tests of fire control radar prior to installation aboard a U. S. battlewagon

Above is shown one section of the component testing unit at Western Electric Company's 11th Avenue plant, where essential parts receive rigid tests by skilled technicians. See also picture at lower right

Here Western Electric experts give radars final check before sending them out to battle with Navy's subs, trimmed for ultimate precision



Not bombs but radar equipment; interior shown on preceding page, lower left. Attached to wings of Navy carrier-based planes, bomb-like plastic case reduces wind resistance, protects equipment from the elements. The operator is attaching a sway brace to the unit, in final assembly

Before radar can pinpoint targets, accuracy must be built in at the factory, as shown above and in foregoing illustrations. Test sets, more precise than radar itself, groom vital elements for Navy equipment

TEST OSCILLATOR FOR

By WERNER MULLER
Consulting Engineer, New York

Reallocation of FM and television channels accelerates development of versatile obsolescence-proof test equipment for lab and factory

● With industry rapidly returning to the manufacture of civilian goods among which radio is a major item, consideration must be given to the new ideas which will be incorporated in receiver design. The biggest design change has been necessitated by the re-allocation of some of the transmitting channels, specifically those for FM and television.

It is with such new designs in mind that a study has been made for a test oscillator that will readily cover all the new requirements and have features which anticipate later developments in the field. Obsolescence can be eliminated, and the instrument described is almost fool-proof and obsolescence-proof.

Desirable functions of a universally useful instrument would include:

1—Continuously variable oscillations from 100 kc to 150 mc.
2—Crystal oscillator for 100 kc and 1000 kc.
3—FM oscillator for three frequencies, to be selected by designers.
4—Variable AF oscillator from 60 to 15,000 cycles.
5—Output indication of AF, and RF voltages.
6—Per cent modulation on AM and bandwidth for FM.
7—Complete attenuation of AM, FM, AF and RF output.

These functions are basic. In addition, the following features should be incorporated:

1—Variable RF alone.
2—Variable RF, AM modulated up to 40% by AF.
3—Variable RF plus FM.
4—Variable RF plus crystal frequencies.
5—Crystal plus AF modulation up to 40% or more.
6—FM at bandwidth or deviation frequency predetermined.
7—AF to modulate all RF positions.
8—AF available externally through attenuator.
9—Provision for external modulation for any RF frequency by frequencies from 60 to 15,000 cycles.
10—Low impedance output for RF and AF.

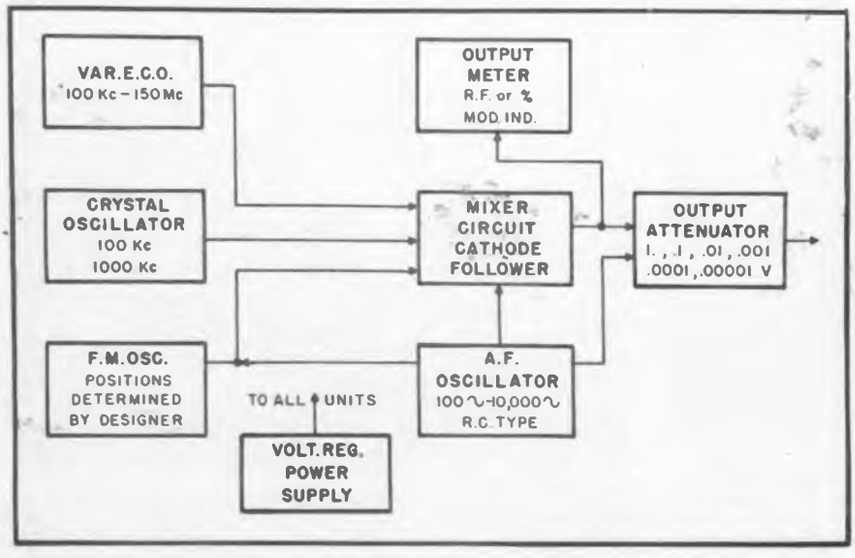
The RF attenuator network should have the following provisions:

1—One volt RMS maximum output fixed.
2—Continuously variable output from 100,000 microvolts to 1 microvolt. Intermediate steps to be in multiples of ten. A variable potentiometer should provide control for setting the output indicator to 1 volt.
3—The output meter should permit ready switching from RF or AF volts, to modulation percentage or Frequency Swing. A meter—and diode or "magic eye" indicator tube can be used.
4—The AF attenuator also should be continuously variable and preferably so arranged as to control either AF output or AF modulation voltage calibrated in percent or deviation for the RF positions and to act also for controlling the magnitude of any external AF signal.
5—The stability of all oscillators should be such as to permit good operation under normal conditions; that is, frequency drift should be a minimum due to line voltage changes. Effects from temperature changes cannot be very well incorporated except for a very small range.

In Fig. 1, the block diagram shows a suggested arrangement. The RF oscillator, mixer and FM oscillator circuits use the 6J6 tube, a twin triode of excellent characteristics. The crystal circuit uses a 6C5. The AF generator an RC circuit, utilizes a 6SJ7 and a 6SN7 tube. The power supply uses a 6X5 and 1-VR-90 and 1-VR-150.

The continuously variable oscillator circuit using a 6J6 tube, is shown in Fig. 2. The circuit is a

Fig. 1—Block diagram of test oscillator to afford flexibility of operation. Complete attenuation of AM, FM, AF and RF outputs is provided. Frequency range is from 100 kc to 150 mc.



NEW AM-FM-TELE NEEDS

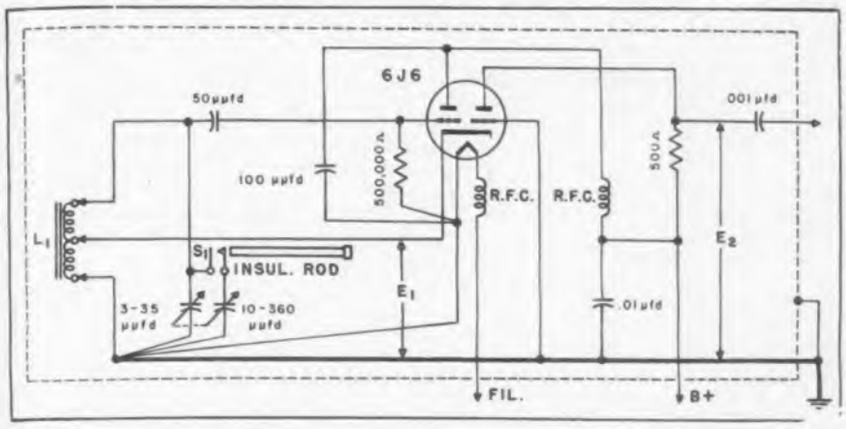


Fig. 2—Continuously variable oscillator. Oscillator is cathode-coupled to grounded-grid amplifier working into low-impedance load. Ten volts rms is developed at 150 mc, with good stability

Hartley with the addition of some new features.

Oscillations are produced in the first section of the twin triode tube 6J6. Since the cathode is common to both sections, the resultant voltage E will operate the second triode section. The second section of the 6J6 operates as a grounded grid amplifier, with the plate circuit operating purely resistive (500 ohms in the example). The oscillator voltage generated in the first section can thus be taken off across the plate load of the second section with the advantage of reflecting a very small load on to the oscillator circuit, thus improving stability.

With a plate supply of 150 v dc and a 15% feedback, an output voltage of 10 volts RMS easily can be developed at 150 mc across the 500 ohms plate load. At lower frequencies the voltage output is slightly higher. Since the plate output circuit feeds into a cathode follower mixer tube (Fig. 3), and the total requirement calls for one volt RF maximum, no trouble will be experienced from the cathode follower mixer due to the loss in gain associated with this form of circuit. The output voltage will be well in excess of the one volt desired. This will hold for the entire operating range.

Particular attention must be paid to the band switching arrangement. The suggested arrangement utilized eight coils to cover the band, using a two-section variable capacitor, section 1 having 330 mmfd and section 2 having 35 mmfd, with 10 mmfd and 3 mmfd being the respective minimums. The capacitors operate in parallel over the first six bands. When using band seven and eight the first section is switched out by a contact arm operated from the front panel.

A few words regarding the oscillator coil arrangement may be of value. To cover the entire range 100 kc to 150 mc, particularly the last two ranges, 45-75 mc, 75-150 mc, calls for exceedingly fine skill, since every mmfd in the tuning circuit counts, and the fight to hold tolerances becomes difficult.

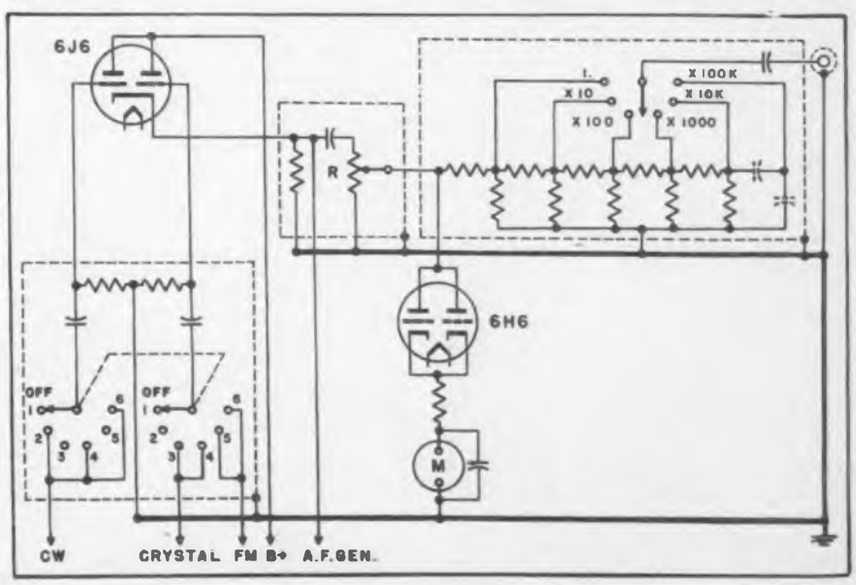
The use of a rotary coil system as shown in Fig. 4 will provide a fairly easy method, which can be adopted for production, with excellent assurances of good performance. As can be noted from the sketches, tube and wiring, switch leads, etc., have been reduced to a minimum without sacrificing operating efficiency. Exact mechanical details are omitted, since they are beyond the scope of this article.

The crystal oscillator uses a 6C5 tube or similar triode in conjunction with a dual frequency crystal operating at 100 kc or 1000 kc. The plate circuit is tuned and the output is capacity fed into the mixer tube as shown in Fig. 5. No particular comments for this circuit are necessary, as it is commonly used.

The FM oscillator circuit in Fig. 6 is a repetition of the oscillator in Fig. 1 with a slight modification. It is this modification which pointed to the possibility of using this circuit for FM. When the 6J6 tube was operated as a normal ECO at 50 mc, a grid resistance of 50,000 ohms was inserted in series with the second section grid. When audio voltage is applied across this resistor, modulation is obtained as noted on an FM receiver tuned to the oscillator frequency.

Two types of modulation are present, AM and FM. The FM modulation observed was checked by a beat note method using a 15 kc audio modulation signal and the BFO in the receiver. The △ F, or

Fig. 3—Mixer circuit uses cathode follower. Total requirement is one volt RF, maximum, which is maintained throughout entire range. Cathode follower reflects small load on earlier circuits



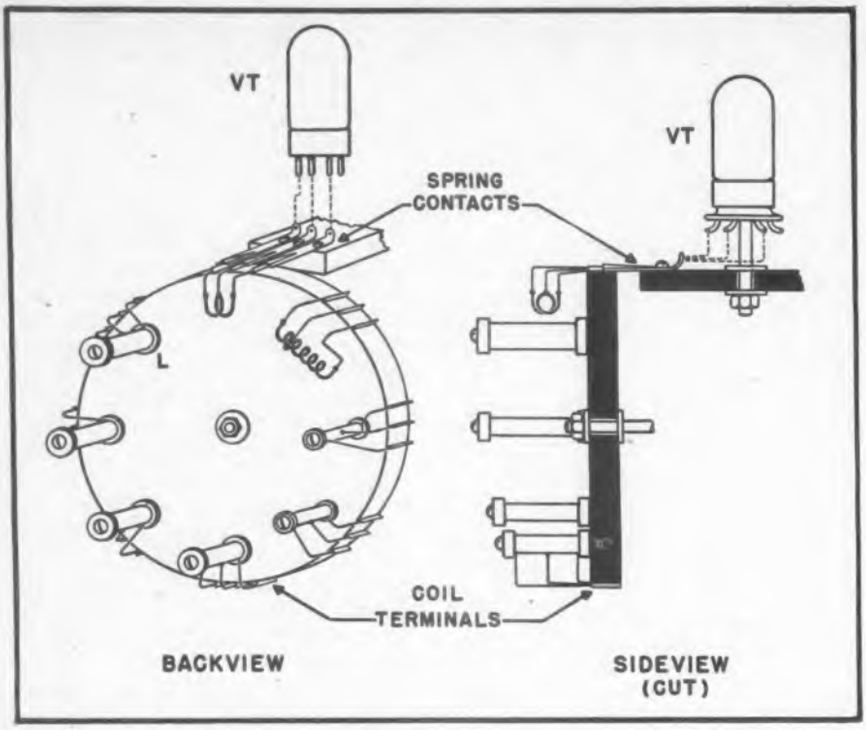


Fig. 4—Turret-type coil mount is preferred from mechanical and electrical standpoints; is a practical production design which maintains low stray capacitances with controlled tolerances

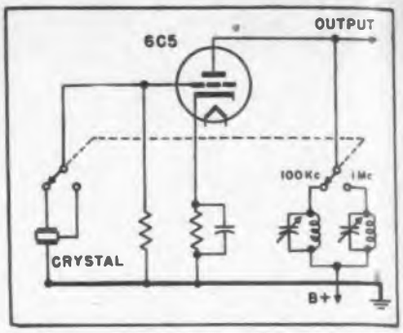


Fig. 5—Dual frequency crystal is used, operating at 100 kc or 1000 kc. Plate mesh is tuned

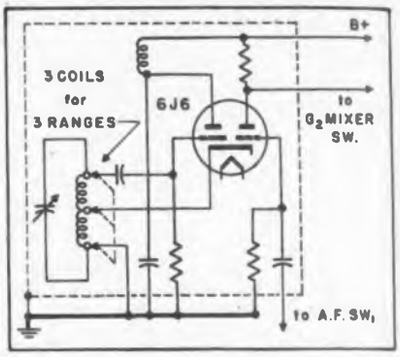


Fig. 6—FM oscillator has AF signal impressed on grid of second section. Is simple, flexible

deviation, as measured showed 750 kc swing, with a given audio voltage impressed on the grid of the second 6J6 section. Varying this audio voltage had a decided influence on the frequency swing, making it smaller or larger as desired. AM was present, but how much was not determined nor were distortion measurements made.

Irrespective of the AM present, the possibility of the circuit warranted further investigation. Should the AM be too great, a limiter can be included at little cost. The most interesting point seemed to be the ease with which any degree of band width could be obtained, by varying only the AF modulation voltage.

The three FM frequencies are of course switched in a normal manner. The desired FM signals are selected by the designer. At the desired signal point, the amount of AF voltage impressed on the second grid of the 6J6 will determine the frequency swing. As mentioned earlier, any AM present possibly can be limited through the addition of a circuit designed for this purpose or if the FM signal impressed on the mixer input is large enough it may be feasible to utilize the mixer tube as the limiter.

Fig. 3 shows the mixer circuit using a 6J6 as a cathode follower and mixer. The two grids are switched to the desired positions providing the following: 1—OFF; 2—CW; 3—crystal; 4—continuous wave and crystal; 5—FM; 6—FM and CW.

Modulation of the CW and crystal positions can be combined or provided for separately; in the suggested circuit the modulation operation is made separate.

The AF circuit suggested is shown in Fig. 7. It is an RC type using tandem resistance controls for changing frequency. The tandem control is cheap and presents a more compact arrangement with some sacrifice in accuracy. The output of the AF oscillator is a cathode follower coupled to the desired circuit, as shown in the diagram.

In one position (SW_1) it causes FM as described earlier; in the other position the AF voltage is developed across the cathode resistor of the cathode follower mixer tube. External and off positions are also provided.

The degree of AM or FM is controlled by the setting of the control in the cathode follower circuit of the AF generator. The wave form of the AF generator is excellent for its range and the amplitude output is constant. This circuit arrangement permits another function, that of utilizing one attenuator network for all operations AM, FM, crystal and AF.

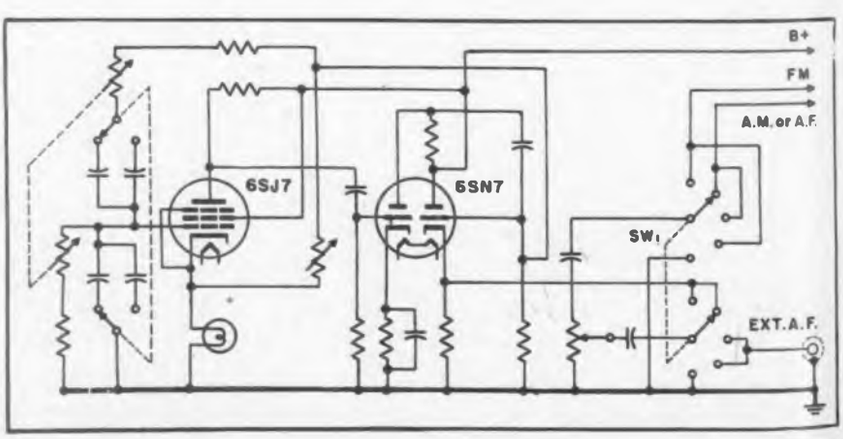


Fig. 7—AF circuit suggested by author. Tandem resistance controls are used in RC oscillator section; design is economical at price of some frequency precision. FM or AM yielded by 6SN7

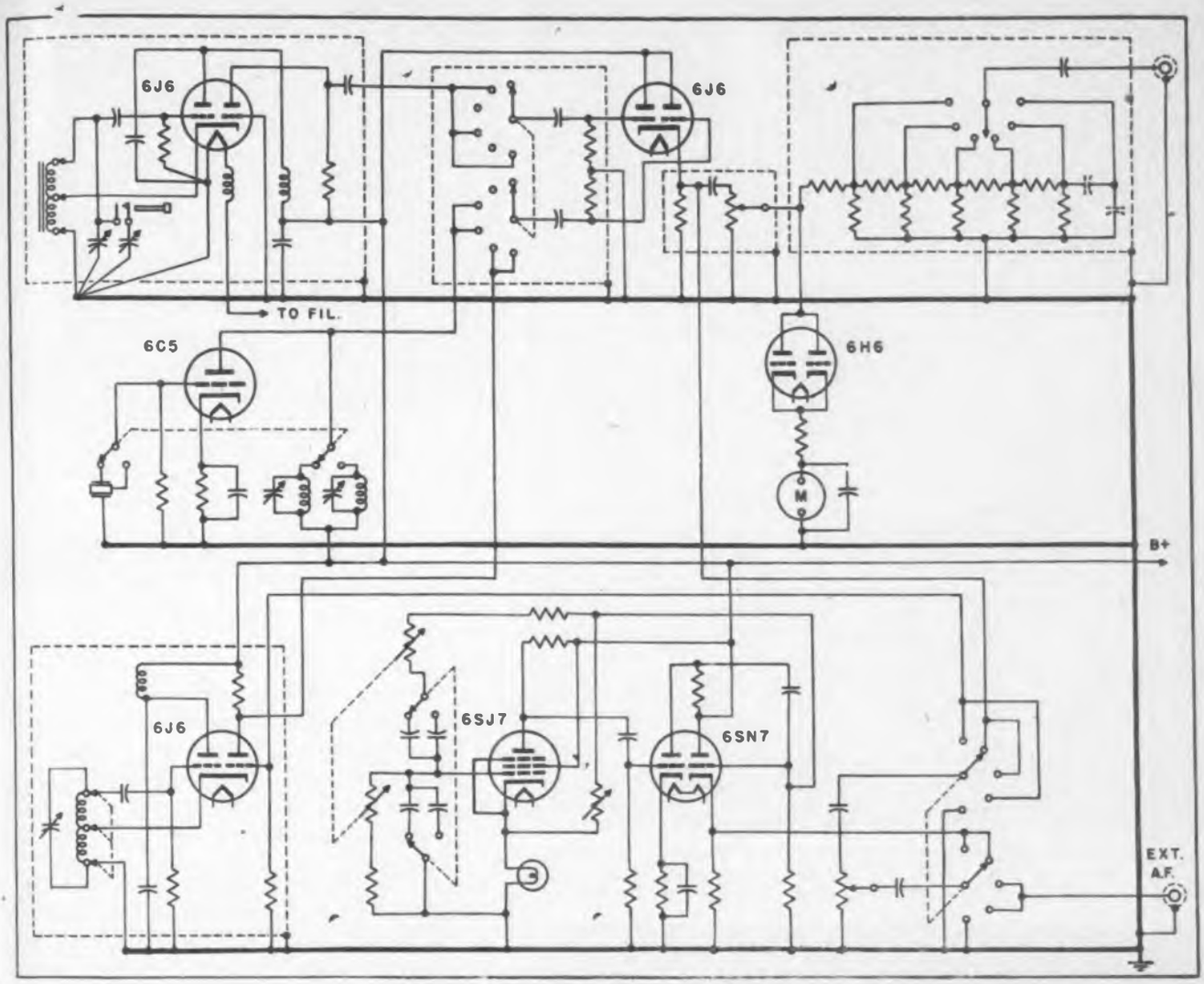


Fig. 8—Complete schematic diagram for the proposed test generator. Indicator is diode rectifier with milliammeter or magic eye tube. Output impedance preferred is 100 ohms. Capacitance network for attenuator to obtain proper operation at high-frequency end, is recommended

The combined circuits of the proposed test generator are shown in Fig. 8.

The indicator can be a diode rectifier with diode and meter or "magic eye" type, with calibrations provided. This circuit measures any output voltage directly. R is the rough control,—the attenuator network with points brought to a switch provides variations by factors of ten. The output impedance should be around 100 ohms or less. For the point of greatest attenuation, a capacity network should be used particularly for the high frequency end.

For measuring FM band width the indicator should be switched to measure the AF voltage necessary to produce the given swing for a desired frequency. Once the voltage is determined, this calibration should hold good for general work.

The power supply is conventional and no comments are necessary.

New G E "Brain" for University of California

Highly sensitive polaroid photoelectric systems in this mechanical brain will permit the handling of differential equations with fourteen simultaneous integrations.

Above, automatic feed punch presses turn out a stream of accurately-dimensioned metal parts for RCA tubes. Below, an Acorn bulb machine. Glass in cane shape is fed into rack at top and is cut and formed into the half shells used in Acorn tubes

A skilled operator is mounting the electrode structure of an RCA-6H6 twin diode. A good weld at each point is assured by precision electronic control of the welding operation

MODERN

The use of automatic feed in punch presses for the manufacture of millions of small metal parts is obvious, but it requires imagination to visualize, and skilled arts and crafts to fabricate a device like the miniature tube stem machine developed by RCA.

In this machine, seven lead wires are automatically placed in position and held while two glass beads are softened, sealed to the wires, and formed into a "button." The button stems are then supplied to mounters, trained young women, who weld the electrode structure to the stem to form a mount.

In the filament tabbing machine, fine coated filament wire is folded and a small section of metal is attached to each end to facilitate welding to the stem lead wires. The mica

Stems for miniature tubes are made in this machine. As compared with its predecessors, the apparatus incorporates automatic feed of both lead wires and glass parts at once

This machine folds very fine coated filaments and attaches a tab to each end of the folded filament for use in 1.4-volt miniature tubes. Tabs are welded to the stem lead wires

MIRACLE

spacers used in tube mounts have their electrical characteristics improved by coating both surfaces uniformly with an insulating material which reduces the surface leakage. This operation is performed in a machine having twin rotating drums and oscillating spray guns. The manual operations consist only of loading and starting. The correct amount of coating is determined by an adjustment of the apparatus. The drawing of very fine wire is done in a machine having a graduated series of dies through which the wire is taken in succession. Wire of a few mils diameter is reduced to half the original size in this device. These three machines represent operations in which mechanisms are producing with greater accuracy and speed, and with less operator fatigue than is possible by hand methods.

Above, a metal-tube test equipment group consists of preheaters, shorts and electrical test set, and an audio frequency noise set. Below (right), Mica insulators often are sprayed with an insulating material to decrease electrical leakage

Fine wires are drawn through a series of progressively smaller dies in one operation. The dies are individually lubricated from the manifold to be seen just above the operator's hand

TUBES ON THE JOB

Carrier Telephone

The installation of the first carrier telephone exchange, in which local telephone service is provided to rural subscribers over electric power lines, has just been completed by the Rural Electrification Administration and the Southwestern Bell Telephone Co. While this new carrier central office is of an experimental type and handles only four customers—a general store, one residence and two farms —it is operating under the conditions that will be experienced in permanent installations. Regular dial telephone instruments are used and the telephone speech modulates a carrier of radio frequency which is superimposed on the power conductors. Transmitter-receiver equipment is used at both the main switchboard of the Telephone Co., in Jonesboro, Ark., and at the subscriber's end of the power line.

Terminal equipment for wired radio system which REA and Southern Bell Telephone have installed to provide subscribers with local telephone service by carrier

Uranium Prospecting

The development of atomic energy has made accurate methods for the location and testing of uranium deposits very important. The U. S. Bureau of Mines has designed a fluorescence test which quickly determines the presence of uranium and does not waste the material being checked. A small quantity of ore is broken down and then exposed to ultraviolet radiations of equipment made by Ultra Violet Products, Inc., Los Angeles 27, Cal. If uranium is present a greenish-yellow glow fluoresces.

Visual indications of paper density and uniformity are shown directly on the milliammeter

Paper Tester

A photo-electric cell which responds to varying light values transmitted through a paper sample is the heart of new paper testing equipment being used at Kimberly-Clark Corp., Neenah, Wisc.

An 8 in. paper sample is inserted between two horizontally-mounted glass discs. These plates are motor driven for circular motion. Attached to a supporting arm over the sample is a light source with an adjustable diaphragm and an associated lens system; under the paper is a photo-electric cell. This supporting arm is also motor driven to have an oscillating motion across the glass discs. These combined motions provide a scanning area which covers a large portion of the sample under test. Comparison with pre-determined standards will quickly show the average compactness or openness of the sheet structure of the paper under test. Unstable needle movement in the dial indicates irregularities in the uniformity of the paper sheet.

In addition to the scanning unit, the paper tester uses a specially designed three-tube amplifier. The equipment is made by Thwing-Albert Instrument Co., Phila., Pa.

Beamed UHF Is Electronic Blowtorch

To focus electronic heat on restricted areas for many industrial jobs, Westinghouse is developing a new dielectric heating unit which projects high frequency heat at work. This method shows promise in eliminating scorching or burning in work consisting of irregularly shaped forms

Vegetable Processing

In order to add to the reserve stock of the nation's food, the New York State agricultural experiment station, Cornell University, has been doing research developing improved methods for freezing or dehydrating fruits and vegetables. With either type of these preservation methods, vegetables are exposed to a brief heat treatment to inactivate the enzymes which are thought to be responsible for the deterioration of flavor and the destruction of ascorbic acid and carotene during storage. The use of steam or boiling water for this heat treatment damages the texture of the vegetable and leeches out the vitamin C and members of the vitamin B complex.

Substituting dielectric heating for the steam or water treatment resulted in an almost negligible loss of ascorbic acid and only a small nutrient loss. A frequency of 1750 mc finally was found to give the best heating with an exposure of about 2.5 minutes. The RCA

Frozen food package ready for heating cycle

electronic heating equipment had an output of 750 w. The two copper heating electrodes were mounted in an electric air oven, which was maintained at a temperature of 100 degrees C., to prevent condensation of moisture on the electrodes. Tuning stubs were attached to the heating elements to eliminate standing waves and improve coupling. Electronic heating has another important commercial advantage in that the vegetables can be packed in the regular frozen food container right after washing and then pass through the dielectric field just before it is passed in the freezing compartment.

One hot dog with roll ready for the eating; and a second being cooked in the electronic oven

Automatic Furnace Discharge Indicator

An application of the photoelectric cell, amplifier, relay combination giving an automatic indication when a charge traveling through a 100 kw roller hearth furnace (General Electric, Ltd.), arrives at a position near the door and is ready to be discharged.

The unit is ac mains operated and incorporates a C.M.G. 8A photocell which controls the plate current of an Osram L. 63 tube, in the plate circuit of which is a telephone type relay. As the light beam of a projector lamp unit mounted on the opposite side of the furnace is intercepted by the charge passing through the furnace, the tube becomes conducting. The relay operates and causes a warning buzzer or bell to sound indicating that the furnace is ready to be discharged.

In an alternative scheme the photocell unit operates through relays and contactors to stop the movement of the furnace hearth until the charge is withdrawn. The interior of the furnace is capable of being raised to a temperature of 1000 deg. C. but suitable heat resisting glass windows adequately protect the photocell from being adversely affected.

Hot Food Canteen

A new dispensing unit which serves hot dogs, cheese sandwiches and hamburgers—all piping hot, is being installed by Automatic Canteen Co., of America. Dielectric heat is used to re-heat the frankfurters and hamburgers after their initial cooking in sanitary kitchens before they are placed in the canteen. The electronic equipment which was developed by General Electric Electronics Department required considerable experimentation with various frequencies before one was found that would heat the meat and roll uniformly. Some frequencies cooked the frankfurter but would burn the roll. Others would heat the bun but not the meat.

INDUSTRIAL RELAY

By RALPH R. BATCHER
Consulting Editor, Electronic Industries

Many complex industrial control problems find use for tube circuits combined with relay technics borrowed from telephone switching practices

● In many applications of electronics to industrial control it frequently happens that the item to be regulated is not nearby to the source of the controlling effect. Therefore, in setting up electronic systems, numerous methods must be considered before selecting the best system to be assembled. The important methods in use are the systems depending on:

1. The level of a current or voltage.
2. The number of electrical pulses in a sequence.
3. The duration of pulses in a sequence.
4. Phase shifts.
5. The polarity of the operating current.
6. Frequency variations.
7. Wave front or rate-of-change discrimination.

To these may be added miscellaneous methods where non-electrical transmission mediums are used; light intensity, pressure of a fluid, sound waves, etc., which frequently serve as a link in an electronic system.

In some signalling systems it is customary to use more than one of these basic methods over a single channel in order to get a greater number of simultaneous control signals.

Suppose that only a single control circuit is available over a path of several miles, but that several functions are to be recorded or utilized to control local equipment. The circuit which represents a single channel of communication may be a radio transmitter-receiver combination when one end of the system is mobile—a car, ship, plane, etc. The primary effect to be transmitted must first be converted to some form of signal variation the simplest being amplitude modulation.

Signal converter

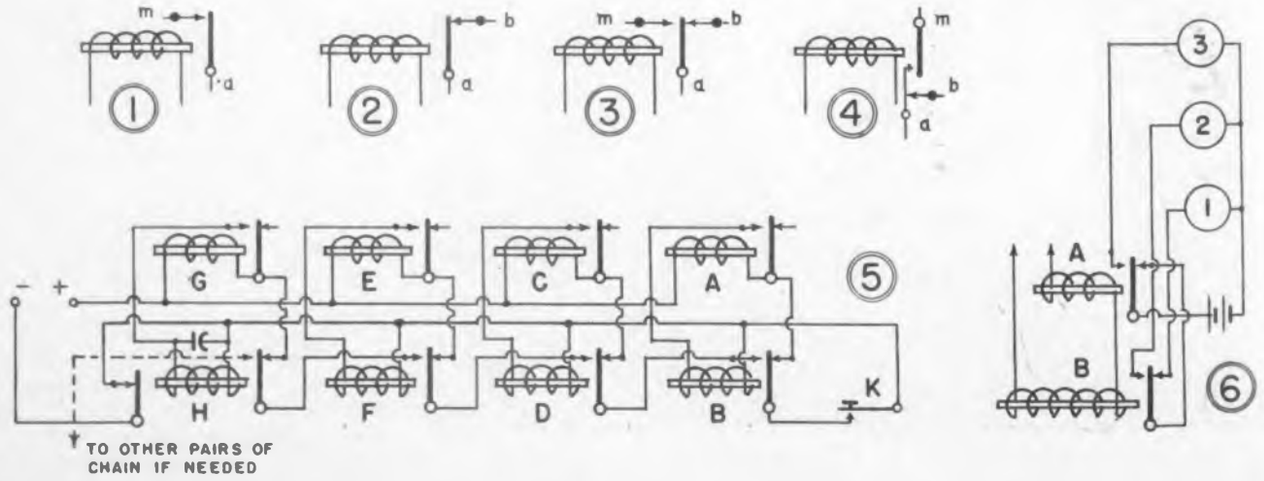
It is, of course, possible to install conversion elements that will take note of changes of the effect under observation. This method is usually not advisable over such distances when more than two levels of signal amplitude are to be handled. In other words, we would then have three conditions only—(off, light current and heavy current) to convey the control intelligence. Moreover, these three conditions cannot be run simultaneously on the same channel.

For short test runs a variable current having a continuous range of levels can be used, which applied to a suitable circuit will give a smooth range of operation. It is not recommended that variable-current signalling be used for precise regulation unless the channel is known to have amplitude constancy.

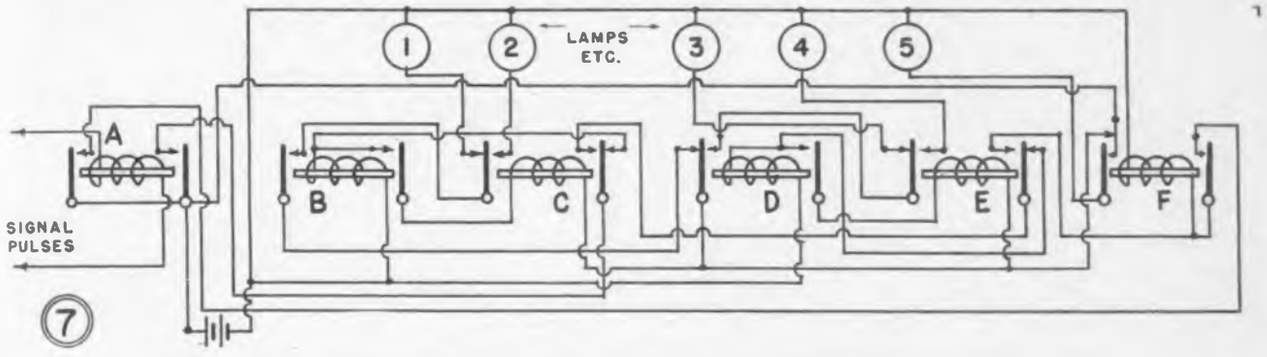
When a more complicated control effect must be transmitted, the simple "on" and "off" control principle can be enlarged by using a series of pulses of equal or unequal duration and by arranging the receiving equipment to take note of their number. The pulse method of controlling circuits is one of the oldest and most used of the circuits in use, as it is found in the dial telephone, teletype, telegraph sytems and others. One finds in use:

1. Simple "on-off" signalling systems.

Complicated timing and sequence effects are built up by combining several simple relay circuits. Relays frequently gain a dozen or more contact combinations in this way. Examples of this procedure are shown here. Item 5 shows the circuit for the pulse counting relay chain



CONTROL CIRCUITS



Multiple selection is accomplished by signals arriving during intervals associated with a group of three pulses

2. Two effects controlled alternately, first pulse operates circuit A, second pulse circuit B.
3. A fixed series of circuits are operated in succession by an assigned series of pulses.

There is more than one method whereby each of these problems can be carried out: a multiple contact switch (ratchet-driven by electrical pulses actuating a solenoid), an "all-relay" system, and an all electronic method, using gas-filled tubes. Nearly all remote control systems find use for one or more relays.

In most of the following arrangements special relays are needed, but these are now obtainable from several supply sources. The relay contact combinations are emphasized in the circuits here described, it being assumed, for the present, that the windings are in accordance with the current levels available for the job.

Complex problems are solved by combinations of simple relays, and a knowledge of a few of the basic principles used in this connection will prove an advantage. The principles described are among those which have found universal application in automatic telephone switching service, and are typical of a few of the common arrangements developed by the Bell system.

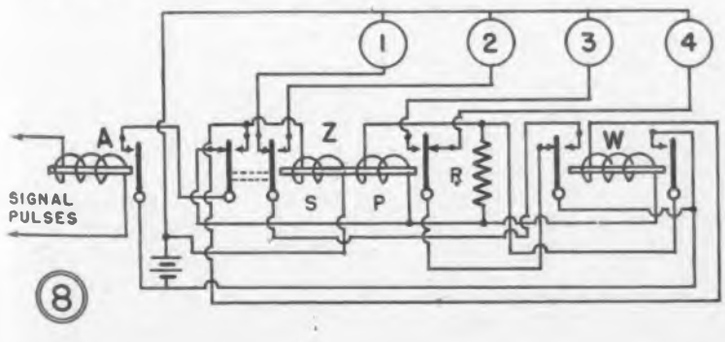
Contact combinations

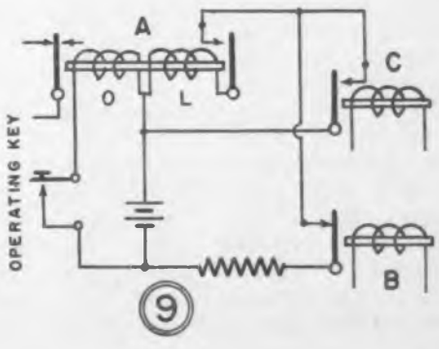
Item (1) shows a simple relay with a "make" contact. The diagram symbolizes a movable armature "a" which is pulled toward the magnet core when the winding is energized, whereupon it contacts "m" and closes a circuit. Using this symbol in a diagram the contacts may be shown at either end of the coil, or if the relay closes several contact combinations at once, the contacts may appear at both ends of the winding core on the wiring symbol. In either case the armature or swinging contact is assumed to move toward the coil in illustrating which contacts open and which close when the relay is magnetized.

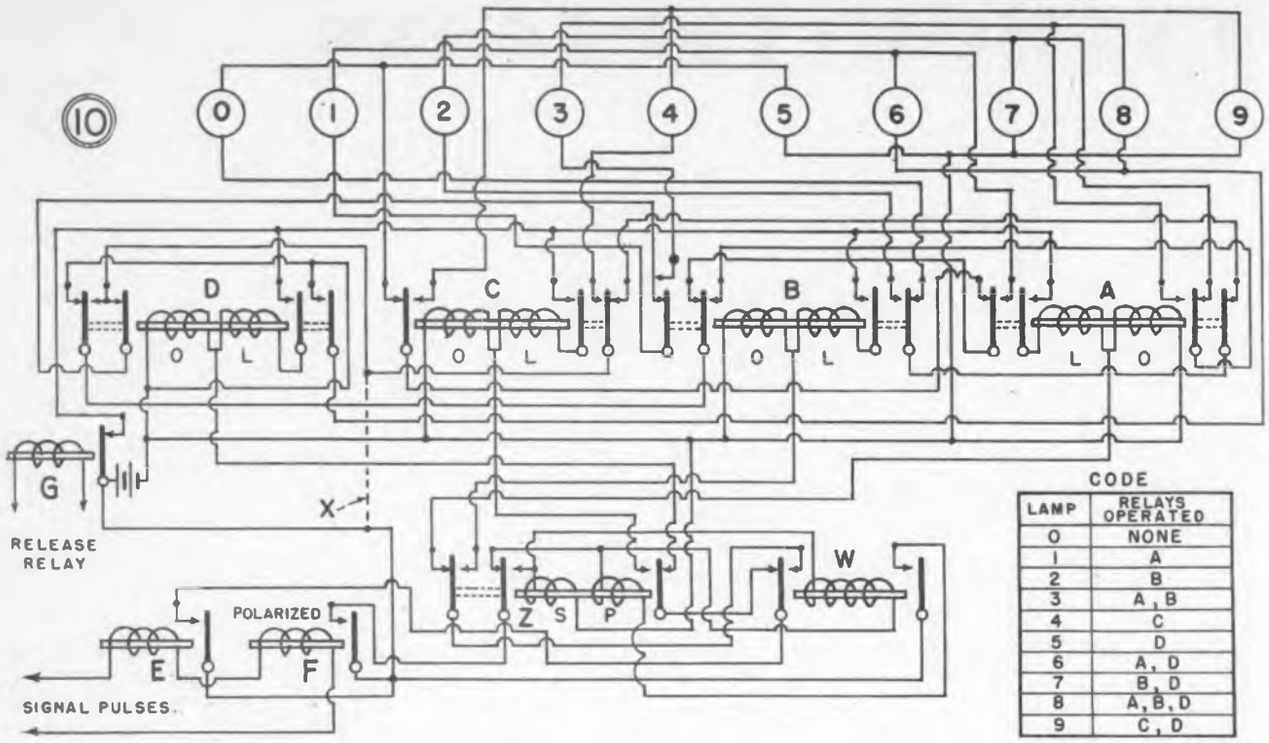
Obviously the contacts may be broken when the relay is operated, which is indicated by item (2) in this figure. A "make-break" or a "transfer" contact is shown in (3) which symbolizes a contact (a) which breaks away from contact (b) and moves over to (m) when the relay is energized. A design sometimes requires that the "make" contacts close before the "break" contacts open. In (4) the magnet pulls the contact (m) against (a) when energized, and both (m) and (a) move in farther so that (a) ultimately pulls away from (b). This is called a "make before break" combination. When the winding releases, (m) and (a) fall back, so that (a) reconnects with (b) before (m) moves far enough back to disconnect from (a). A circuit wired through (m) and (b) would be only momentarily closed while the relay is operating or releasing, giving a momentary closure interval.

Item (5) shows a counting relay chain containing two or more pairs of similar relays. A closure of the contacts at K (which may result from some remote agency by means of relays operated from lines or

A pulse distribution circuit whereby four circuits are selectively operated by presence or omission of pulses during timing interval are shown in circuit (8). At right (9) two methods of releasing a relay held operated through self-locking contacts







Circuit whereby ten different signalling or operating functions can be selected by operating particular groups of relays by a series of pulses. A typical circuit used in telephone call indicator service, adaptable to a wide variety of industrial applications involving multiple control

radio circuits) operates relay (A). This relay stays operated as long as K remains closed. When K opens relay (B) operates in series with A, so that (A) and (B) are then both separated. This connects the operating circuit from K into the next relay.

The next time K closes relay (C) operates followed by the operation of (D) at the end of the second pulse duplicating the operation of A and B in all particulars through any other pairs in the chain on succeeding pulses. The last relay in the chain (relay H in circuit shown) releases all relays so that on the next pulse the whole action is started again, beginning with relay (A).

The relay H may be made slow release (one method is to shunt its winding with a large capacitor) so that all relays have time to drop back before H does. In the usual circuit other contacts are added to particular relays in this chain to perform the circuit functions of counting or control.

In (6) a simple marginal control is illustrated. The two relays have different sensitivities, so that with a light pulse only (B) operates, whereas with a heavy current pulse both relays operate. When (A) operates it nullifies the circuit through the contacts of (B), however. In the circuit, (B) is closed with a light current pulse, closing circuit through device (2). When (A) operates with a heavy pulse, device (2) is de-energized and (3) is operated. When both relays are non-operated device (1) is energized.

It is evident that a similar circuit could be used with polarized relays so that a change in the polarity of the current would operate either (A) or (B).

Pulsing methods

Circuit (7) represents how relay combinations can be built up to produce different control effects by transmitting various combinations of pulses. Here relay (A) operates from the remotely initiated pulses, and operates relay (B) which operates device (1). The latter may be a control valve, solenoid, and indicating lamp, a motor, etc. When relay (A) releases after the first pulse ends, relay (C) operates in series with relay (B), whereupon device (1) is released or stopped and (2) operated. When the next pulse comes along relay (D) operates, releasing device (2) and operating (3). At the end of the second pulse relay (E) operates also in series with D, releasing (3) and operating (4). At the start of the third pulse, relay (F) operates, releasing all other relays and device (4) as well. However, (5) is energized along with relay (F) for the full length of the third operating pulse. At the end of the third pulse, relay (F) falls off and the circuit is restored to the initial condition. The whole cycle of events repeats during successive groups of three pulses.

Another system is the W-Z combination which operates four lamps or other devices from pairs of pulses, shown in item (8). Here when the relay (A) closes, relay W operates first. The relay (Z) is sensitized by current flowing through (S) winding at this time but this current is not strong enough to operate it. At the end of the first pulse (Z) now operates since its (P) and (S) windings are both energized the (P) winding having been shorted previously by the contacts of A. At the start of the second pulse, (W) releases since its winding is now short-circuited by this pulse reoperating (A). Relay (Z) holds up however until the second pulse ends. When (Z) releases the circuit is in the same condition as at the start. The next pair of pulses will cause the whole cycle to repeat. In actual use the relays have additional contacts which operate lamps or control devices (1) (2) (3) (4). These operate in succession, (1) throughout the du-

(*Continued on page* 132)

DISCONTINUITY EFFECTS

By G. GLINSKI
Electronic Division, Northern Electric Co., Montreal, P.Q.

By locating the position of the voltage minimum on each side of a discontinuity, the impedance effect can be found

• The standard transmission line measuring technic is based on the uniformity of a transmission line connecting the source and the load. In practice, however, it often occurs that at least two physically different sections (in dimensions, dielectric, etc.) of transmission lines are used as a link between the source and the load. The junction point of these two sections constitutes a "discontinuity". That is, the usual electromagnetic behavior of uniform transmission line is not valid at that point and the reflection of the principal wave and the apparition of the higher order waves take place. More precise mathematical analysis, including the effect of the electromagnetic waves of higher orders, shows that such a discontinuity always can be replaced by some equivalent lumped four terminal network.[1]

From the engineering point of view, we would like to have simple means of checking the magnitude of the disturbing effect introduced by a given discontinuity and a method of measuring the load impedance even though the effect of discontinuity is present. The modification of transmission line measuring technic as described here seems to be the simplest way of getting the required information.

To check the magnitude of the discontinuity effect we can proceed as follows. Let us introduce the slotted measuring sections (physically similar to the respective transmission lines) to the left and to the right of the point of discontinuity and let us locate the short-circuiting plug (if coaxial lines are used) at some point of the right section.

If the lines to the left and to the right were physically the same, there would be no discontinuity present and the shift of the short-circuiting plug on the right section

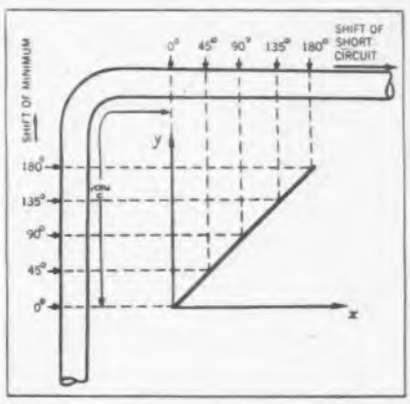


Fig. 1—On a uniform line, the movement of the short circuit point along X shifts the position of any voltage minimum by an amount Y

from some arbitrary zero position to the right would produce equal shift of the voltage minimum on the left section (Fig. 1). The graph of the position of the voltage minimum γ on the left section (vertical on Fig. 1) versus the position x of the short-circuit on the right one (horizontal on Fig. 1) would be a straight line with 45° slope as shown on the graph in the same figure.

S-curve

Since actually the lines are physically different and discontinuity exists (Fig. 2), the shift of the voltage minimum versus shift of the short-circuit will differ from the straight line and will appear as an S-shaped curve shown on the same figure.

Hence the existence of any appreciable discontinuity can be simply detected by plotting a γ versus x curve in the way explained above. As far as the author knows this peculiar shape of γ versus x curve was first noticed by R. W. King and used for the purpose of measurement of the dielectric constant at ultra high frequencies.[2]

The physical explanation of the appearance of the S-shaped curve is simple. The simplest discontinuity is equivalent to some lumped impedance bridged across the uniform transmission line. The shift of the short-circuit can be also interpreted as the shifting of the point at which this discontinuity impedance is connected across the line permanently short-circuited at the given point. For a given amount of the discontinuity the effect will be proportional to the input impedance of the line at the point of connection of the discontinuity impedance. For example, the discontinuity impedance has a negligible effect when connected at the short-circuit or any multiple of a half-wave therefrom. On the contrary, the effect of the discontinuity is the greatest when it is connected at a distance from the short-circuit of ¼, ¾ or any subsequent half wave multiple therefrom.

Having thus determined qualitatively the existence of a discontinuity, the next step is to find the means of determining quantitatively the influence of the existing discontinuity on the value of measured impedance.

Applying the law of transformation of impedance of a uniform transmission line by the insertion of a general four-terminal network, it can be shown[3] that

$$Z_{o1} \tan(\gamma - \gamma_o) = k\, Z_{o2} \tan(x - x_o) \qquad (1)$$

$$k = \frac{Z_{o1}}{Z_{o2}} \cot^2(x_1 - x_o) \qquad (2)$$

where Z_{o1} & Z_{o2} are characteristic impedances of the left and right sections respectively.

x_o & γ_o are the coordinates of the point of inflection on the S-curve (Fig. 3).

[1] J. R. Whinnery, H. W. Jameson and T. E. Robbins—Coaxial Line Discontinuities Proc. I.R.E., Vol. 32, p. 695 (Nov. 1944).

[2] R. W. King—Absolute Method for Measuring Dielectric Constants of Fluids at Uhf. Rev. Sc. Instr., Vol. 8, p. 201 (June 1937).

[3] A. Weissfloch—Ein Transformationssatz uber verlustlose Vierpole und seine Anwendung auf die experimentelle Untersuchung von Dezimeter—und Zentimeterwellen—Schaltungen. Hochfr. u El-ak., Vol. 60, p. 67 (Sept. 1942).

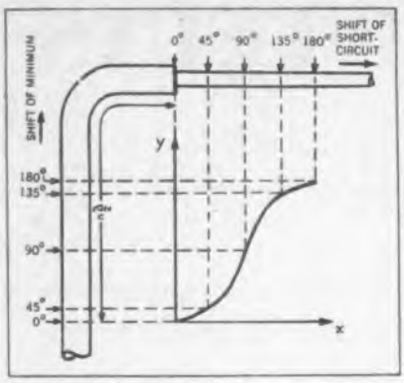


Fig. 2—On a non-uniform line, the movement of the short circuit point X shifts position of voltage minimum by a different amount Y

x_1 is the abscissa of the upper point of minimum slope on the S-curve (Fig. 3).

The equation (1) can be interpreted also as meaning that the discontinuity together with the sections of transmission lines up to γ_0 (to the left) and x_0 (to the right are equivalent to a transformer with transformation ratio

$$t = \sqrt{k} \qquad (3)$$

Therefore, any impedance Z_2 connected at x_0 appears at γ_0 as an impedance $Z_1 = k\,Z_2$.

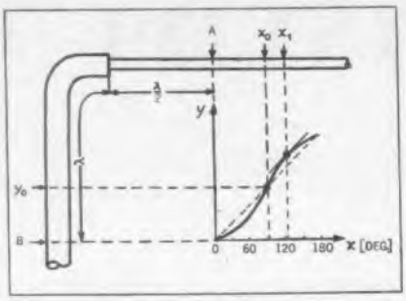


Fig. 3—Effect of discontinuity produced by shift from 35 ohm to 75 ohm characteristic impedance line

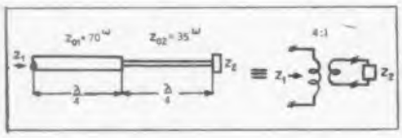


Fig. 4—Equivalent circuit on Fig. 3

As we see the determination of the S-curve together with its points x_0 and x_1 gives a simple means for quantitative determination of the effect of the discontinuity.

The S-curve plotted in Fig. 3 refers to the simple case of a 35 ohm characteristic impedance coaxial line (right) connected to a 70 ohm characteristic impedance coaxial line (left). The frequency used is such that the effect of higher order waves is negligible. The shift of short-circuit is counted from the position A, half-wavelength from the location of the discontinuity. The shift of minimum is counted from the position B, one wavelength from the location of discontinuity. From the curve: $x_0 = 90°$; $x_1 = 125°$. Hence $k = \frac{70}{35} \cot^2 (125\text{-}90) = 4$. Therefore any impedance Z_2 connected at x_0 appears at γ_0 as an impedance $Z_1 = 4Z_2$ (Fig. 4). In the case considered, the correctness of the above result can be easily verified. Since x_0 and γ_0 are quarter-wave points, the impedance Z_2 is transformed by the quarter-wave section of characteristic impedance 35 ohms into the impedance $\frac{35^2}{Z_2}$. This impedance is in turn transformed by the quarter-wave section of characteristic impedance 70 ohms into the impedance $\frac{70^2}{35^2/Z_2} = 4Z_2$, which checks the previous result.

Equations for Resonators

L. S. Goddard (Proceedings of the Cambridge Philosophical Society, London, Vol. 41, Part 2).

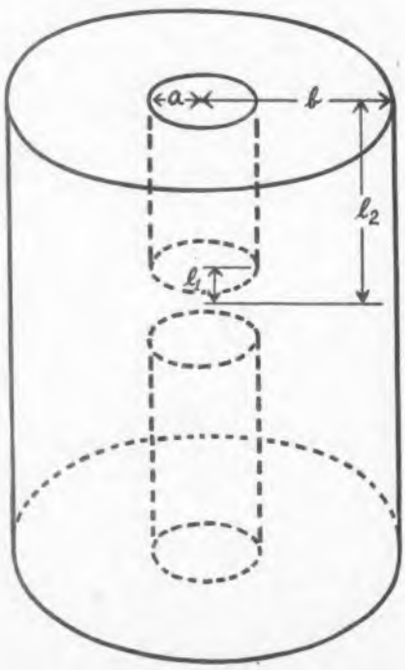
Recently developed mathematical formulas are used for calculating the electromagnetic field inside an axially symmetrical cavity resonator of the general shape illustrated; the fundamental mode of oscillation is considered. It is assumed that the length 2 x l_2, is smaller than resonant wavelength, λ, and that the radius b, is larger than twice the radius a.

Relationships, involving first and second order Bessel functions, are given between the dimensions of the resonator a, b, l_1 and l_2 and the resonant wavelength λ; a comparatively simple method of the evaluation of b from the other variables is suggested.

For l_2 much larger than l_1, or for small gaps, the formula for the resonant wave length may be simplified to the expression:

$$\lambda = \pi a \left[2(l_2/l_1) \log (b/a)\right]^{\frac{1}{2}}$$

An expression for the figure of merit, Q, involving only knowledge of the magnetic field strength within the resonator and at its boundaries is given; the magnetic field strength can be found by the computations proposed in the article.



It is further suggested that the method developed be used in the treatment of problems involving the transmission and reflection of energy along wave guides or transmission lines when there is a discontinuity in the cross-section.

Determining RF Resistance of Wires

By Chandler Stewart, Jr. (Journal of Applied Physics, October, 1945).

A method was developed for measuring the resistance of wires at frequencies between about 200 kc and 40 mc. The test specimen is strung down the center of a metal pipe about ten to a hundred feet in length, depending upon the test frequency, to form a coaxial transmission line. One end of the line is short circuited and the other connected to a commercial Q-meter.

The formulas required for the measurement are derived and the device, the method used, and the precautions to be taken are described in detail. Curves for determining the resistance from the Q-meter reading are included.

This method appears to be more reliable than the use of coils where the proximity effect and the effect of distributed capacitance cannot be determined accurately. For round wires known to consist of homogeneous material, calculated values of rf resistance appear to be just as reliable and accurate as experimental values, and are much more easily obtained; this is no longer true if copper clad steel and flexible wire types are considered.

SURVEY of WIDE READING

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

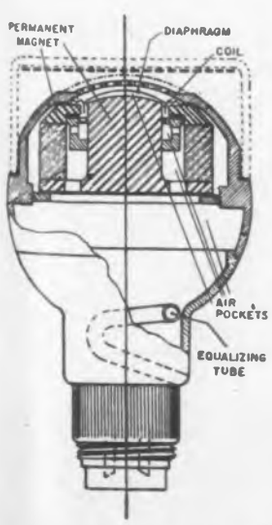
Dynamic Microphone

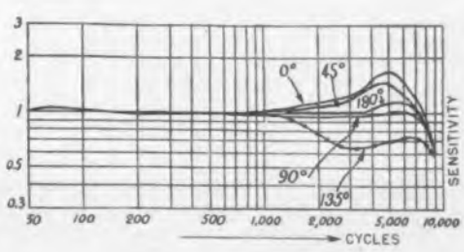
Walter Baer, Laboratorium der Reichs-Runfunk-Gesellschaft (Akustische Zeitschrift, Leipzig, Vol. 8, No. 4).

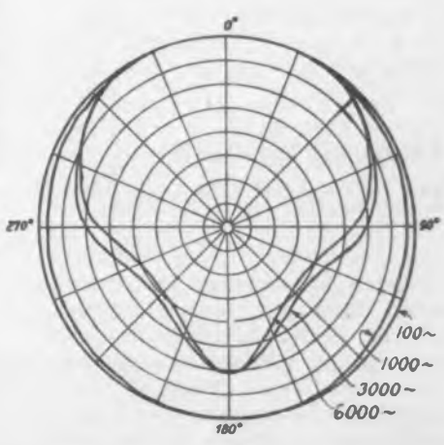
The design of a moving coil microphone installed at the German Reichs - Rundfunk - Gesellschaft (Government Radio Association) is described. High sensitivity and comparatively constant frequency response are obtained by the provision of air pockets behind the diaphragm (Fig. 1). These are responsible for resonances at 450 cycles, 2,500 cycles and 8,000 cycles. The sensitivity at these frequencies otherwise would be undesirably low. Frictional forces on the air are provided by special damping materials in the narrow channels connecting the air cavities. The narrow, long equalizing tube connects the largest air pocket with the outside space; it increases the sensitivity at the low frequency end.

The directional characteristic of the microphone is carefully considered. For the reception of diffuse sounds, a constant frequency response at a 90 deg. angle of incidence, i.e., from the sides, is desirable. A sound screen (as described by Marshall and Romanow in the Bell System Technical Journal of January, 1936) is used. A single layer of fabric reinforced at the edges by a circular piece of material proved most satisfactory as the ratio of reflected sound at 180 deg. incidence to absorbed sound at 0 deg. incidence was thereby increased as compared with an evenly dense screen. In Figs. 2 and 3 are plotted average values of the directional frequency characteristics obtained for a series of microphones.

The acoustic sensitivity of the microphone, i.e., the ratio of output voltage to sound pressure at the diaphragm, is at least 100 microvolt/dyne per square centimeter for an output resistance of 200 ohms at 800 cycles and for a noise level of 54 decibels referred to 1 dyne per square centimeter. The overall efficiency of the microphone is approximately 0.4%; the efficiency of the transducer system is 2%. The mechanical input resistance is evaluated as 660 gram/square centimeter/sec. At a pressure of 100 dynes per square centimeter the diaphragm displacement amounts to 5 microns or 2×10^{-4} inches at a frequency of 50 cycles; non-linear distortion is not to be expected for such small movements, nor has it been observed.







Portable Electrometer

By D. Bulgin (Journal of Scientific Instruments, London, August, 1945).

A vacuum tube voltmeter with associated circuit (Fig 1) is adapted for measurements of electrostatic voltages, electrostatic charges, ac voltages and resistances to ground; the portable instrument is particularly designed for testing insulators.

The instrument measures voltage by the induction of a small voltage, proportional to that of the source under examination, onto the grid system of the electrometer tube. Capacitive coupling between the voltage to be measured and the grid of the tube is used; one plate of the coupling capacitor is indicated in the drawing, the other plate is constituted by a surface of the system under investigation.

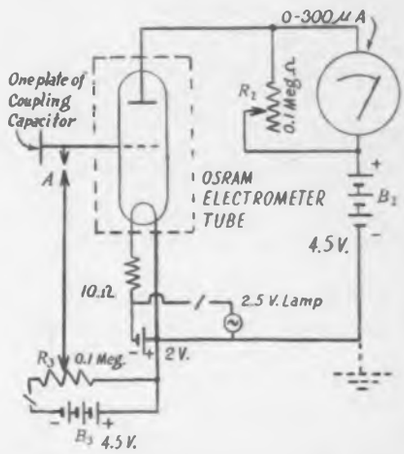


Fig. 1: Portable voltmeter for testing insulators

While fundamentally a voltmeter, the apparatus may be used either to read the potential of the surface if the additional capacity to ground introduced by the proximity of the instrument is small, or as an indicator for the charge if at a small separation from the object the capacity of the capacitor formed by the instrument and the surface is large compared with other capacities of the surface to ground.

Zero adjustment for the meter in the plate lead of the electrometer tube is made by variation of R_2; R_3 and battery B_3 enable a voltage negative to the filament to be

Fig. 1, left: Dynamic microphone. Figs. 2 and 3, center and right: directional frequency response curves

applied to the grid by making contact A. The input to the grid depends on the size of the aperture in front of the coupling capacitor plate as well as on the distance of the voltage source from this plate. The electrometer tube is enclosed in a shielding tube (Fig. 2) having

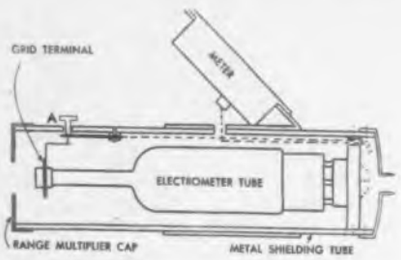


Fig. 2: Details of voltmeter within dashed line of Fig. 1 showing range multiplier mounting

an adjustable circular aperture, the diameter of which can be changed by the insertion of different size caps. This permits the operating range of the instrument to be varied. The meter scale is calibrated in 100 v steps to 1500 v per ft. for a plane source, with the end of the shielding tube open. Two caps, or range multipliers, are provided which cover the end of the shielding tube except for central apertures 0.95 in. for the ten times range multiplier and 0.45 in. diameter for the hundred times range multiplier. In this way voltages from 50 v 6 in. away to 10^6 v 7 ft. away can be read.

For the measurement of surface charges, it is practicable to provide a probe to explore details of the charge distribution. Reversal of charges occurring within 2 mm distances on an insulated surface have been examined. Calibration in coulombs per sq. cm is available by the provision of a capacitor cap of known capacitance.

The resistance measurement is carried out by observing the time required for a voltage of 4.1 v across a known capacitor to decrease to 2.5 v; a range of capacitors is provided to cover resistances from 10^7 to 10^{11} ohms.

Filament Vibrations

By R. W. Carlisle and H. W. Kaoren (Journal of the Acoustical Society of America, July, 1945).

A method of testing undesired tendency to vibrations in vacuum-tube filaments was developed wherein the vacuum tube, mounted in a suitable vibrator, was actuated by an oscillator. When the tube and mounting was placed in a magnetic field, a voltage is generated which is proportional to the vibration amplitude. This voltage is amplified and detected with headphones and an ac meter. Vibrations may be investigated with filaments either cold or hot, in open mounts or in sealed bulbs. Due to expansion, the resonance frequency of the strands when hot is lower than when cold. The tension spring is not heated by filament current, hence the corresponding resonance frequency is constant. The two resonance conditions can thus be distinguished.

Measuring Balanced-Pair Cables at HF

By J. C. Simmonds (Journal of the Institution of Electrical Engineers, Part III, London, June, 1945).

Apparatus has been developed which enables the characteristics of balanced-pair cables and feeders to be determined at high frequencies and on short lengths of cables (not more than one to two wavelengths long). The apparatus consists essentially of the parallel tuned L,C circuit energized from some suitable source S, and a standard variable resistor represented by the diodes D_1,D_2 and associated variable cathode resistors R_1,R_2 each shunted by a large capacitor. The voltage developed across the circuit is monitored by a high-impedance vacuum tube voltmeter VTVM.

The unknown impedance is measured by connecting it across the circuit to terminals T,T and determining the change required in the tuning capacitor C and the diode resistors R_1,R_2 to restore the resonance condition and the voltmeter to its former reading. The diode-capacitor-resistor combination used as variable resistor element is equivalent to approximately half the resistance of the resistor in the cathode lead.

Calibration of the diode variable resistor and of the variable capacitor is described and procedures for measuring the open and the short circuit impedance of cable lengths less than a quarter wavelength and cable lengths a multiple of a quarter wavelength are explained. In the first instance an accuracy of ±3% over a frequency range from about 100 kilocycles to 7 megacycles can be obtained; in the second instance the error will not exceed ±2% up to 10 megacycles.

Indicating Changes in Concentration

G. G. Blake, University of Sidney (Journal of Scientific Instruments, London, September, 1945).

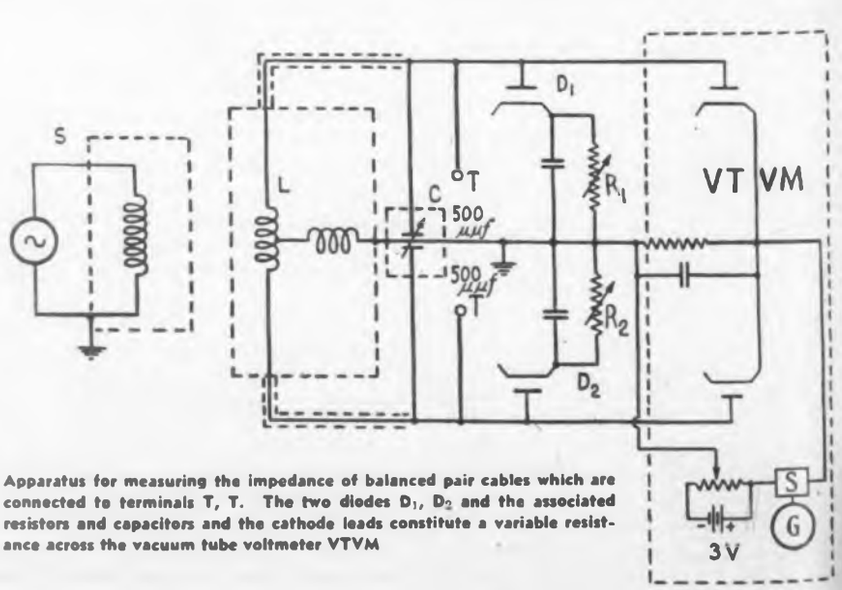
A liquid column containing the solution of an electrolyte is connected across the tank circuit of an oscillator. Changes in concentration of the electrolyte cause impedance variations of the liquid column which are indicated by a microammeter in the plate supply of the oscillator. The apparatus may be adapted for relay operation which permits control of liquid flow, stopping it if the concentration deviates from a desired value. Details of the apparatus are given.

Current Distribution Between Coaxial Cylinders

By L. Page and N. I. Adams, Jr. (Physical Review, September, 1945).

Solutions of the space charge equation for coaxial cylindrical electrodes are obtained which apply in cases where the radius b of the outer electrode (plate) is large

(*Continued on page* 124)



Apparatus for measuring the impedance of balanced pair cables which are connected to terminals T, T. The two diodes D_1, D_2 and the associated resistors and capacitors and the cathode leads constitute a variable resistance across the vacuum tube voltmeter VTVM

A Joint Development of ERIE RESISTOR CORP. and CINCH MANUFACTURING CORP.

CINCH-ERIE
Plexicon Tube Socket

...to the By-Pass Condensers where they belong . . . around the Tube Pins

Provides shortest possible electrical path to ground.

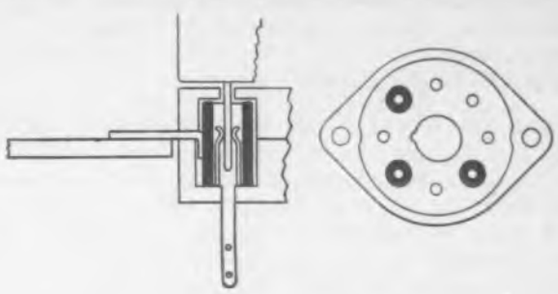
Saves space—permits moving other components closer to tube socket.

Reduces set assembly costs.

Capacitive coupling effect between by-passed tube pin and adjacent pins is reduced by shielding effect of outer electrode of condenser.

Plexicon sockets are installed exactly the same as standard Cinch Lock-in, Octal, and Miniature type sockets.

Top of Cinch-Erie Plexicon Lock-in type socket matches tube base.



The above two schematic diagrams show the basic design principles of Cinch-Erie Plexicon Tube Sockets.

In the plan view, the socket is shown with condensers for by-passing three tube pins. The silvered-ceramic condensers are shown in green.

Note in the side view that standard tube prong clips are used, and that the condenser completely surrounds the tube pin.

Mounting dimensions of the Lock-in type are: 1.312" between center line of mounting holes; chassis hole 1.125" diameter.

Electronics Division

and ERIE RESISTOR CORP.

ERIE, PENNSYLVANIA

WASHINGTON

Latest Electronic News Developments Summarized by Electronic Industries' Washington Bureau

DECISION ON ADDITIONAL FM BAND—FCC was slated to set the last of January or early February on proposal of Zenith's Commander MacDonald for enlargement of FM broadcasting space to give wider rural coverage for that new service. Zenith tests in old band, 42-50 megacycles, in Wisconsin proved highly interesting in presentation at the FCC hearing Jan. 18, in which a number of manufacturers and licensees of FM and television stations participated. Despite FCC previous adamant stand for placing FM upstairs. 88-108 mc band, because of Sporadic E interference, use of the lower band appeared a good possibility. FCC was likely to give new FM space of 44-50 mc for Area II (outside heavily populated Eastern states). This space, now the Community Television Channel, would be utilized for Television in Area I (Eastern states). FCC realizes there may be need for providing rural FM service (a radius of about 25 miles beyond the primary FM range), which even if subject to interference, would be better than nothing.

FCC STRONG FOR PERMANENT UPSTAIRS SPOT FOR FM—Commission still adheres to "upstairs" assignment for FM broadcasting. Insists that 1% interference from Sporadic E during the season from May to October when it is concentrated would result in defective FM service if left in lower band. FCC experts point out that interference in FM is different from standard broadcasting because it would mean blotting of station being heard by another program from a far-distant FM station.

FM TRANSITION TO BE EVOLUTIONARY—Plans of transmitter manufacturers are to produce FM transmitters in moderate numbers so that transition from AM to FM broadcasting will be evolutionary and NOT revolutionary in the sense of dumping several thousand station equipments on the market at once. Of course, the labor unrest and walkouts have affected the plans of the major manufacturers to start this orderly program of production. Designs have been completed by nearly all manufacturers for their FM home receivers so that production is geared to start with either the single "upstairs" FM set or two-band sets. Pending determination of the frequency situation by the FCC, manufacturers of receivers have been badly handicapped, but are set for the "starting gun" for full production.

TELEVISION DELAYED IN WASHINGTON INAUGURAL—Decision of President Truman not to make a personal appearance before Congress with his annual message on Jan. 15 was disappointing to television broadcasters as the three TV groups with stations in Washington had planned an outstanding video presentation via coaxial cables to New York. Television therefore is awaiting another outstanding opportunity to launch this important intercity service. The hearings from Jan. 21 to Feb. 1 on Washington television stations gave the industry a good guide to FCC thinking in regard to this new service. The Commission and Washington radio consultant engineers also were greatly interested in the CBS color television demonstration in advance of the annual IRE sessions.

INTERNATIONAL CONFERENCES—1946 is witnessing a series of highly important international radio conferences which are to be especially significant for the industry's engineers and manufacturing planners because of determination of permanent frequency assignments. First is the comparatively tiny conference on the North American Regional Broadcasting Agreement which starts Feb. 4 in Washington and is to iron out the clear channel and allocation engineering standards for AM, FM and television in the North American sphere. In March, or possibly later in early summer, will come the projected meeting of the "Big Five" countries (United Nations) on frequency and radio engineering standards. This is likely to be in the United States, close to Washington, according to present plans and it will be the preview for the World Telecommunications and Radio Conferences.

SURPLUS DISPOSAL AGENTS—Despite the efforts of certain cliques in the Washington governmental setup, probably urged by some speculator groups, Surplus Property Administration has agreed not to change drastically—or, more important, not to scrap—contracts with manufacturers to be the Government's agents in disposing of military surplus in the radio-electronics field. This decision was reached in Mid-January by Surplus Property Administration top officials after meeting with industry—a five-member RMA committee composed of Sylvania's Balcon, Hallicrafters' Halligan, General Electric's Henyan, International Resistance's Searing and Stromberg-Carlson's Gibson. Contracts are being refined to have agreements to fit manufacturers who are specialists in distribution and companies highly qualified for testing and renovation work; non-productive agents are to be weeded out on basis of RFC questionnaire.

RADAR RULES AND STANDARDS—FCC is continuing to issue experimental licenses in radar, but is delaying formulation of its Rules and Standards for Radar and Loran until it has consulted the Army and Navy as to what technics still must be kept secret. A determination must be made as to how far radar developments by the military during the war can be disclosed for public usage. The U. S. Coast Guard under the leadership of Commodore E. M. Webster, Chief Communications Officer, recently paved the way for stimulation of the use of Radar by merchant marine and aviation in its conferences and in a booklet, just issued, on Loran-Racon-Radar.

National Press Building
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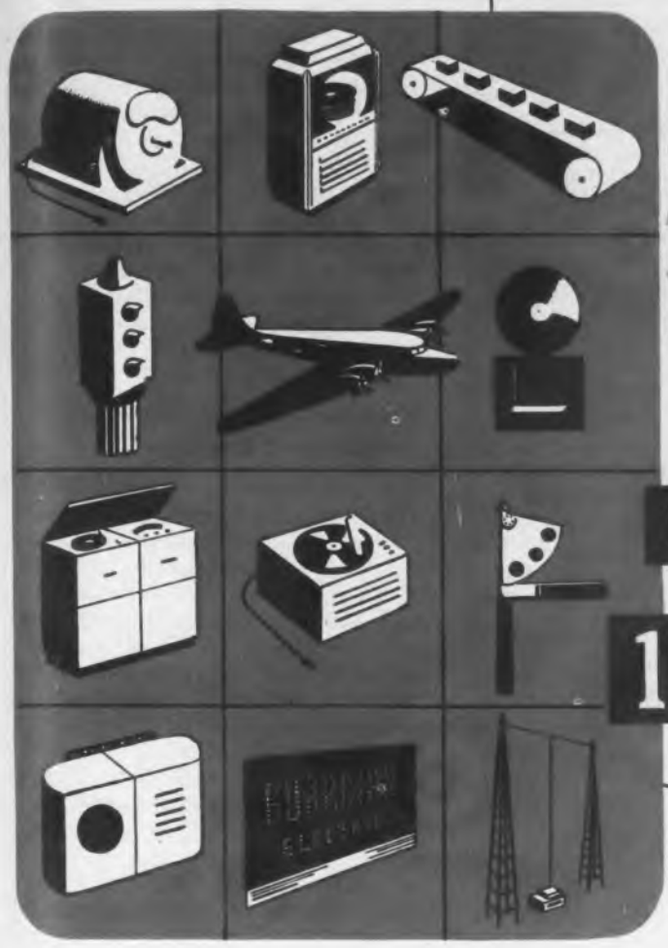
ROLAND C. DAVIES
Washington Editor

TOMORROW'S relays



1947

1946

for Designs of

TODAY

Relays BY GUARDIAN

Electrical control in today's home radios and appliances—in home lighting—on the farm—in planes—on trains—for telephony—broadcasting—coin-automatic music and innumerable applications reveals a definite trend toward increased usage of *standard* Relays by Guardian. Such recognition of *standard* relays by forward thinking design engineers is the result of forward planning by Guardian to produce basic relays having a multiplicity of variations. Thus, where a "special" could have been specified Guardian invariably came through with a *standard* unit better qualified on

PERFORMANCE • PRICE • DELIVERY

For example, the Guardian Series 100 Relay is a *standard* type with replaceable coil and contacts. Operating range 3 v. to 230 v. at 60 cycles. Another unit, the Series R Stepping Relay is built for three basic types of A.C and D.C. operation: 1. Continuous rotation; 2. Electrical reset; 3. Add and subtract. Write on your business letterhead for NEW RELAY CATALOG showing many *basic* relay types, a complete line of solenoids, magnetic contactors, switch parts together with operating data, specifications, suggested applications. No cost. No obligation. Your catalog is waiting.

Series 100 A. C. Relay

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GUARDIAN ELECTRIC

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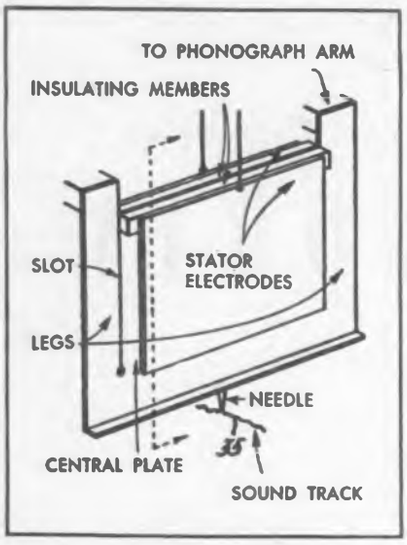
A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

NEW PATENTS ISSUED

FM Phonograph Reproducer

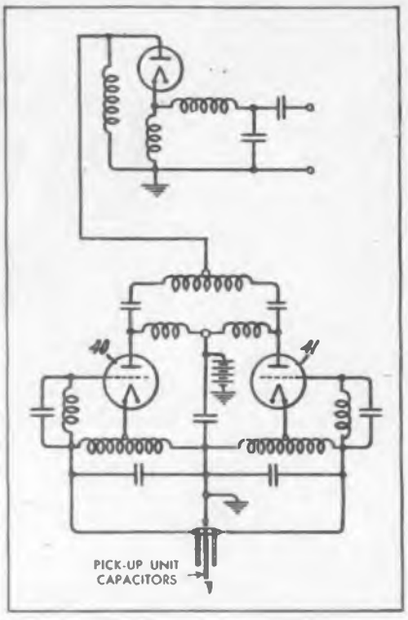
The pick-up unit designed for use in the frequency-modulated reproducer does not respond to very low frequencies which may be caused by eccentricities in the recording. Excessive resonance in the useful frequency range is avoided and the driving force of the record on the pick-up unit is maintained at a low value.

In the capacitive pick-up unit, the central electrode which carries



the needle is carried by a pair of legs which are attached to the phonograph arm. The stator plates are supported by isolating members made of a material which, when deformed, returns to its previous shape with a minimum of oscillations. These members are connected to the two sides of the central plate.

Movement of the needle along the track causes the central plate to vibrate at audio frequencies. Preferably, the mass of the stator plates plus the insulating members is such that the natural frequency of vibration of this combination in conjunction with the central plate occurs below the audio frequency range. Consequently at audio frequencies, this portion of the apparatus will remain at rest while the lower part of the central plate is vibrating. However, application of a very low frequency force to the needle is effective to move the whole unit avoiding response of the



unit to this type of force which may be caused by off-center records or other eccentricities in the recording. In the operating range, the only mass moved by the vibrating needle is the mass of the needle plus the mass of a small lower section of the central plate keeping the driving force at low value. Further, at frequencies considerably above the natural frequency of the assembly, a constant needle amplitude results in a constant percentage change in capacitance of the two capacitors at both sides of the central plate.

The electronic circuit associated with this pick-up unit is a frequency-modulated push-pull connected oscillator and a diode rectifier. Tubes 40 and 41 and their associated circuits generate high frequency oscillations of different frequencies. These frequencies are frequency-modulated in opposite sense by the two capacitors formed by the pick-up unit. Push-pull connection of these two capacitors eliminates even harmonics. Detection is accomplished in the diode, only the difference frequency being passed through the following filter which difference frequency is frequency-modulated in accordance with the signal on the record.

W. Hausz, General Electric Co., (F) March 9, 1943, (I) October 2, 1945, No. 2,386,049.

Stabilizing Frequency in LF Crystal Oscillators

In low-frequency (about 1 to 10 kc) flexure mode types of piezoelectric crystals, the natural frequency of the crystal increases as a result of an increase in vibration amplitude which in turn may be caused by a change in supply voltage or oscillator tube characteristics. It is therefore proposed to incorporate a compensating network in the oscillator circuit to stabilize the frequency against variations of supply voltage or tube characteristics.

The low-frequency flexure mode type crystal may be a duplex crystal body consisting of two thin flat quartz plates bonded or soldered together in major face to major face relation vibrating in a fundamental flexure mode of motion bending in the thickness direction at a desired frequency within a range of frequencies which are practical down to a few hundred cycles per second. These piezoelectric crystals of the low frequency flexure mode type which inherently have a relatively large magnitude of vibratory motion may considerably increase their natural resonant frequency with an increase in

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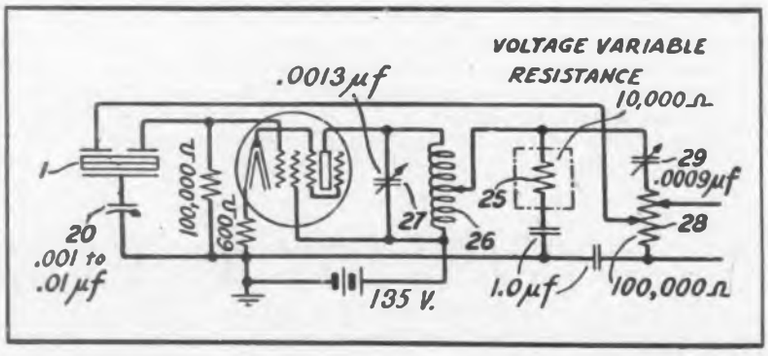

NEWS OF THE INDUSTRY

New Wire Recorders

Two new magnetic wire sound recording equipments have been developed by the Armour Research Foundation of the Illinois Institute of Technology. Both units were revealed at a meeting held in Chicago early in January. The first of these is a small, inexpensive recorder, which will be styled Camras Transitional Model and is designed for installation in home receiver sets. The device includes a high speed rewind and despite the fact that it occupies only about half the space of a standard disk recorder measuring about 6 x 12 in. nevertheless it is so arranged that the large take-up spool can be used as a turntable for a disk record if desired.

The other development is a Demonstrator model which also incorporates a high-speed rewind and has been engineered to provide fidelity equal that of electrical transcriptions. To date, some twenty-five manufacturers have been licensed by the Wire Recorder Development Corp., 135 South LaSalle Street, Chicago, which handles the entire licensing program.

Enters Radio Field

The Asco Corp. has been formed in Cleveland with a factory at 874 East 140th Street for the manufacture of radio, television, electronic, mechanical and electrical components. The company is headed by John Altmayer. Associated with him as secretary and treasurer of the company is E. E. Slabe, who was president of the Slabe Machinery Products Co., Cleveland, a manufacturer of screw machine parts. A. R. Keskinen formerly with the Engineering Department of Bendix has been retained as a project engineer.

N. Y. Transformer Moves

The New York Transformer Co. has changed its location. Since the first of the year the company has occupied new headquarters at 62 William Street, New York 5, N. Y.

FCC Names Engineers

Following the reorganization of the engineering department of the Federal Communications Commission made public about a month ago, engineers who will have charge of the various divisions have been named. Under the Field and Research Branch headed by Assistant Chief Engineer George E. Sterling there are to be four divisions as follows: Field and Monitoring Division (George S. Turner); Technical Information Division (Dr. Lynde P. Wheeler); Laboratory Division (Charles A. Ellert); Allocation Division (Paul D. Miles).

The Safety and Special Services Branch which is headed by William N. Krebs consists of three divisions as follows: Marine and General Mobile (Howard C. Looney, acting chief); Emergency and Miscellaneous Division (Glen E. Nielsen); Aviation Division (George K. Rollins, acting chief pending return of Edwin L. White).

IRE Buys Home

The Institute of Radio Engineers has completed arrangements for the purchase of the permanent home for which it has been working during the past many months. The Institute has acquired the four-story residence originally built by Isaac V. Brokaw more than half a century ago and located at 980 Fifth avenue, New York.

Allied Buys Miller

Allied Control Co., Inc., New York, manufacturers of relays and electronic devices has acquired the B. F. Miller Co., Trenton, N. J., which since 1910 has been a manufacturer of transformers. It is planned to enlarge the facilities of the company. B. F. Miller remains executive vice president and general manager.

Philco Re-names Subsid

Philco Radio & Television Corp. which is a wholly-owned subsidiary of the Philco Corp., Philadelphia, and has handled national distribution of Philco products in the United States, henceforth is to be styled Philco Products, Inc. The change in corporate style has been made to better identify the expanded operations of the corporation.

Price Changes Name

Henceforth it is to be the Price Electric Corp. instead of Price Brothers Co. by which name the company has been known heretofore. The organization manufactures relays and controls. Its plant is in Frederick, Maryland. Aside from the change in name there has been no other change in ownership or management.

Hotel Tele

It begins to look a little as though hotels would go for television in their rooms, at least to some of the extent that they now provide guests with radio reception. Some time ago the Hotel New Yorker in New York surveyed its guests and got an almost overwhelming response for pictures. Now it is reported that the Statler chain of hotels is seriously considering installation of video equipment.

Sprague Advances Two

The Sprague Electric Co., No. Adams, Mass., has made two changes in its executive personnel. Julian K. Sprague and Dr. Preston Robinson have been elected vice-presidents of the company.

Conventions and Meetings Ahead

Institute of Radio Engineers, New York Section (330 West 42nd Street, New York): February 6, paper on 5RP-multiband tube, I. E. Lempert and R. Feldt, DuMont Labs.

Institute of Radio Engineers, Chicago Section (135 So. LaSalle Street, Chicago 3, Ill.), February 15, March 15, April 19, and May 17.

American Society for Testing Materials (260 S. Broad St., Philadelphia); 1946 Spring Meeting, Feb. 25 to March 1, Pittsburgh.

Optical Society of America (A. C. Hardy, Mass. Inst. of Tech.; Mar. 7-9, Cleveland.

National Association of Broadcasters (Bruce Starkey, Chief, News Bureau, 1760 N St., N. W., Washington 6, D. C.); Broadcast Engineering Conference, March 18 to 22, Ohio State University, Columbus.

American Institute of Electrical Engineers (H. H. Henline, 29 West 39th Street, New York); South West District Meeting, April 16 to 18, San Antonio, Tex., Northeastern District Meeting, April 21 to 25, Buffalo. Southeastern Dist. Meeting, May 13 to 16.

American Society for Testing Materials (260 South Broad Street, Philadelphia); Forty-ninth Annual Meeting, June 24 to 28. Buffalo, simultaneously, Seventh Exhibit of Testing Apparatus and Related Equipment.

American Institute of Electrical Engineers (H. H. Henline, 29 W. 39th Street, New York); Summer Convention, June 24 to 28, Detroit. Pacific Coast Convention, August 26 to 30, Seattle.

Instrument Society of America (L. Susany, Secretary, Carnegie Institute, 4400 Forbes Street, Pittsburgh); 1946 Exhibit and Conference, September 16 to 20, Pittsburgh.

★ TELEVISION TODAY* ★

New Developments in the Video Field

FCC Allocates Metropolitan Frequencies

It appears likely that there may be a considerable gap in the television situation between the time when existing stations must go off the air for a change in frequency and the time when they may return to the air on the newly assigned frequencies just released by Federal Communications Commission.

According to the present schedule, existing stations that must change frequencies will be required to go off the air on or before March 1 and to return to the air on the new frequency on or before July 1.

As it stands at present, the amateurs are still allotted the frequencies between 50 and 54 mc. and will not be required to move from 56-60 mc. until March 1. This, of course, ties up channel 2 until after March 1.

Late in December FCC made public a list of assignments for the present commercial television licensees and licensees of ten existing experimental television stations. These are all Metropolitan stations with their existing powers and antenna heights. Below is FCC's complete assignment of frequencies.

Commercial Television Broadcast Stations

Location	Licensee	Call Letters	New Channel No.
Chicago	Balaban & Katz	WBKB	4 (66-72 mc)
New York	Columbia Broadcasting System, Inc.	WCBW	2 (54-60 mc)
New York	Allen B. DuMont Labs., Inc.	WABD	5 (76-82 mc)
New York	National Broadcasting Co.	WNBT	4 (66-72 mc)
Philadelphia	Philco Radio & Television Corp.	WPTZ	3 (60-66 mc)
Schenectady	General Electric Co.	WRGB	4 (66-72 mc)

Experimental Television Broadcast Stations

Chicago	Balaban & Katz	W9XBK	4 (66-72 mc)
Cincinnati	Crosley Corp.	W8XCT	4 (66-72 mc)
New York & Passaic, N. J.	Allen B. DuMont Labs., Inc.	W2XVT W2XWV	5 (76-82 mc)
Los Angeles	Don Lee Broadcasting System	W6XAO	2 (54-60 mc)
Springfield Twp. Pa.	Philco Radio & Television Corp.	W3XE	3 (60-66 mc)
Los Angeles	Television Productions, Inc.	W6XYZ	5 (76-82 mc)
Chicago	Zenith Radio Corp.	W9XZV	2 (54-60 mc)
Camden, N. J.	Radio Corp. of America	W3XEP	6 (82-88 mc)
Iowa City, Ia.	State Univ. of Iowa	W9XUI	1 and 13 (44-50 mc) and (210-216 mc)

Argentine Experts Study US Tele

Two distinguished television experts from south of the border have been visiting in the United States. They are Dr. Eduardo E. Grinberg and Alejandro Ubertini. Grinberg is president of the Centro Argentino de Television (Argentine Television Society), founder of the Instituto Experimental de Television (Experimental Television Institute), and a director of the Primera Cadena Argentina de Television (Argentine Television Network). Ubertini is a director and engineer of the Argentine Television Network. The two Argentinian experts have been spending a considerable amount of time in the General Electric Television Station WRGB in Schenectady.

Institute Honors Hartley, Goldmark

Among other matters of routine business, the Institute of Radio Engineers presented special awards to two engineers at its Winter Meeting annual banquet, held at the Hotel Astor, New York, late in January. The first of these awards, the Institute's Medal of Honor, went to Ralph Vinton Lyon Hartley, Bell Telephone Laboratories engineer. The award was made "For his early work on oscillating circuits employing triode tubes and likewise for his early recognition and clear exposition of the fundamental relationship between the total amount of information which may be transmitted over a transmission system of limited bandwidth and the time required."

The other award, the Morris-Liebmann Memorial Prize, was presented to Dr. Peter C. Goldmark, engineer of the Columbia Broadcasting System and long-time exponent of color television. The award was presented "For his contributions to the development of television systems, particularly in the field of color."

WBKB Ups Schedule

Chicago's pioneer television station WBKB, operated by Balaban & Katz, shortly after the first of the year added substantially to its broadcasting schedule. Starting January 2nd WBKB added five hours of weekly telecasting to its regular schedule. The present schedule calls for hour-long programs daily Monday through Friday from 4 to 5 P.M. The station is operating exclusively on "live talent" and expects eventually to reach a peak of approximately eleven hours a week.

*Title registered U. S. Patent Office.

HARVEY Regulated Power Supply 106 PA.
For Laboratory D.C. Source—
Range 200-300 Volts at 140 ma.

HARVEY Regulated Power Supply 206 PA
For Laboratory D.C. Source—
Ranges 500-700 at 250 ma., 700-1000 at 200 ma.

REGULATED POWER SUPPLIES

HARVEY MARINE 25
A 6-Channel Marine Radio Telephone

MARINE TELEPHONES

HAR-CAM
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RADIO AND ELECTRONIC EQUIPMENT

HAR-CAM GALVASCOPE
An AC Electronic galvascope for visual detection of 1000-cycle bridge balance

GALVASCOPES

HAR-CAM MFR-15
FM-AM RECEIVER

EMERGENCY COMMUNICATIONS EQUIPMENT

HAR-CAM 250 WATT FM BROADCAST TRANSMITTER

FM BROADCAST TRANSMITTERS

And Now The HAR-CAM VISUAL ALIGNMENT SIGNAL GENERATOR

A precision unit designed and developed by HARVEY OF CAMBRIDGE for swift, accurate, *visual* alignment of IF circuits in FM Receivers. Write for new bulletin.

The HAR-CAM products shown above are representative of the type and calibre of apparatus HARVEY OF CAMBRIDGE has specialized in manufacturing through years of war and peace. Each is a precision product designed and developed by HARVEY. Into each has gone months, often years, of painstaking research, testing, proving and design refining until HARVEY OF CAMBRIDGE'S able engineering staff has been thoroughly convinced that it offers a maximum of efficiency and dependability. Then, and only then, is a new HAR-CAM development released.

This strict HAR-CAM policy of proving every product, plus the skill and experience gained through years of development of this and other closely related equipment, is your guarantee of absolute satisfaction from *every* HAR-CAM unit.

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HARVEY RADIO LABORATORIES, INC.

441 CONCORD AVENUE · CAMBRIDGE 38, MASSACHUSETTS

WHAT'S NEW

Devices, products and materials the manufacturers offer

Midget Crystal

Available in a frequency range from 3 to 15 mc., a new small size shock-proof crystal is being made by James Knights Co., Sandwich, Ill. Total weight with phenolic holder is less than 1/5 oz. Dustproof and moisture resistant it has a frequency tolerance of 0.01% over a temperature range of 0 to 70 degrees C.—Electronic Industries

Electronic Pantograph

Using a photoelectric cell, which traces outline drawing templates, as a line control guide for oxyacetylene cutting machines, Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y., has developed a unit that puts intricate metal design cutting on a production basis. The General Electric tracing head faithfully follows the complex angles and curves.—Electronic Industries

Labels

Identification of wires, motor leads, terminal boards and other components are made easy with a new strip label. Special mounting of labels make them ready for instant use. Over 200 codes are available including 14 colors for complex wiring requirements. Made by W. H. Brady Co., 2902F E. Linwoode Ave., Milwaukee 11, Wisc.—Electronic Industries

Battery Eliminator

A new unit designed to replace two dry cells is being manufactured by Electrox Div., Schauer Machine Co., 2077A Reading Rd., Cincinnati 2, Ohio. It will deliver a smooth, noiseless dc utput of 3 v 150 ma. Outside dimensions are 3 in. high by 2½ in. in diameter.—Electronic Industries

Signal Generator

A high-level rf signal generator covering the range from 400 kc to 60 me is being manufactured by Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa. Output is 3v. A 30%, 1000 cycle modulated signal is optional. Calibration is better than half of 1%.—Electronic Industries

Rectifier Tube

A new type high vacuum rectifier tube designed for use in video receivers is being manufactured by Electronic Enterprises, Inc., 67 Seventh Ave., Newark 4, N. J. It will handle 12,700v at an average anode current of 5 ma. Peak inverse voltage rating is 40 kv.—Electronic Industries

Electronic Heating Unit

A new high frequency dielectric heating unit, Model 88XO has been developed by Thermex Division, The Girdler Corp., Louisville, Ky. With an output of 5 kw at 20 mc, it will raise the temperature of four pounds of average material 170° in one minute. Entire operation is controlled by sliding drawer in which work is placed for heating.—Electronic Industries

Switch Cover

Bat handled toggle switches can now be sealed against water and moisture by a new type of waterproof switch cover. Made by Waterproof Electric Co., 72 E. Verdugo Ave., Burbank, Cal., this Neoprene boot requires no tools for installation.—Electronic Industries

Push Switch

Heavy duty jack switches that will carry 5 or 10a ac are being made by Donald P. Mossman, Inc., 612 N. Michigan Ave., Chicago 11, Ill. They can be had in locking or non-locking build-ups. These switches are also available as a heavy duty jack taking a standard phone plug.—Electronic Industries

Coming

THIS NEW IMPORTANT REFERENCE BOOK

ELECTRONIC CONTROL HANDBOOK

by
RALPH R. BATCHER, E.E.
and
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More than 350 pages. Hundreds of Charts, Diagrams, Tables, Drawings, Photographs, Completely Indexed for Reference Purposes.

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ELECTRONIC CONTROL HANDBOOK
Contents

ELECTRONIC INDUSTRIES

P.O. Box 14, CALDWELL-CLEMENTS, Inc.
480 LEXINGTON AVENUE NEW YORK 17, N. Y.

Conduit

A new type of duct for convenient power wiring layouts has been designed by National Electric Products Corp., Pittsburgh, Pa. A patented bridge within the raceway locks the snap-on cover and also provides a method of installing necessary outlet units. Fittings are available for hooking in to any existing wiring system.—Electronic Industries

Meter Checker

Marion Electrical Instrument Co., Manchester, N. H., has designed a new Metertester for the calibration of dc meters. It has a self contained power supply working off 110v ac. Full scale readings of 25 microamperes to 10 ma and 100v are provided. Accuracy is better than one half of 1%.—Electronic Industries

Pickup

A crystal phonograph pickup cartridge made by Shure Bros., 225 W. Huron St., Chicago 10, Ill., uses a lever that considerably improves the transmission of needle chuck torque into the crystal. This new lever action reduces needle point impedance and absorbs the impact of sudden jars and shocks. Minimum needle force of under 9/8 oz. is now attainable with an output voltage of about 3v.—Electronic Industries

Telephone Type Relay

Operating up to 20 springs, a new relay developed by Control Corp., 718 Central Ave., Minneapolis 14, Minn., can be adjusted for either slow or fast release. Bobbin windings can be single or double wound for control from two independent circuits.—Electronic Industries

Lamp

A new cold light lamp for industrial and commercial use is manufactured by Amglo Corp., 4234 N. Lincoln Ave., Chicago. Light is produced by the direct ionization of inert gas by a concentrated electron stream flowing through the closely wound spiral. It can be used as a photoflash, or for stroboscopes, traffic and railway signals, buoys and aviation lighting.—Electronic Industries

Heat Control

A new control for the exact temperature regulation of electric furnaces, using proportional plus floating control, has been developed by Automatic Temperature Control Co., Inc., 34 E. Logan St., Philadelphia 44, Pa. Heating power is conserved because no current is dissipated in rheostats or transformer type controls and overshooting is reduced to a minimum.—Electronic Industries

Motors

A new line of fractional hp motors is being made by Eastern Air Devices, 583 Dean St., Brooklyn 17, N. Y. Improvements in noise reduction and bearing lubrication have been made. Capacitor, shaded pole and synchronous types in 3 5/16 in. and 1¾ in. diameter frames are available.—Electronic Industries

Insulation

Fiberglass sleeving which is non-fraying, non-burning and non-stiffing is being made by Bentley, Harris Mfg. Co., Conshohocken, Pa. It comes in all standard colors and sizes and is available in 36 foot lengths and 500 foot rolls.—Electronic Industries

Vibration Mount

Using a stainless steel spring and a built-in damping mechanism and limiter snubbers, a new unit mount to absorb vibration from any direction is being made by Robinson Aviation, Inc., Teterboro Air Terminal, Teterboro, N. J. Made in three sizes and with a wide range of load carrying capacities.—Electronic Industries

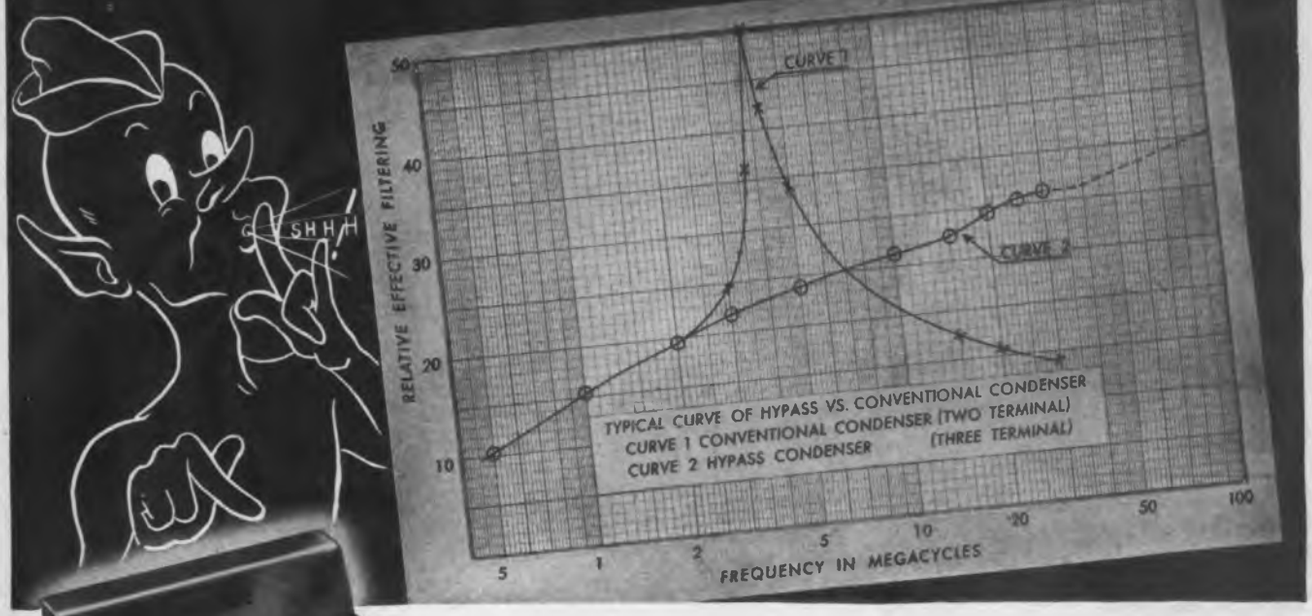
Pillow Speaker

An electro magnetic sound reproducer designed primarily for use as a pillow speaker has been developed by Telex Products Co., Minneapolis, Minn. 5 milliwatts electrical input gives normal volume through the average pillow. With minor internal modifications speaker can be used as an all weather recording microphone.—Electronic Industries

Metal Punching Units

New individual hole punching and notching units have been developed by Wales-Strippit Corp., North Tonawanda, N. Y. Design permits mounting these units on single or multi-slotted base plates. This entire per-set assembly is then placed in a stamping press or press brake and is ready for production operation with the first stroke of the ram. Units are available in seven holder widths with a maximum punch diameter of 2 in. Will handle metal up to ⅛ in. thick—Electronic Industries

RADIO INTERFERENCE ?



SPRAGUE HAS *the Answers!*

From inexpensive noise suppression capacitors for automotive use, to heavy-duty designs for service on power equipment, and for current ratings from 5 to 200 amperes capacity, Sprague produces modern filter units for practically any need. An unsurpassed background of engineering experience in dealing with all types of radio noise interference problems, is here at your disposal. Write for Sprague Capacitor Catalog 20.

ANTI-RESONANT FREQUENCY PROBLEMS SOLVED

Have you a vibrator "hash" problem that a conventional by-pass capacitor shunted by a mica capacitor only partially solves?

If so, write for details on Sprague HYPASS Capacitors, the 3-terminal networks that do the job at 100 megacycles or more!

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North Adams, Mass.

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5-Times Cited for Distinguished Wartime Service

PIONEERS OF ELECTRIC-ELECTRONIC PROGRESS

Regulated Power Supply

A unit for supplying 6.3v at 6a unregulated and regulated dc voltage up to 500v at 300ma is being made by Electronic Measurements Co., Red Bank, N. J. Regulation is within 1% for voltages between 80 and 500—from no load to full load. At 10v regulation is better than 2%. Hum voltage is less than 10 millivolts at any voltage and load.—Electronic Industries

Sweep Generator

Designed primarily for use with television, FM and high frequency equipment, this new sweep generator has a continuous output range between 500 kc and 110 mc. Sweep range is adjustable from 10 mc down to 5 kc. 1 mc and 10 mc interval markers are provided. Output signal can be controlled from about 30 microvolts to 0.1v. Made by United States Television Mfg. Corp., 106 Seventh Ave., New York 11, N. Y.—Electronic Industries

Bending Tool

A new hand-bender for working with tubing or electrical cables has been developed by Glenn L. Martin Co., Baltimore 8, Md. Equipped with a scaled bend roll, production bending requiring identical bends can easily be made.—Electronic Industries

Test Oscillator

For use with equipment designed for the 40-500 mc frequency bands, Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y., is making a test oscillator which covers this frequency range in two bands. Output is controlled by an adjustable pickup loop. Either an unmodulated, a short regulated pulse or a 1000 cycle modulated signal can be obtained.—Electronic Industries

Flame-failure Alarm

Using a photoelectric unit to watch the fire in industrial and commercial oil and pulverized coal burners, Combustion Control Corp., 77 Broadway, Cambridge 42, Mass., is making a new automatic alarm that will shut off the fuel when the flame fails. The unit is mounted on the furnace wall and observes the fire through a 2 in. pipe connection.—Electronic Industries

Electronic Wiring

Frederick Lissau, operating Micron Machine Co., 29 Junel Place, New York, has patented a rapid method of chassis wiring utilizing template die-stampings and multiple-electrode spot welding. Three subassemblies are used, two of which are insulating panels; the third is a conducting panel. In the final stage, the subassemblies are sandwiched together and "wired" in a carbon-soldering press. Placement and tabbing of stampings is automatically carried out as a part of the template die operation. —Electronic Industries

Varnish

An extremely flexible, oilproof finishing varnish with high wet and dry dielectric strength is being made by John C. Dolph Co., 168 Emmett St., Newark 5, N. J. This black varnish has a non-fading opacity and will air dry in 6 hours. Slow initial set provides easy brushing, dipping or spray application.—Electronic Industries

Power Supply

The Porta-power unit, made by General Transformer Corp., 1250 W. Van Buren St., Chicago 7, Ill., will supply 1.5v at 200 ma and 90v at 13 ma for the operation of farm and portable radios. Hum-free output is obtained by the use of heavy filter components.—Electronic Industries

Temperature Control

With a wide choice of adjustable temperature ranges, a new control unit is being made by Paul Henry Co., 2037 South La Cienga, Los Angeles 34, Cal. Differentials as close as one degree can be had. A variety of mountings make this CAM-Stat adaptable for the temperature control of air, gas, liquids or solids.—Electronic Industries

Marking attachment

A new cup shaped marking attachment is being made by Acromark Co., 809 Morrell St., Elizabeth 4, N. J., for imprinting half spherical, spherical and cup shaped metal and plastic components. The marking head carries both fixed and consecutive numbering identifications.—Electronic Industries

A rugged performer with a big voice and keen ear!

Collins AN/ARC-2 Autotune transmitter-receiver

The AN/ARC-2 Autotune transmitter-receiver was designed and is built by Collins for two place and larger military aircraft. It is an example of the experience, design ingenuity and manufacturing skill also available, in the Collins organization, to commercial users of communication equipment.

Remote Control Box

Transmitter, receiver and dynamotor are all contained in the same case. The weight and space requirement of the AN/ARC-2 is considerably less than that of the equipment it replaces. Any one of eight pretuned channels is immediately and automatically available by means of the Collins Autotune, operated either at the main panel or by remote control. The transmitter and receiver operate on the same frequency and are tuned simultaneously by a single set of controls.

This equipment, including its Autotune mechanism, functions reliably at all temperatures from −58° to +140° F, all altitudes from sea level to 40,000 feet, and all conditions of humidity up to saturation.

The Collins organization specializes in fulfilling exacting requirements. We will welcome an opportunity to make recommendations regarding your needs in the field of radio communication equipment.

Collins Radio Company, Cedar Rapids, Iowa;
11 West 42nd Street, New York 18, N. Y.

IN RADIO COMMUNICATIONS, IT'S . . .

COLLINS

Selenium Rectifiers

By using aluminum in place of iron and similar metals, Radio Receptor Co., 251 W. 19th St., New York City, have reduced the weight and increased the heat dissipation of their new rectifiers. Current capacities are from 25 ma to several hundred amperes.—Electronic Industries

Tester

A new tube tester for checking the performance of all types of receiving tubes including octal, loktol and miniatures; ballasts and magic-eye tubes has been designed by Hickok Electrical Instrument Co., 10528 Dupont Ave., Cleveland 8, Ohio. Meter indicates directly the condition of the tube under test.—Electronic Industries

Soldering Iron

A new type soldering iron, the Eject-O-Matic, trigger feeds solder that is reeled within its handle. The amount of solder can be varied by a thumb screw adjustment. A special replacable, grooved tip guides the solder to the point of use. Nine cooling vanes protect the handle from the heat of the heating element. Made by Multi-Products Tool Co., 123 Sussex Ave., Newark, N. J.—Electronic Industries

MC Transmitter Tube

Lewis Electronics, Los Gatos, Cal., has a new high frequency tetrode in production. Operation is possible up to 250 mc with fullpower input and up to 44 mc with half power input. The tube has unusually low inter-electrode capacities, using a top plate connection and ceramic base. Maximum power output is 130 w. It can be used as a radio power amplifier, oscillator or amplified doubler.—Electronic Industries

Glassed Selenium Stacks

New type selenium rectifiers hermetically sealed in glass are being made by Federal Telephone and Radio Corp., Newark, N. J. No larger than a fountain pen and constructed like a cartridge fuse, the stacks can be mounted in 30 ampere fuse clips. Units are available to 4000v.—Electronic Industries

Blanket

A new electronically controlled, electrically heated blanket for personal sleeping comfort has been designed by Simmons Co., 383 Madison Ave., New York City. Flexible conductors are spaced throughout the interior of the blanket for distributing the heat and acting as a feeler for the temperature control. This three tube control unit will automatically regulate the warmth of the blanket within one degree of any pre-set temperature.—Electronic Industries

New Plastic

Styraloy, a new Dow Chemical Co., Midland, Mich., product is the lightest in weight of all that company's plastics. Its properties place it in the field between rigid plastics and rubber. It has good flexibility at low temperature. Combined with synthetic rubber, it will improve electrical properties, lower water absorption, impart greater flexibility.—Electronic Industries

Timing Unit

A compact, waterproofed self-contained motor-driven switch for exact timing of intervals from one minute to two hours is made by American Time Corp., Springfield, Mass. Special dials and knobs can be provided for specific requirements. Unit will control up to 20a ac.—Electronic Industries

Overload Relay

Providing an almost instantaneous magnetic overload protection for general purpose and mill motor applications, Westinghouse Electric Corp., Pittsburgh 30, Pa., has developed a new dc relay known as AYJ. Contacts will carry 5 a. Coils and coil studs are available for currents ranging from 75 to 625 a.—Electronic Industries

Capacitors

The new plastic film dielectric capacitors made by Condenser Products Co., 1373 N. Branch St., Chicago 22, Ill., can be supplied in tolerances of plus or minus 1%. Available in metal containers and glass tubes these units can be had in capacities from .0005 to 35 mfd., with voltage ratings from 100 to 100,000v.—Electronic Industries

HERE IS THE NEW WESTINGHOUSE FAMILY OF

POWER TETRODES

FOR FM TRANSMITTERS

Designed specifically for FM . . . Full power input at 120 mc . . . Low driving power . . . Low grid-to-plate capacitance . . . Simplified neutralization . . . Forced air cooling . . . Concentric terminal construction.

Two WL-477R tubes are used in the output stage of a 1-KW transmitter; two WL-478R tubes in a 3-KW transmitter; and two WL-479R tubes in a 10-KW transmitter.

For descriptive data write your nearest Westinghouse office or Electronic Tube Sales Department, Westinghouse Electric Corporation, Bloomfield, N. J.

Forced Air Cooled Tetrode

Filament: Thoriated Tungsten	5 Volts
Voltage	23 Amperes
Current	240
Amplification Factor	
Transconductance (I_b = 300 ma, E_c = —5V., E_{c2} = 500 V.)	13000 umhos
Max. Screen Voltage	750 Volts
Max. Anode Voltage	3000 Volts
Anode Dissipation (Max.)	700 Watts
Approximate Anode Power Output (Class C)	1000 Watts

Forced Air Cooled Tetrode

Filament: Thoriated Tungsten	5 Volts
Voltage	70 Amperes
Current	240
Amplification Factor	
Transconductance (I_b = 330 ma., E_c = —5V., E_{c2} = 500 V.)	14800 umhos
Max. Screen Voltage	1000 Volts
Max. Anode Voltage	5000 Volts
Anode Dissipation (Max.)	2500 Watts
Approximate Anode Power Output (Class C)	3000 Watts

Forced Air Cooled Tetrode

Filament: Thoriated Tungsten	5 Volts
Voltage	206 Amperes
Current	140
Amplification Factor	
Transconductance (I_b = 914 ma., E_c = —5V., E_{c2} = 750 V.)	33200 umhos
Max. Screen Voltage	1000 Volts
Max. Anode Voltage	6000 Volts
Anode Dissipation (Max.)	6000 Watts
Approximate Anode Power Output (Class C)	7500 Watts

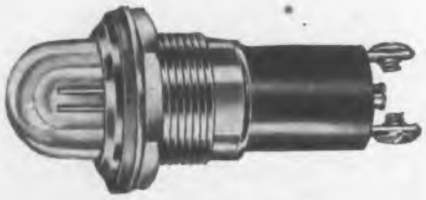
Westinghouse *Electronic Tubes at Work*

Multi-Power Supply

Moulic Specialties Co., 105 W. Washington St., Bloomington, Ill., has in production a new multi-power supply unit MS-1 which is specifically designed to deliver all necessary voltages for the operation of electronic tubes. With a voltage regulation of better than 1% over the output range of 50 to 300 v., this unit is particularly suited for determining tube characteristics and the performance of experimental circuits in school and industrial laboratories. Model MS-1 has three dc channels, the first for supplying grid bias voltages has a range of —75 to +25 v. at 5 ma.; channels 2 and 3 for plate and screen supply each have a range of 0-300 v. at 100 ma. A center-tapped adjustable ac range of 0-20 v. at 3.5 amperes is also provided. Both dc and ac supplies are separately metered and selector switches permit the reading of any voltage or any current in any channel.—Electronic Industries

Dual Oscilloscope

A new two channel oscilloscope using a dual gun type cathode ray tube is being made by Electronics Tube Corp., 1200 E. Mermaid Ave., Philadelphia 18, Pa. This unit provides for simultaneous investigation of two independent phenomena or of a single study with a timing trace, such as ignition, pressure and torque studies in connection with automobiles and aircraft engines.—Electronic Industries



Pilot Light

New Pilot Light assemblies featuring a built-in resistor for direct connection to 115 or 220v circuits have been developed by Dial Light Co., of America Inc., 900 Broadway, New York 3, N. Y. Integral resistor unit eliminates the possibility of short circuits. Units are designed to use Neon bulbs.—Electronic Industries

Component Cans

Electrical Industries, Inc., 42 Summer Ave., Newark 4, N. J., is making a new line of can enclosures for relays, coils and transformers. Terminals are brought out through sealed headers in the base. Along with protection from dirt, dust and moisture, these enclosures provide a quick method of servicing and replacement.—Electronic Industries

Resistor

New 1.5 w hermetically sealed Akra-Ohm resistors are now being made by the Shallcross Mfg. Co., Jackson & Pusey Aves., Collingdale, Pa. They are approximately 2 in. long and 7/8 in. diameter. Wound with nickel chromium wire, maximum resistance values are 1 megohm.—Electronic Industries

Coaxial Cable

A new coaxial cable for high frequency transmission lines is being made by Boston Insulated Wire & Cable Co., Boston, Mass. This cable has a fixed alignment and may be gassed in either the flexible or rigid sheath. The special construction permits greater flexibility with less danger of cracks on bending or physical shock.—Electronic Industries

Portable Power

Homelite Corp., Port Chester, N. Y., is manufacturing a new 2,000 w, 120 v dc generator which was designed as a portable power source for many industrial or communication needs. Total weight of these units is slightly over 100 lbs., and the overall dimensions 24 in. long, 17 in. wide.—Electronic Industries

Silicone Greases

Two new silicone greases for lubrication at abnormally high or low temperatures are being made by Dow-Corning Corp., Midland, Mich. These greases were developed for ball-bearing lubrication at speeds up to 10,000 rpm and their low volatility and very slight tendency to bleed particularly recommend them for sealed-in lubrication units. They will stand temperatures up to 345° F.—Electronic Industries

Marine Radio

A 25w radiotelephone using a five channel, crystal controlled transmitter-receiver is being made by Jefferson-Travis Corp., 245 E. 23rd St., New York 10, N. Y. With an interchangable self-contained power supply the unit is adaptable for operation on 12, 32 or 110v dc or 115v ac.—Electronic Industries

Distortion Meter

For the direct reading of distortion, noise and hum in audio frequency systems, the General Radio Co., Cambridge 39, Mass., have developed their Type 1932-A Meter. A continuous frequency range of 50 to 15,000 cycles is covered by a single dial and push-button multiplier.—Electronic Industries

Small Motors

Two new four pole shaded pole motors with ratings from 1/10 to 1/100 hp are being made by Small Motors, Inc., 1308 Elston Ave., Chicago 22, Ill. Suitable for moderate torque requirements, they have laminated field and rotor cores and either ball or oilless bearings. Can be wound to stand locked rotor conditions.—Electronic Industries

SEE *Two* PHENOMENA AT ONCE

on your Oscillograph Screen with the

DUMONT

Type 185A

Electronic Switch

Phase shift introduced through an R-C network.

Square-wave input (top) to differentiator network, showing differentiated output (below).

The utility of any oscillograph can be greatly increased by operating it in combination with a Du Mont Type 185-A Electronic Switch!

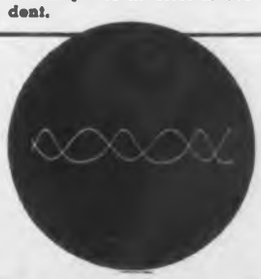
Imagine the convenience and the time saved in being able to view simultaneously TWO or MORE related signals and readily compare them for amplitude, waveform, and frequency or phase relationship. Sound, light, heat, mechanical motion—in fact, any quantity which may be translated into an electrical function may easily be compared with a standard signal. A balance control makes it also possible to separate or superimpose the signals at will. By operating two Du Mont Type 185-A Switches in cascade, three independent channels are provided for the study of signals from three different sources . . . all THREE signals appearing AT ONE TIME on the SINGLE SCREEN of the cathode-ray oscillograph.

This versatile but inexpensive Du Mont instrument may also be used as a square-wave generator with an output range of from 5 to 500 cycles . . . suitable for many uses including the testing of audio amplifiers.

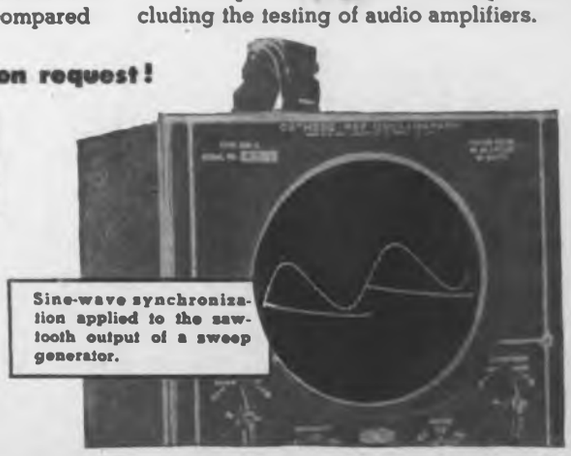
Sine-wave input (bottom) to full-wave rectifier showing rectified output (top).

Descriptive literature on request!

Comparison of input and output of phase inverter. Distortion in phase inverter is evident.



DU MONT "Cathode-Ray Headquarters" also offers oscillographs and cathode-ray tubes in a wide range of types and sizes to meet all requirements. Ask for information.



Sine-wave synchronization applied to the sawtooth output of a sweep generator.

DUMONT *Precision Electronics & Television*

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

Miniature Tube

A new half-wave vacuum rectifier tube that will handle 20,000 v is only 2½ in. high. Its small size and low filament power consumption make it of value where space limitations are important. Made by National Union Radio Corp., 15 Washington St., Newark 2, N. J.—Electronic Industries

Diversity Receiver

New triple diversity receiving equipment for use on transoceanic and airways point-to-point communications has been developed by Schuttig & Co., Ninth and Kearny Sts., N. E. Washington 17, D. C. It is designed for voice, telegraph and printer operation. —Electronic Industries

Plastic Pliers

Speco plastic pliers are being made for special needs. They are shock-proof, non-magnetic, will withstand 6,000 v breakdown, heat resistant to 300 degrees and weigh only 1½ oz. Will not short when working around live circuits. Special Products Co., Silver Spring, Md.—Electronic Industries

Reversing Spindle

A friction drive, that runs clockwise or anti-clockwise depending on the pressure of the work, is being made by Samual S. Gelber, 32 S. Jefferson St., Chicago 6, Ill. Used for a tapping operation a slight pressure of the work starts the tap into hole, when the required depth has been reached a light pull on the work reverses the spindle direction removing the tap from the work.—Electronic Industries

Demagnetizer

A new unit primarily designed for demagnetization of small tools is being made by Grayhill, 1 N. Pulaski Rd., Chicago 24, Ill. The component to be demagnetized is simply passed through the 7/16 in. hole while the button is held down. Screwdriver blades can be magnetized by pushing the switchbutton, inserting the blade and releasing the button before removing the blade.—Electronic Industries

Terminals

Midget lugs either individually or set in terminal boards are being made by Cambridge Thermionic Corp., 445 Concord 38, Mass. Quick soldering and of precision construction they are of particular value where space is limited.—Electronic Industries

Vacuum Tube Voltmeter

A new portable, vacuum tube multi-range tester is being manufactured by Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y. Direct reading megohmmeter, milliammeter, ammeter, output and decibel scales are included on the 7 in. rectangular meter face. A stabilized bridge circuit using 3 vacuum tubes is incorporated in the unit and readings remain constant over a wide range of line voltage variations. A vacuum tube probe for supersonic rf and uhf voltages is available as an optional accessory.—Electronic Industries

Conduit Support

A new type tubing or conduit support that enables easy removal or insertions of individual lines is made by Double T. Fairlead Co., 801 Acacia Ave., Hawthorne, Cal. Supports are made to handle either a single size of conduit or any combination of sizes.—Electronic Industries

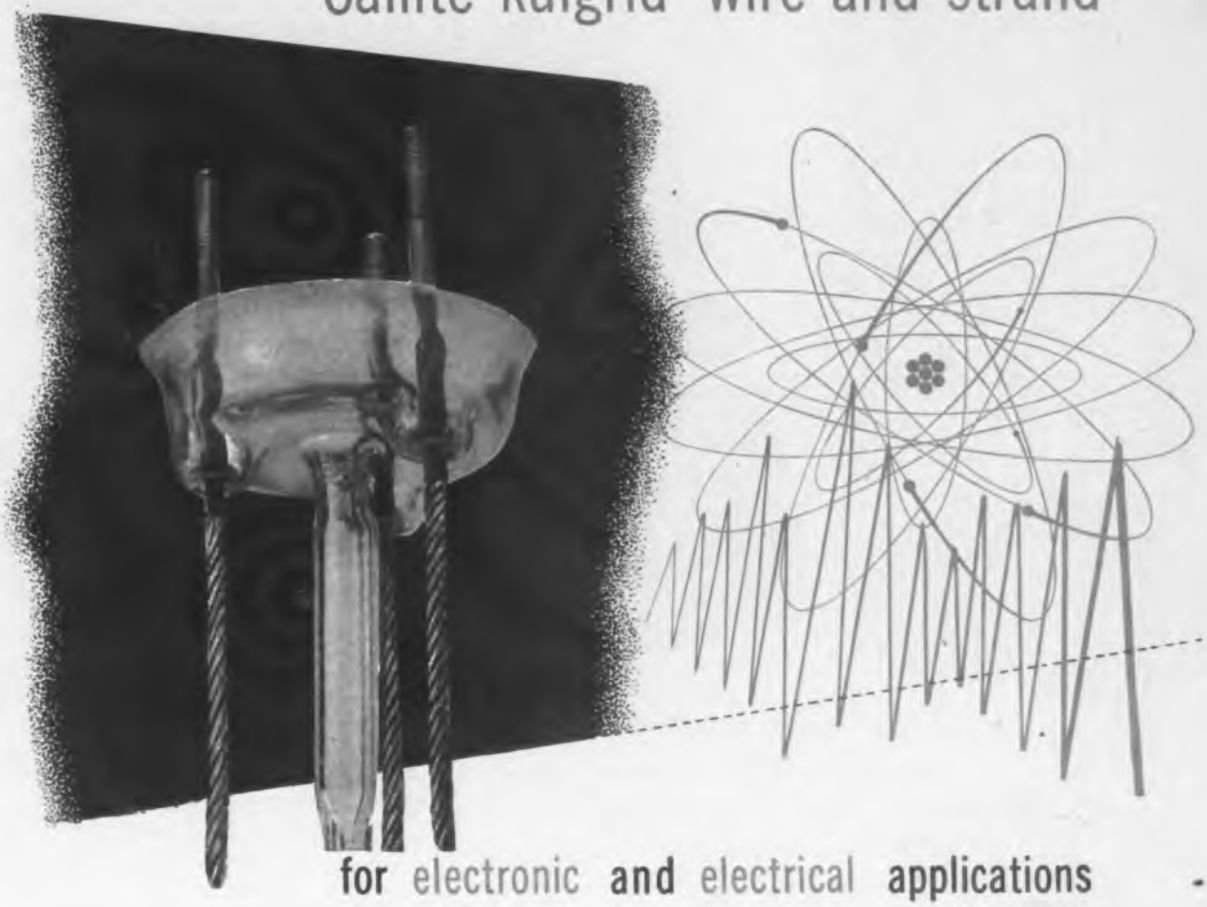
Transmitting Triode

With an rf output of 5000w at low frequencies and 3500w at 110 mc, a new medium mu, external anode tube made by Eitel-McCullough, Inc., San Bruno, Cal., is of compact construction. Grid terminal is a ring interposed between the plate and filament permitting easy use of the triode as a grounded grid amplifier at high frequencies. Forced air cooling is a design feature.—Electronic Industries

Special Glass

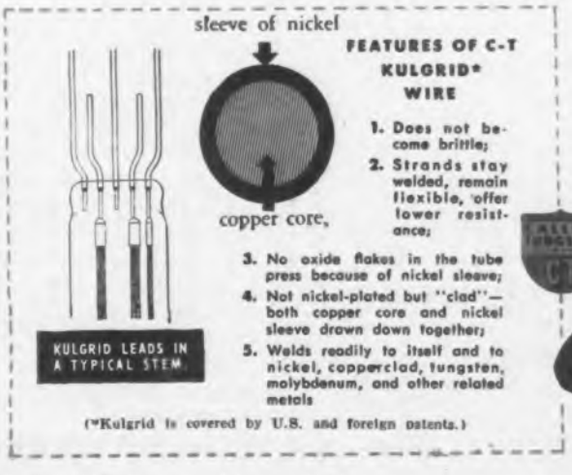
An improved color-transmitting, heat-absorbing glass is being made by American Optical Co., Southbridge, Mass., for use in television and photographic projection. The new glass absorbs approximately 90% of the infrared (heat) radiations and will transmit up to 90% of available light if reflections are reduced by glare-removing methods.—Electronic Industries

Callite kulgrid* wire and strand



for electronic and electrical applications

Callite developed Kulgrid to meet the needs for a stranded wire that does not oxidize nor flake under the high temperatures of beading, stem-making, sealing-in and exhaust operations. Kulgrid is a composite wire having an inner core of copper alloy bonded to a nickel sleeve. It has 70% of copper's conductivity, plus all of nickel's strength and resistance to oxidation. Kulgrid is widely used for lead-in wires, welds and grid supports in electron tubes.



FEATURES OF C-T KULGRID* WIRE

1. Does not become brittle;
2. Strands stay welded, remain flexible, offer lower resistance;
3. No oxide flakes in the tube press because of nickel sleeve;
4. Not nickel-plated but "clad"—both copper core and nickel sleeve drawn down together;
5. Welds readily to itself and to nickel, copperclad, tungsten, molybdenum, and other related metals

(*Kulgrid is covered by U.S. and foreign patents.)

Because of its special characteristics, Kulgrid is gaining popularity as a connector from terminals to heating elements in electrical appliances. We will be glad to discuss applications of Kulgrid and furnish samples. Callite Tungsten Corporation, 544 Thirty-ninth Street, Union City, New Jersey. Branch offices: Chicago, Cleveland.

Callite

KULGRID AND OTHER "CLAD" WIRES

also fine alloy wires in aluminum, phosphor bronze, silicon bronze, commercial bronze, stainless steel, silver, nickel silver, monel, brasses and special alloys. Precision diameters down to .002" or smaller.

GERMAN HF TUBES

(*Continued from page* 82)

tween 2.6 cm and 6.3 cm. The anode is a closed cylinder, the interior of which forms the oscillator cavity. The desired mode of oscillation is selected by adjusting the anode voltage, and the intensity and direction of the magnetic field. For some anodes, the angle between the magnetic field and the cathode may be as much as 3°. A small hole in the surface of the anode permits the insertion of a coupling loop, which is extended outside the anode but within the envelope, to form an antenna. The operating voltage is 2 to 3 kv, and the magnetic field 2000 to 5000 gauss. The efficiency of the tube for which the power output is not known, is said to be 0.5%. This tube has been used as a continuous wave oscillator for testing research receivers.

NEW PATENTS

(*Continued from page* 106)

their vibration amplitude. This amplitude - frequency effect may amount to some 20 cycles per million as a result of supply voltage variations or changes in tube characteristics.

The frequency-stabilizing means comprise a voltage-variable resistance (varistor or thermistor) and either a capacitor in series or a tapped inductance; the latter arrangement (25, 26) is represented in the drawing. It is proposed to use a varistor of the silicon carbide Thyrite type as the voltage-variable resistor 25 to secure quick response. Its resistance decreases with an increase in applied voltage and, in the circuit shown, it will tend to operate as a voltage limiter, equalizing the amplitude of the voltage fed back to the crystal.

The variable resistor-coil combination 25, 26, also introduces a change in phase with a change in applied voltage because the resistance value varies and therefore the ratio of the reactive to the resistive component of the impedance is a function of the voltage amplitude. This phase shift reduces the frequency as the voltage increases and vice versa, correcting for the variations in the natural quartz frequency with changes in voltage amplitude. The frequency may be made stable to a few parts in ten million even with tube gain changes of several decibels.

It is often convenient to choose

TRANSTATS

used by The International Nickel Co., Inc. for "...close electrical temperature control"

In this research laboratory at Bayonne, N.J., Transtats are used to control elevated temperatures in "creep testing" of alloys for high temperature applications. Since these tests are continuous over long periods, a high degree of reliability and accurate control are essential. The Transtats in conjunction with automatic controllers, connected to resistance heaters, keep the temperature at the required degree within close limits.

For a continuously adjustable voltage or a constant voltage from a fluctuating source, specify Transtats.

6 TRANSTAT "EXTRAS"

1. **Potentiometer smoothness** with transformer efficiency (93-99%)
2. **High turn-to-turn insulation** and solid insulating material between commutator bars—a combination of extra wire insulation and varnish impregnation of core and coil.
3. **Broad, Uniform Commutating Surface** ground from the evenly spaced outer wires of the coil.
4. **Smooth Commutating Surface.** Velvety action—no arcing—every turn a perfect contact.
5. **Longer Brush—more contact area,** reducing current density and providing greater area for heat dissipation.
6. **Balanced Collector Arm** maintains brush setting at any degree of mounting.

AMERTRAN

MANUFACTURING SINCE 1901 AT NEWARK N. J.

AMERICAN TRANSFORMER COMPANY
178 Emmet Street • Newark 5, New Jersey

Pioneer Manufacturers of Transformers, Reactors and Rectifiers for Electronics and Power Transmission

a standard coil 26 and to adjust its effective inductance at the oscillator frequency by trimming capacitor 27. Potentiometer 28 and capacitor 29 are dimensioned to provide proper phase shift in the feedback circuit. Adjustable capacitor 20 permits tuning over a small frequency range of the order of one cycle per second. The component values indicated on the figure refer to an operating frequency of 4 kc.

L. R. Cox, Bell Telephone Laboratories, Inc., (F) April 30, 1943, (I) September 18, 1945, No. 2,385,260.

WIDE READING

(*Continued from page* 100)

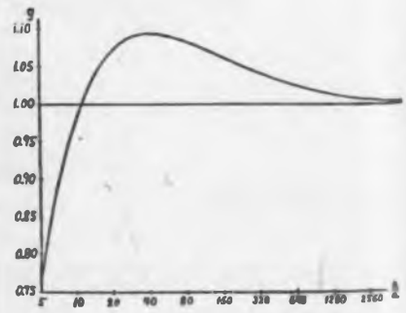
compared with the radius a of the inner electrode (cathode). The current I_l per unit length of the coaxial electrodes is given by the expression

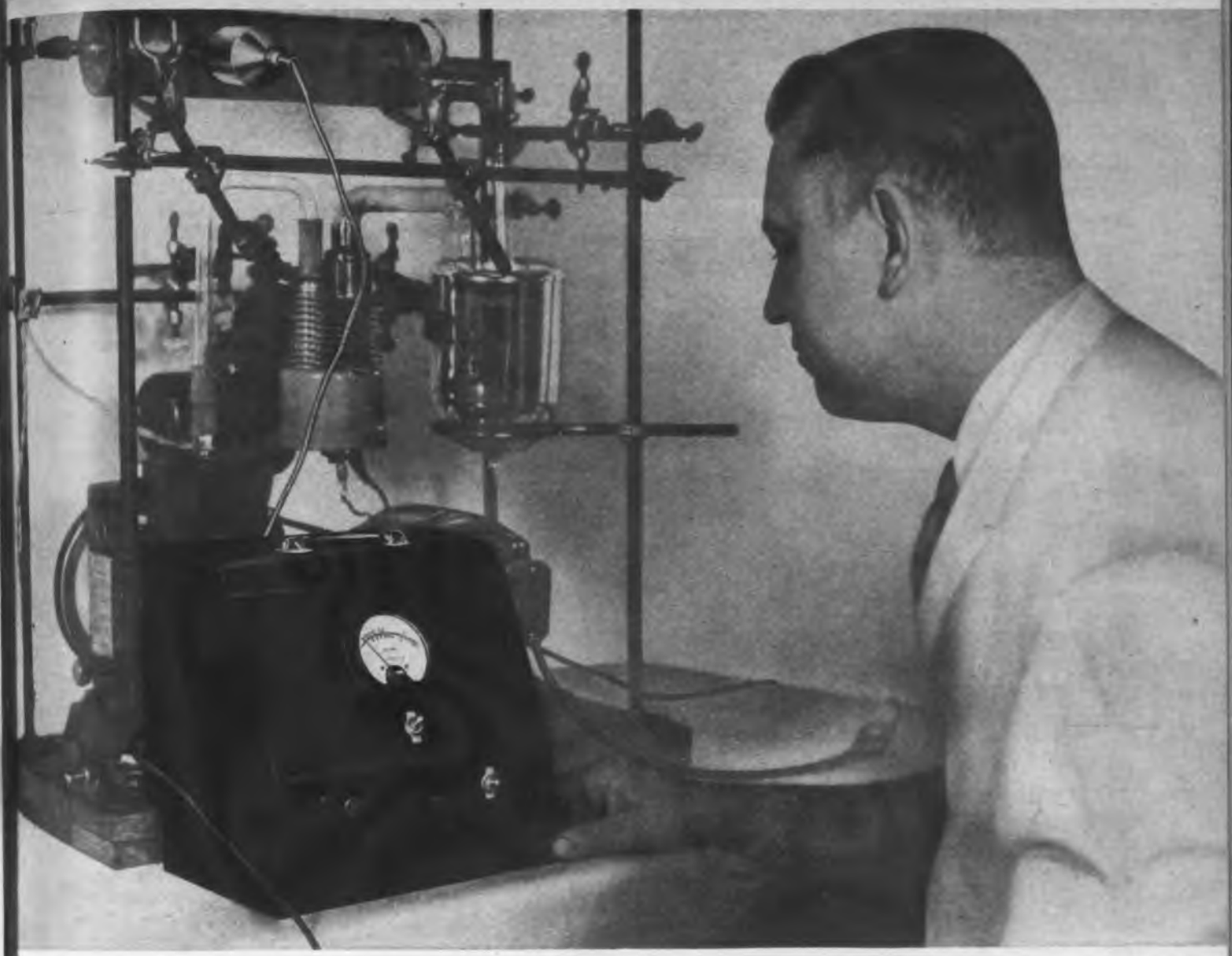
$$I_l = \frac{8\pi}{9}\left(\frac{2e}{m}\right)^{\frac{1}{2}} \frac{(-V)^{\frac{3}{2}}}{rg(a/r)}$$

where V is the voltage between the point considered and the cathode, r is the radial distance of the point from the common axis of the electrodes, and g, the solution of a nonlinear differential equation, is a function of the ratio a/r. A rather complicated mathematical derivation leads to the numerical values for g listed in the table and plotted on the graph.

r/a	*g*	*r/a*	*g*
1	0	40	1.0947
2	0.2793	80	1.0846
3	0.5171	160	1.0634
4	0.6670	320	1.0422
5	0.7667	640	1.0253
6	0.8363	1280	1.0135
7	0.8870	2560	1.0060
8	0.9254	5120	1.0019
9	0.9549	10240	0.9998
10	0.9782	20480	0.9991
11	0.9970	40960	0.9990
12	1.0123	81920	0.9991
20	1.0716		

Table and curve giving values of g in the formula for the current as function of r/a





Measure Vacuum Accurately

WITH THE D.P.I. PHILLIPS GAUGE

These are the essential features of this versatile gauge:

- Stable, accurate readings within a convenient, wide range (approximately 25 microns or 0.025mm. to 2 x 10-5 or 0.00002mm. Hg).
- Internal elements are not damaged by sudden upsurges in pressure.
- Light weight, compact, easy to carry —easy to install.

For full details on the D.P.I. Phillips Gauge, high-vacuum equipment, installation, or service, write—

HIGH VACUUM HEADQUARTERS
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ROCHESTER 13, N. Y.

Instantaneous D/F Units Located Submarines

Seaborne and land-based high frequency direction finding equipment was demonstrated early in January by Federal Telephone and Radio Corp. engineers. It was similar to the previously released SCR-291 radio direction finder used by the AACS. The SCR-291 was used to give bearings to military aircraft on world-wide routes.

The Navy used HF-DF in its war against enemy U-boats. It was demonstrated that bearings on radio transmissions could be taken in one-tenth of a second. It was further shown that the transmitted intelligence could be received without any interference to the bearing determination. This effective counter-measure located submarines whenever they surfaced for communication or radar work. The enemy unknowingly gave away his position despite the fact that he used Kurier, or "squirt" type transmissions. This method compressed all information into split-second bursts. Reception was accomplished by playing back the recorded message at a reduced speed.

The frequency spectrum used in HF-DF extended from about one to thirty megacycles. This range was covered by four receivers of the usual communication type. Panoramic receivers were an aid in first determining the frequency of the broadcast. Enemy transmissions were consistent in their use of fixed frequencies, hence detection was easy. The effective range of the DF depends upon the frequency used, but there is almost no limitation. Indication of bearing direction and sense were read in azimuth on a calibrated CRT.

Future uses of this equipment include position-locating for air-sea rescue work by the Coast Guard, and the furnishing of bearings for air navigation. It has been considered as a counter-measure against V bombs, and radio controlled atomic bombs.

Smell Television

Among the research that is being carried out to provide greater realistic appreciation of future television programs, is the unique development work of Hans E. Laube, 2 East End Ave., New York city, in perfecting synchronized scent control to go along with the picture and sound. While the technical control features are not yet ready

CUT *MAN HOURS* TO *MAN MINUTES* ON SHORT RUN PIERCING WORK

WIEDEMANN TURRET PUNCH PRESSES

ONE USER REPORTS . . . "We solved *the problem of punching the great variety of holes required by installing a battery of Wiedemann turret presses. The relatively small runs do not justify making complete dies, and the large dimensions of many of the pieces would require enormous presses.*

"We save both time and tool costs by using turret presses. Experience shows a tremendous saving from the use of these presses in runs up to 800 or 1000 as well as in making one or two pieces for experimental work."

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WIEDEMANN TURRET PUNCH PRESSES & GAUGE TABLES

for publication, a demonstration of Laube's Smell Television equipment reveals that smell response was synchronized and controlled by motion picture projection. Laube claims only a few hours' work would be required to adopt his present motion picture control to actual television.

The demonstration picture opened with a walk through a rose garden and as the EI reporter stooped to smell the flowers, the gentle scent of the roses seemed to envelop the area. The scent disappeared immediately, leaving no lingering after smell. In rapid succession the picture visited a butcher shop and the smell was the distinctive one of smoked hams and bacon; a carpenter shop gave the fragrance of fresh mahogany being worked; in a kitchen, the aroma of steaming coffee; then see peaches, oranges, the ether in a hospital operation and finally the good solid smells of tanbark and animals during a circus parade. All of the scents fitted in with the picture and each disappeared quickly as the picture faded. After the demonstration, Mr. Laube explained that any one of 500 different scents can be controlled instantly and in any sequence. The receiving set response controls are electronic and the only small replacement maintenance is a small unit about the size of a flashlight battery which must be renewed every two years at the cost of five dollars. Both the studio control and the receiving set equipment is simple and should not add materially to the costs of television receivers.

Radio Club Elects

Alan Hazeltine (Stevens Institute of Technology) was elected president of the Radio Club of America at that organization's annual meeting early last month. Other officers elected were: Treasurer Joseph T. Stantley; Corresponding Secretary Harry Sadenwater (RCA); Recording Secretary John Bose (Columbia University).

Vibration Fatigue Test Equipment

The products of the L.A.B. Corp., Summit, N. J.—vibration fatigue testing equipment or vibration test tables—as fully described on page 128 of the December issue, was incorrectly listed in the Engineering Directory Section of that issue. The correct listing is shown in the heading above.

Claude Neon Buys Reeves-Ely

Claude Neon Lights, Inc., 545 - 5th Ave., New York, has acquired Reeves-Ely Laboratories, Inc., 25 West 43rd St. Subsidiaries of Reeves-Ely are the Waring Products Corp., American Transformer Co., Hudson American Corp. and the Winsted Hardware Mfg. Co. American Transformer Co., 178 Emmet St., Newark 5, N. J., manufactures power transformers for radio and industrial applications. The Hudson American Corp., (25 West 43rd St.), with office and plant in New York, has developed a marine radio telephone and other electronic equipment. It also manufactures various types of ship-to-shore radio-telephones.

West Coast Engineers Form Instrument Company

H. H. Carey, for many years vice-president and director of research of the National Technical Laboratories and George W. Downs formerly chief electrical engineer of the William Miller Corp. are, respectively, president and vice-president of the newly formed Applied Physics Corp. at 40 South Oak Knoll Avenue, Pasadena, Cal. This new firm will manufacture instruments and do a development and consulting business as well.

E. L. Adds Cabinets

Electronic Laboratories, Inc., Indianapolis, Ind., best known for its vibrator inverter products, has added a wood products division at Harbor Springs, Michigan. The new division will manufacture radio cabinets and other wood products.

RUNYON BEMEDALED

To Carman Randolph Runyon, Jr. has gone the Radio Club of America's Armstrong Medal. Here, Runyon (right) receives the award from Fred. A. Klingenschmitt (Amy, Aceves and King)

INDUSTRIAL RELAYS

(*Continued from page 96*)

ration of first pulse, (2) during the interval between pulses, (3) while the second pulse is taking place, and (4) after both pulses have passed. Device (4) is operated normally all the time between the pulse groups. The resistor R is used to adjust the sensitivity of the P winding on relay Z.

One operating feature that can be utilized to advantage in any of the circuits shown here is that the operated devices, designated lamps in some cases, can be the windings of other relays. These relays can become locked up through auxiliary windings on their own cores so they stay operated when the operating pulse ends, and are released at some later period by another circuit functioning. While a momentary pulse will operate a relay, they can be made to stay operated for as long a period as desired.

For example, in circuit (9) relay (A) is operated from a short closure of a circuit from another point (indicated here by a key) but remains operated even at the termination of this pulse through its winding (L). It will stay up until either relay (B) operates and opens the holding circuit or relay (C) operates short-circuiting the locking winding. Both release methods find frequent use.

Combine basic details

To illustrate how combinations of relays can be assembled, circuit (10) is arranged to let a combination of four pulses in sequence light one of 10 lamps or start one out of 10 control functions of some other nature.

Assume circuit (8) is rearranged to close the operating circuit to four other relays in succession during or between the pulses, instead of the four lamps. This is shown in circuit (10). Each of the relays (A) (B) (C) or (D) may or may not operate, however, depending upon whether an auxiliary circuit is also closed during the same time that each is connected in by the W-Z relay combination. To get this auxiliary closure one can use the marginal relay combination of circuit (6) or a polarized relay in series with relay (A) of circuit (8). The idea is, that relay (E) closes only when the strength of the received pulse is high enough to operate it, while another relay in

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FOR INTRICATE CERAMIC DESIGNS

TURNING

DRILLING

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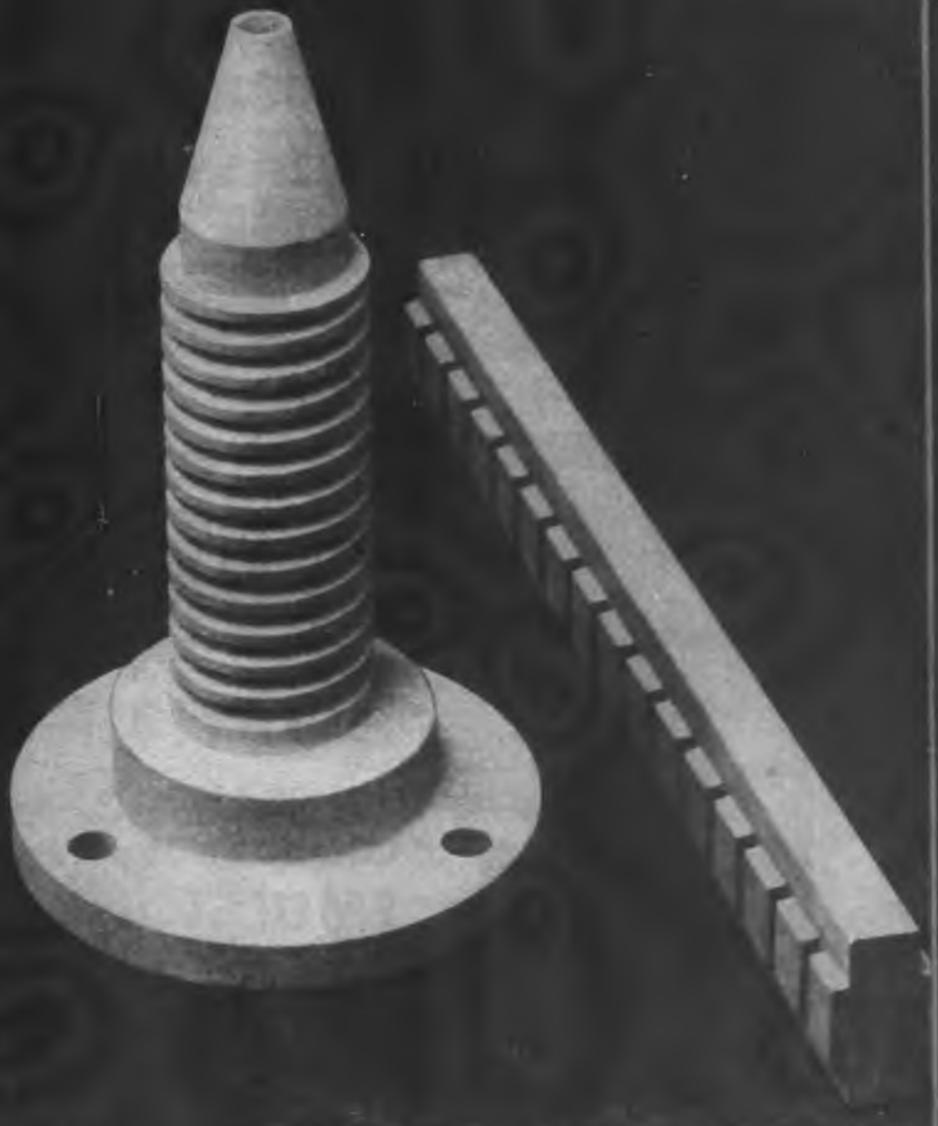

E ★★★ NAVY

Original Award July 27, 1942
Second Award February 13, 1943
Third Award September 25, 1943
Fourth Award May 27, 1944
Fifth Award December 2, 1944

ALSIMAG

IF your equipment requires intricate or unusual Ceramic designs, we can furnish machined ALSIMAG Steatite parts. Highly specialized equipment of our own design, as well as conventional machine tools, is used for turning, threading, drilling, slotting and other machine operations. Send us a sample or blueprint of your design.

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series is added (F) which is of the polarized type which may operate during the pulse periods or the spacing intervals between them, from an auxiliary pulse of correct polarity is provided at those times. That is, a light pulse of this polarity will operate (F) but not relay (E), while a strong pulse of this polarity will operate both. A reversed heavy pulse will operate only relay (E).

Pulse distribution

To those accustomed to telephone circuit procedure this circuit is straightforward and much less complicated than any others in common use. To others a description of its operation will be in order. Suppose that the line pulse polarity that will operate relay (F) is called positive. Suppose the following signal is transmitted over a line: first a heavy positive pulse, followed by a spacing interval, then a light positive pulse, and then a heavy negative pulse. When the heavy positive pulse starts both relays (E) and (F) operate. Relay (F) can be designed to operate a little faster than (E), and operates relay (W). Then (E) closes a circuit to relay (A), which latter operates and locks up. At the end of this pulse, relays (E) and (F) both fall back and relay Z operates. At the start of the second pulse relay (F) operates but not (E) and (Z) remains operated, but (W) falls back. At the end of this pulse (Z) releases. The heavy negative pulse then starting operates (E) relay, which in turn operates relay (D). The latter relay locks up.

Thus relays A and D are left operated, and lamp No. 6 is lighted until the release relay (G) is operated by some kind of local signal or timing device. The operation of (G) releases all relays and permits a new set of signals to function. Other combinations of pulses light other lamps as shown in the code table in circuit (10).

In general relays (A) (B) (C) and (D) operate whenever a heavy pulse appears during the respective time periods represented by the two operating and two release periods of the polarized relay (b) comprising one operating cycle. Should the short flashing of lamps of wrong denominations that occurs while the correct group is being set up, prove troublesome it is possible to open up dotted lead X to the D relay, and close it through a delayed action relay.

DeJUR

MODEL 120 . . . A New DeJUR Miniature Meter . . . precision instrument for more permanent accuracy in small panel space. Conforms to forthcoming JAN-1-6 specification . . . self-contained up to 1 ampere and 150 volts. D.C. or A.C. (rectifier) . . . external shunts or multipliers . . . in a wide variety of ranges.

ALNICO MAGNETS . . . highest grade . . . provide stability and quick response under high torque, with increased protection against magnetic fields.

EXTERNAL PIVOTS . . . insure maximum accuracy . . . reduce pointer-rocking, side friction between jewels and pivots, and wear on bearing surfaces.

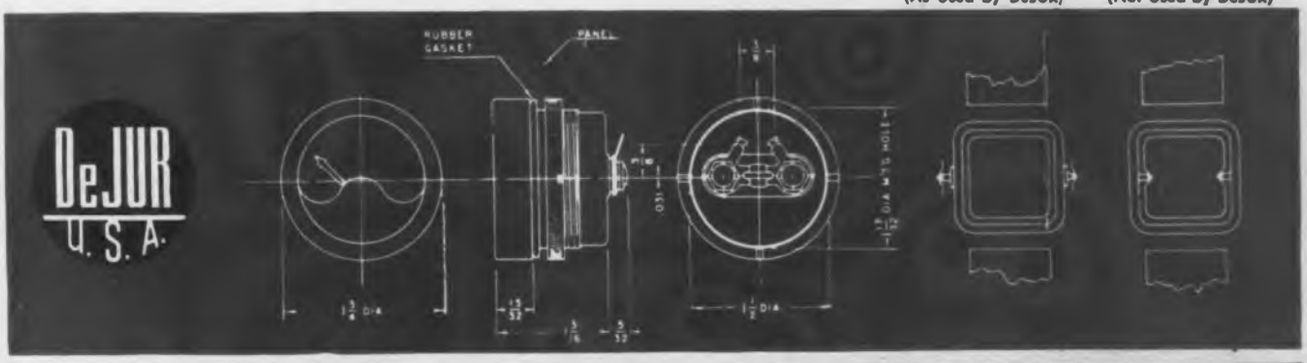
EXTRA-TIGHT SEALING . . . completely waterproof . . . in addition, rubber gasket seals flange to panel. Model 120 is particularly adapted for water-proof equipment.

For full information on DeJUR Miniatures and special applications, write

DeJUR-AMSCO CORPORATION, Long Island City 1, N.Y.

Compact, Trouble-Free Modern Design

External Pivot (As Used by DeJUR) **Internal Pivot (Not Used by DeJUR)**



Model 120 . . Exploded View
Black Anodized Aluminum
Case . . . Ring-mounted

1 1/2 INCH
With the accuracy resulting from external pivot design.

AMMETERS . . . VOLTMETERS . . . POTENTIOMETERS

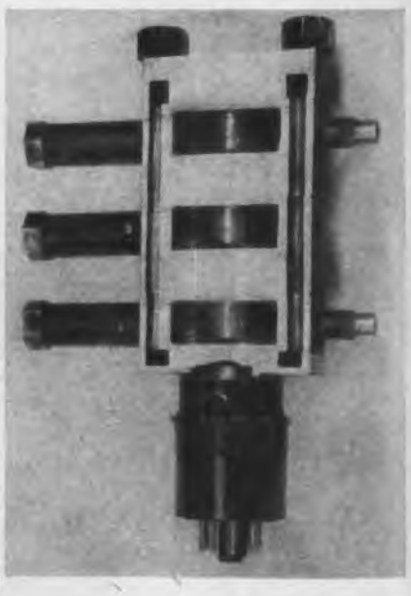
LANDING SYSTEM

(*Continued from page 64*)

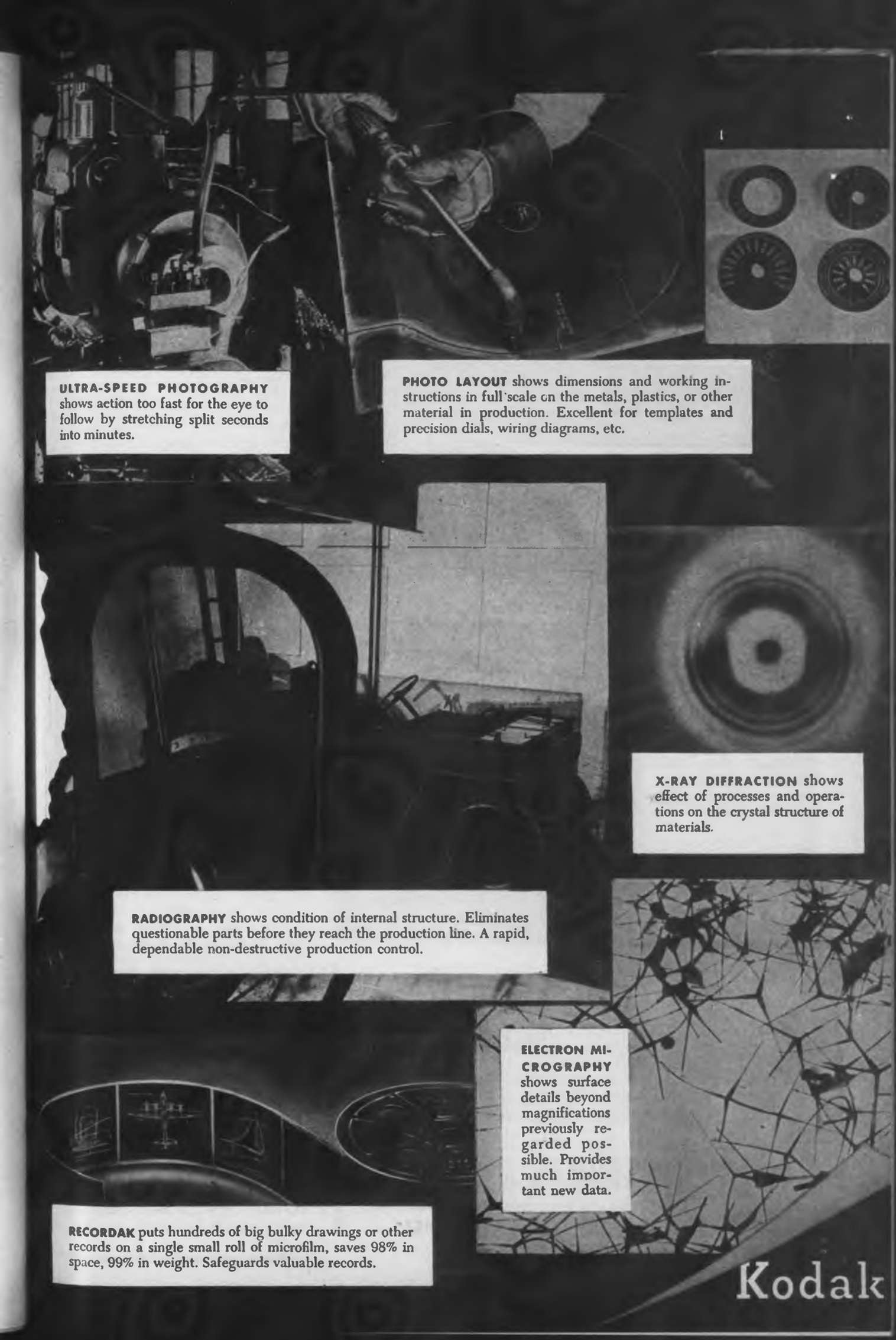
weight of 68.5 lbs.

Advantages claimed for this system are that the beams are not affected to any practical extent by reflections from stationary or moving objects near the runway. In addition no ground reflections are used, making the system independent of terrain and obviating necessity for local adjustments and radio checks. Furthermore, weather variations are said to have no affect as indicated by about 1000 flights made in all types of weather.

Cutaway view of Klystrons, multiplier above, triple cavity amplifier below



Installation is made by optical means and the equipment can be quickly moved from one runway to another to accommodate wind shifts.



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Kodak

PROPAGATION

(*Continued from page 65*)

path which is responsible for the absorption. The Needham Laboratory maintains continuous field intensity recordings of seven distant stations from the broadcast band to television frequencies. This material was available for discussion of the interpretation of variations in fields of one and two hop paths and for evaluation of the effects of sporadic "E" on reception.

Need was shown for additional stations throughout the world capable of broadcasting continuously well controlled standard frequency signals such as are emitted from the National Bureau of Standards station at Beltsville, Maryland. Continuous field intensity records of such signals around the world would provide needed supplementary information to ionospheric soundings now being made. It was also suggested that a coordinated program of absorption measurements at ionospheric stations should be made as soon as facilities become available.

Scatter effects

Following a discussion of sporadic "E" and high night "E" fields in the 5 mc records of the Needham Laboratory, H. W. Wells introduced a report of scatter effects observed at the Hawaiian Islands. Carrier waves broadcast from station KQF at Oahu on a frequency of 13.45 mc were received at Maui as though reflected from an ionic cloud lying off the California coast, the region toward which KQF's transmitter was beamed. "It was impossible", said Wells, "to obtain an accurate bearing of the source of scatter, although the mean direction of the widely swinging reflected beam indicated a bearing of 94° as a center of the scatter source."

The afternoon session was devoted to a discussion of VHF transmission from 30 mc up. Stetson and Pickard exhibited the results of field intensity measurements of W2XMN, Alpine, New Jersey, 42.8 mc, as received during the year at Needham. These showed a marked seasonal variation with the maximum field recorded in September, 1945. Pickard called attention to the fact that this was consistent with measurements taken by him-

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self at Seabrook Beach for WGTR, 44.3 mc, in 1941. It has been suggested that sporadic "E" may be of some importance in FM reception beyond the line of sight. Pickard showed, however, that a study of sporadic "E" occurrences showed no significant correlation with the Alpine reception at Needham over the 150 mile path.

A comparison of Alpine's reception with upper atmospheric data provided by the Weather Bureau showed important relations to temperature gradients and humidity; the approach of a warm air mass being conducive to higher fields. Dr. Brooks suggested an explanation for the higher fields in September as being due to the more stabilized condition of the troposphere at that season. In the discussion it was brought out that probably the chief atmospheric effects involved occur below the 5000-ft. level. The meteorological effects on Alpine reception were accentuated in reporting the reception of WRGB's television frequency, 71.7 mc, from Schenectady as received at Needham.

Tropospherics

The subject of tropospheric transmission led to the question of the relative reception at the lower and upper ends of the VHF band. At this point Major Armstrong was called to the chair and recapitulated early experiences in FM reception on 110 mc and 40 mc. He reported that over a three-and-a-half year period extended fadeouts occurred on the 110 mc frequency at distances of 70 miles and that transmission was greatly improved when his station was allowed the 40-50 mc frequency. The differences in opinion that have arisen as to the soundness of conclusions in favor of the 100 mc region must in the end be settled by performance records.

At this point Mr. Carnahan, of the Zenith Radio Corporation, Chicago, summarized the results of recent experimental transmission between Richfield, Wis., and Deerfield, Ill. The transmissions were from WMFM's transmitter at 45.5 mc and W9XK experimental transmitter at 91 mc. Signal strength was recorded continuously for two months at Deerfield, Ill., 76 miles distant. A full report of these experiments was subsequently published in *Electronic Industries* (December, 1945).

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LAB RECEIVER

(*Continued from page* 71)

were noted, the first being stage gain. The gain in the one stage is considerably more than two stages of the conventional type. Along with this high gain, absolute stability was obtained and much wider pass band characteristics. The limiter will operate or limit with an input to the receiver of four microvolts, which is remarkable with only one if stage. This if system, as can be realized, has remarkable possibilities in commercial receivers. The following points should be food for thought:

1—Only one stage of if necessary.
2—Very high degree of stability.
3—Less components needed.
4—Only one circuit to align.
5—Wider pass band characteristics.

For obvious reasons this extremely close coupled transformer (bifilar winding) cannot be used for the discriminator (see pages 160-161 and 163 Terman, Radio Eng. Handbook). However, it does have distinct advantages when used with the G. L. Beers system of FM reception. (Electronic Industries, November, 1944.)

Single meter

As there are no trick methods of alignment or adjustment I will pass this by saying alignment should be done with the minimum signal possible, and a 50 microampere zero center meter is incorporated in the circuit. It is used for signal strength, stage alignment, and frequency deviation. In Los Angeles I could receive WWV on 10 mc, by connecting the antenna to the grid of the mixer, or by pulling out the oscillator coil when receiving 15 mc, to check the if alignment. A typical signal generator was used for BFO for heterodyne purposes when required.

The AM-if pass band is 4 kc and is sufficient to make the tests mentioned earlier in this article. The receiver sensitivity on AM is four microvolts. AVC is not used as can be seen from the schematic because its worth at VHF is nil. The AM-if transformers are Aladdin 12 mc with additional shunt capacity to bring them down to 10 mc. They are loosely coupled and temperature corrected by the use of NTC ceramic capacitors and silver mica ZTC capacitors.

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Even though high Gm tubes (type 6AC7) are used, extreme stability is obtained, one point that adds to this stability being a socket shield that shields tube input from its output pins. This shield takes the form of a Cinch solder lug No. 4406 soldered to No. 1 pin and bent to form a half circle around pin No. 8 and its other end soldered to pin No. 7.

The FM-if pass band is 300 kc. this being wide enough for wide band FM reception. The discriminator transformer is a reworked Bendix 12 mc, rewound and shunted with the capacities shown on the schematic. The discriminator was linear over the range of 200 kc. This transformer, being loosely coupled and slug tuned, was very stable and would stay put.

The power supply and audio amplifier being on a separate chassis was another factor contributing to the overall results obtained. The amplifier and power supply used was a 6J5 voltage amplifier, 6N7 phase inverter and a pair of 6L6G's in class A. The rectifier is a 5R4GY with the power transformer incorporated in an electrostatic shield; line by-pass capacitors were used.

FM TRANSMITTER

(Continued from page 80)

value of grid resistance is required, necessitating considerable driving power from the first doubler.

The third doubler is the driver for the two 4-125A's in the final amplifier. To develop sufficient third-doubler power to supply transmission losses between the output tank circuit and 4-125A grid circuit, an 829B push-pull beam-power amplifier is used. Used as a push-push doubler, total output capacitance of the plates connected in parallel is approximately 14 mmf, which prohibits use of lumped parameters in the 88-108 mc plate tank circuit.

A linear concentric line element is therefore used with the outer conductor grounded. This concentric line construction was chosen to prevent external coupling between grid and plate circuits by suppressing tank-circuit radiation. An added advantage of the grounding is to provide greater safety for the operator.

Mechanical layout features vertical construction in order to obtain shorter leads, to minimize radiation losses from the various circuits, and to afford maximum accessibility to individual components.

PERSONNEL

William S. Paley has been elected chairman of the board of the Columbia Broadcasting System, **Paul W. Kesten** was elected vice-chairman and **Frank Stanton** was elected president of the company, at the regular January meeting of the Directors.

At the same time Adrian Murphy, long CBS' champion on color television, returns to the company from the Army. As a Lt. Colonel in the Signal Corps he took over Colonel Paley's work in Europe when the latter returned. Murphy rejoins CBS as vice-president, and television will be one of his main over-all management responsibilities.

Paley, continues as senior executive, served as president since September 1928. Kesten joined the company in 1930 as director of promotion, became a vice-president in 1934, general manager in 1942, and executive vice-president in 1943. Stanton, who joined CBS in 1935 as director of research, became a vice-president in 1942 and general manager in 1945. Both Kesten and Stanton are Directors of the company.

Leonard F. Cramer who has been a vice-president and director of the Allen B. Du Mont Laboratories. Inc., Passaic, N. J., has been elected a director of the newly established Television Broadcasting Division. He will assume responsibility for the company's expanding telecasting operations.

Leonard F. Cramer R. C. Longfellow

R. C. Longfellow has been appointed engineer of the specialty division of General Electric's Electronics Department. His headquarters will be at the Wolf Street Plant in Syracuse, N. Y., where he will have charge of all engineering activities for the division.

C. Edwin Williams has been appointed general manager of the

Here are the advantages when you Stratopax your electrical devices and components -

Illustration of Stratopax relay used with a machine control unit ready for plug-in connection (left) and with cover removed before gas filling and sealing (right).

Contactor ready for Stratopaxing before covering. Wrap around mounting bracket, blister on cover for adequate terminal clearance, and binding post terminals meet specifications for unit.

Two typical Stratopax enclosures showing fill tube protectors, glass seal terminals and variations of design and mounting to meet requirements.

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While the packing and sealing of instruments may at first seem relatively simple, the steps involved in Stratopaxing already existing equipment are, however, more complex. How Cook engineers adapt existent equipment to Stratopax with consideration of present mounting and space limitations, and the steps taken in preparation of Stratopax are completely described in the Cook Stratopax Engineering Report. Fully illustrated, it explains thoroughly the need for, and features of, Stratopax techniques used in filling, sealing, testing and selection of gases. A request on your letterhead will bring you a copy immediately.

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cathode-ray oscillograph and tube division of the Allen B. Du Mont Laboratories, Inc., Passaic, N. J. He joined Du Mont after completing three years' war service in Washington, as chief of the transformer unit of the Radio and Radar Division of the War Production Board.

Ivan G. Easton has been advanced to be manager of the New York engineering and sales office of the General Radio Co., Cambridge, Mass. He succeeds Martin A. Gilman, manager of the office for the past two years, who returned to the engineering staff at the Cambridge office. Easton is a senior member of the IRE and for the past two years has been program chairman for the Boston Section.

Ivan G. Easton

Walter C. Kirk

Walter C. Kirk has been appointed designing engineer of the Ken-Rad division of the General Electric Co.'s Electronics Department, with headquarters at Owensboro, Ky. In this capacity, he will represent tube division engineering at Ken-Rad and will be responsible for the design engineering of receiver tubes there.

Paul Peckar has joined the engineering staff of Tenney Engineering, Inc., 26 Avenue B, Newark, N. J. He was formerly assistant senior division engineer of the Reconstruction Finance Corp. The company manufactures automatic temperature humidity and pressure control equipment.

R. E. Samuelson, vice-president in charge of engineering for the Hallicrafters Co., Chicago, has been named chairman of the Marine Section of the Radio Manufacturers Association Transmitter Division.

Thomas Ryan Warner has been appointed assistant communications engineer for the Greyhound Corp., bus operating affiliate of the New York Central Lines. He will be in charge of engineering the

two-way radio communication equipment soon to be installed on buses of the Greyhound Lines and two other intercity carriers operating into Chicago. He has recently left the Army with the rank of Lieutenant-Colonel.

Samuel C. Avallone has been appointed chief metallurgist of the Spencer Wire Co., West Brookfield, Mass. He will also function as General Sales Manager.

George R. Larsen has been appointed development engineer by the Marion Electrical Instrument Co., Manchester, N. H. During the war he was associated with the Signal Corps Engineering Laboratories at Fort Monmouth, N. J.

Two changes in the executive personnel of the American Transformer Company, New Jersey, involve; **A. A. Emlen,** who as a vice-president henceforth is to have charge of engineering and related activities; Vice-president **Walter Garlick, Jr.,** has been placed in charge of sales and its related activities.

William R. McMillin has rejoined the engineering department of the National Broadcasting Co. He will be associated with the Radio Facilities Group as a broadcast engineer, has just returned after 3½ years service in the United States Navy.

Nat Gada has been appointed sales manager of emergency communication equipment at the General Electric Co.'s Transmitter Division of the Electronics Department. A graduate of MIT, Gada's headquarters will be at the GE Thompson Road Plant in Syracuse.

Commander G. Robert Mezger has rejoined the Allen B. Du Mont Laboratories, Inc., Passaic, N. J., after a spell of 4½ years with the U. S. Navy. He originally joined Du Mont in 1936.

Porter Turner who has been a sales engineer with the Alliance Mfg. Co., Alliance, Ohio, for the past eight years, has been appointed field engineer for the New York and Philadelphia territories. His headquarters will be at 401 Broadway, New York.

Paul M. Reyling has been appointed manager of production and engineering of Freeland & Olschner Products, Inc., 611 Baronne Street, New Orleans 13, La., manufacturers and rebuilders of transmitting

tubes. In his new capacity, Reyling will manage the New Orleans tube plant and supervise the company's tube development projects. He comes to Freeland & Olschner directly from the Tennessee Eastman Corp., where he was senior engineer in charge of all phases of the vacuum tube program for the Oak Ridge atomic bomb project.

Howard K. Morgan, formerly director of engineering for TWA, Inc., has joined the engineering staff of Bendix Radio Division of Bendix Aviation Corporation in Baltimore, He has been assigned to engineering programs related to long range planning of product development.

John N. Cage, former University of Colorado associate professor of electrical engineering and previously industrial electronics chief of Allis-Chalmers, has been appointed manager of the Industrial Electronics division of Raytheon Mfg. Co.

George D. Rice who had been in charge of the home radio service group for Lear, Inc., has been advanced to the post of acting assistant chief engineer of the radio division. He will make his headquarters in the company's Grand Rapids office and will have complete responsibility for all radio engineering projects.

Captain Adolph B. Chamberlain has resumed his post at the Columbia Broadcasting System's general engineering department as chief engineer. Prior to more than three years of war service with the U. S. Navy he had previously held this same position for eleven years.

R. H. Mecklenborg has returned to the Automatic Temperature Control Company, Inc., Philadelphia, as an instrumentation specialist. He returned to ATC after two years of European service with the Signal Corps.

Dr. James R. Downing has been appointed director of research at Cook Electric Co., Chicago. Since 1942 his major work has been on the atomic bomb project of the Manhattan Engineer District, and in the development of high vacuum equipment for industry.

Ralph A. Powers has been named engineer-in-charge of electronic engineering at the Allis-Chalmers Mfg. Co., Milwaukee. Powers, formerly was with the Bundy Tubing Co., Detroit.

Frazier Vice-President Freeland & Olschner

Howard S. Frazier, former director of engineering, National Association of Broadcasters and vice-chairman of the Radio Technical Planning Board, was elected vice-president of Freeland & Olschner Products, Inc., 611 Baronne Street, New Orleans 13, La., at the annual stockholders meeting held December 14.

Frazier's appointment is in line with the Company's expansion program and reconversion to the manufacture of new tubes. During the war, F & O was devoted exclusively to the rebuilding of large transmitting tubes. He will be in charge of sales and financing of the company, operating from offices at 1730 Eye Street, N.W., Washington 6, D.C. In addition to his duties with F & O, Frazier is conducting a radio management consulting practice for broadcast stations and manufacturers of broadcast equipment.

Transformer Engineers

A new company, Transformer Engineers, has acquired the assets of the Hollywood Transformer Co. They are located at 389 South Arroyo Parkway, Pasadena, Cal. E. E. Hoskins is president, E. O. Woodward is vice-president and Ray Olesen is chief engineer. The company will specialize in the design and construction of high grade transformers and inductors and is ready to supply research laboratories with special jobs in small quantities to specification.

Decalcomania Service

The Meyercord Co., Chicago, manufacturer of decalcomanias, has revitalized its technical consultation service and reconverted its research laboratories from Army to civilian work. The consultation service is again available through the Meyercord branch offices in thirty cities in the United States.

Test Equipment

The illustration of the special vacuum tube testing unit which appeared in the "What's New" section of the January issue was designed and is being used by the Raytheon Mfg. Co.; though built by Lyman Electronic Corp., Springfield, Mass., it was constructed to meet specifications and is not available for general sale.

NEW BULLETINS

Industrial X-Ray

North American Philips Co., Inc., 100 E. 42nd St., New York 17, N. Y., has issued a new booklet describing the specifications and features of Norelco Searchray industrial x-ray equipment, spectrometer and diffraction units. X-ray inspection applications which have speeded up production and provided better quality safety checks are shown. The various models, including one for conveyor belt operation, are illustrated.

Thermoplastics

Many suggested uses and a listing of the properties and advantages of vinyl compounds, cellulose acetate, ethyl cellulose and polystyrene plastics are shown in a new booklet issued by Chemaco Corp., Berkeley Heights, N. J. This information should prove helpful to anyone interested in plastic fabrication. The several commonly used molding methods are briefly described.

Transmitting Tube Data

New or revised description and rating sheets for the "Radio Transmitting Tube Handbook" have been issued by the tube division, Electronics Dept., General Electric Co., Schenectady, N. Y. Information on ten tube types has been revised, while seventeen new tubes have been added. Three types—GL-846, GL-860 and GL-861—have been dropped. Seven revised installation and operation instructions are included in this issuance.

Fluorescent Ballasts

A four-page folder gives complete information about Amertran ballasts for fluorescent lighting. Fifteen types for 1, 2 and 3 lamp operation are included. Ballasts are made for both 50 and 60 cycle circuits. Issued by American Transformer Co., 178 Emmet St., Newark 5, N. J.

Corrosion Protection

A new folder—Hastelloy Facing for Corrosion Resistance—describing a new process for protecting chemical-plant and oil-refinery equipment from corrosion, has been issued by Haynes Stellite Co., Kokomo, Ind. Two methods of equipment surface protection are given; the

use of Hastelloy welding rods for covering small areas and welding thin sheets of Hastelloy alloys as a lining. Corrosive media and possible protection are included.

Ceramic Capacitors

A new folder giving the specifications and construction details of their Hi-Q silver electrode ceramic capacitors is being distributed by Electrical Reactance Corp., Franklinville, N. Y.

Plastic Fabrication

Illustrating many of the various types of work in the field of plastics, Emeloid Co., Inc., 287-291 Laurel Ave., Arlington, N. J., has issued an anniversary booklet — 25 Years of Progress in Plastics. It covers the many kinds of plastic services the company renders, including molding, laminating, printing, stamping, embossing, etc.

Plastics

A 20-page booklet in color—Plastics Newsfront — explains some of the uses that have been made of American Cyanamid Company's plastics. Included is a two-page illustrated spread giving hints which should be remembered when product design is being developed for plastic fabrication. The book is distributed by American Cyanamid Plastics Division, 30H Rockefeller Plaza, New York 20, N. Y.

Components

Illustrating a portion of the 500 different items they make, Alden Products Co., 117 N. Main St., Brockton 64, Mass., has issued a new four-page folder. Many types of connectors, sockets, coil housings, stampings, etc., are described.

Miniature Ball Bearings

Along with some general informative data on the application and selection of correct bearing types, the new catalog of Landis & Gyr, Inc., 104 5th Ave., New York 11, N. Y., shows a complete line of standard and precision ball bearings. Several types of radial bearings not available before this time, are shown.

Ceramics and Kovar Seals

An 8-page folder describing the use of ceramics for padder and trimmer bases, resistors, strain and spreader insulators and metallized ceramics has been prepared by

Stupakoff Ceramic and Mfg. Co., Latrobe, Pa. Many components using kovar metal-glass seals are also illustrated.

Marking Equipment

A new bulletin just issued by Acme Marking Equipment Co., 2222 W. Fort St., Detroit 16, Mich., describes units and equipment for marking all types of material from hard steel to soft rubber. Such items as steel stamps, machine stamps, hobs and molds, embossing dies, numbering heads, branding irons, etching equipment, rubber stamps are shown.

Self-lubricating Bushings

An 8-page pamphlet giving the properties and engineering data necessary for the effective use of Graphalloy bushings has just been issued by Graphite Metallizing Corp., 1050 Nepperhan Ave., Yonkers 3, N. Y. This type of bushing will operate for long periods of service, without attention, at either low or high temperatures. They also provide long life lubrication when submerged in water, gasoline and many chemicals.

Hermetic Terminals

An 8-page pamphlet giving complete engineering data about Fusite hermetic terminals and HermetiCans has been prepared by Cincinnati Electric Products Co., Cincinnati 12, Ohio. Details of design construction are shown for eight different series of terminals. Specifications of HermetiCans for enclosing electric and electronic components and the Fusite automatic HermetiCan sealer are also covered.

Germicidal Equipment

A new booklet—Disinfectaire Electronic Air Disinfection—issued by Art Metal Co., Cleveland 3, Ohio, gives concise data on the advantages of germicidal equipment and the correct installation of ultraviolet apparatus. Industrial, institutional and residential uses are covered. Specifications and radiation distribution curves are shown for each of the model types.

Temperature-Pressure Controls

A 40-page booklet, in color, gives the complete story of Thermoswitch and Pres-Sure-Switch controls. Issued by Fenwal Inc., Ashland, Mass., specifications and

suggested applications are shown for the various unit types. Special models for flame control, fire detection and railway journal box heat indicators are included. Fenwal also makes accessories and modifications of standard equipment for installations operating under special conditions.

Phenolic Resinoid Coatings

Complete laboratory and actual usage reports along with practical applications of Heresite plastic coatings, synthetic resins and molding compounds are contained in a new booklet issued by Heresite and Chemical Co., Manitowoc, Wisc. Designed as corrosive resistant coatings for industrial equipment requiring protection against chemical liquids and fumes, these Heresite materials now have many uses in the home appliance, packaging, food and textile industries.

Special Transformers

A 4-page folder by Red Arrow Electric Corp., 100 Coit St., Irvington 11, N. J., illustrates seven transformer types built for special applications in the radar and other electronic fields. The company is equipped to develop and build transformers and reactors up to 1 kva.

Precision Resistors

A 16-page loose leaf booklet just issued by Precision Resistor Co., 334 Badger Ave., Newark 8, N. J., gives the electrical specifications and physical dimensions of 26 resistor types. Wattage rating vary from ½ to 50w. Resistance values up to 1 megohm can be had in both inductive and non-inductive windings.

Liquefied Gases

Superior Air Products Co., 132 Malvern St., Newark 5, N. J., have two new booklets. One shows their line of liquid air containers. The second explains in non-technical language the features and equipment necessary for the preparation of liquid air, liquid nitrogen or liquid oxygen in the user's plant.

Air Capacitors

Specifications for a complete line of air dielectric capacitors, both variable and fixed, are contained in a new bulletin issued by Allen D. Cardwell Mfg. Corp., recently absorbed by Grenby Mfg. Co., Plain-

ville, Conn. Couplings, dials and miscellaneous accessories for use with Cardwell capacitors are also covered.

Recording Equipment

Presto Recording Corp., 242 W. 55th St., New York City, has prepared a twenty-two page booklet on sound recorders, transcription turntables, automatic equalizers, amplifiers and associated equipment. Considerable informative matter on the general art of sound recording is included.

Speakers

Racon horns, horn units and cone speakers are described in a new booklet issued by Racon Electric Co., Inc., 52 E. 19th St., New York 3, N. Y. Models for many special speaker applications are shown.

Crystals

A new bulletin — Piezoelectric Crystals — issued by Aireon Mfg. Corp., Kansas City, Kans., shows the company's many types of crystals and mountings, together with frequency coverage and suggested uses. Principal types described: Octal, with cylindrical metal shield and standard eight pin base; three pin, two channel, aircraft type; standard two pin phenolic holders for various kinds of mobile and stationary installations (banana or pin plugs); variable air-gap mounting with screw top electrode.

Frequency Meters

James G. Biddle Co., 1211 Arch St., Philadelphia 7, Pa., in Bulletin 1770 shows many models of Frahm vibrating reed meters for frequency indication. Mechanical construction and operating characteristics of this type of instrument are covered, as are several special applications of the vibrating reed principle for tachometers and harmonic analyzers.

Diversity Receivers

Schuttig & Co., Ninth & Kearny Sts., N.E., Washington 17, D. C., has a 35-page booklet describing diversity receiving equipment developed for circumventing signal fading in commercial communication systems. The information is presented in non-technical language.

Vacuum Pumps

Supplementing the detailed descriptions of high vacuum and

liquid pumps, a new bulletin issued by Kinney Mfg. Co., Boston 30, Mass., gives suggestions for the selection of proper pump types and necessary accessories.

Service Tools

The entire line of Xcelite screw and nut drivers is shown in a new color pamphlet issued by Park Metalware Co., Orchard Park, N. Y.

Buyers' Guide

Walker-Jimieson's 1946 Radio and Electronic Reference Book & Buyer's Guide will soon be ready for delivery. Published as an aid to users of industrial electronics, the volume has been designed to assist in the proper selection of radio and electronic parts and replacements. The handy 6 x 9 in. reference book contains listings of over 10,000 parts, including complete sections devoted to public address and inter-communication systems, tubes, batteries, test equipment, and electrical maintenance supplies.

Featured in its compact 100 pages are clearly illustrated products developed through wartime research in the field and in the laboratory. Aviation, communications, electrical, and industrial engineers should find this book valuable in solving electronic equipment problems. The technical data contained will assist engineers in the improvement of inspection, production, maintenance, and research facilities. Publisher is Walker-Jimieson, 311 S. Western Avenue, Chicago 12, Ill.

Organize Electronic Development Labs

Michael T. Harges and Joseph Lorch, formerly chief engineer and research engineer respectively of Harvey-Wells Communications, Inc., have organized Empire Laboratories, specializing on electronic consultation and the development of aircraft and communication equipment, marine telephones, television receivers, industrial electronics and other radio equipment. These laboratories are located in the Chamber of Commerce Building, Flushing, N. Y.

Electronic Calculator for Weather Forecasting

Scientists of Princeton University and the Radio Corporation of America Laboratories are developing plans for an electronic supercalculator that will solve problems running into 400 correlated stages. Officials of the Weather Bureau

and the Navy and Air Forces are interested because they feel that apparatus of this type might have a revolutionary effect in solving the mysteries of long-range weather forecasting. One of the present handicaps to accurate future weather forecasting is the lack of mechanical means of solving the many mathematical variables within the time limit that such information is necessary and useful.

Proposed calculator

The proposed electronic calculator, capable of performing a multiplication in eleven micro-seconds, would solve 100,000 equations in about one minute. The equipment would use over 2,000 tubes and require up to twenty operators to guide its results. An alarm bell would sound if an error developed in any calculation. Because the largest of the existing calculators will only handle equations involving twelve or fourteen integrations, it is expected that it will be at least two years before even a practical working model of these advanced plans can be made.

NEW BOOKS

Principles of Industrial Process Control

By D. P. Eckman, John Wiley & Sons, New York, 240 pages, 1945, $3.50.

This book is an introduction to the science of automatic control. It is intended to treat the important laws of operation of industrial automatic control systems and to provide a practical background of theory.

Chapter 1, The Art and Science of Control, outlines the general terms, applications and advantages of automatic control. Chapter 2, Measuring Means of Industrial Controllers, discusses principal process variables, the pressure thermometer, thermal-electrical elements, basic potentiometer systems, the flowmeter, mechanical type pressure gages, liquid level meters, and miscellaneous controllers. A part of the chapter covers transmission of measurement and compares the pneumatic and electric systems.

Chapter 3, Characteristics of Measuring Means, deals primarily with the response lag in thermal and mechanical pressure measuring elements. The effects of time lags in response due to protecting wells on thermal elements is shown in curves and equations. Response under both step-function and cyclical variable changes is shown. A lag coefficient table for pressure and resistance thermometers, thermocouples, pressure gages, flowmeters, and potentiometers is included.

Chapter 4, Modes of Automatic Control, differentiates between two-position, single-speed floating, proportional-speed floating, proportional, proportional reset, and proportional-reset rate systems of controller operation. Included under the description of each mode of operation are curves and equations giving the characteristic response of the variable to demand changes.

Chapter 5, Final Control Elements, covers only liquid and gas flow valves. Flow equations, curves and port shapes are discussed.

Chapter 6 covers process characteristics, including process variables, transfer lags, storage capacity, and dead time. Chapter 7, Theory of Automatic Control, extends the basic ideas presented in earlier chapters, showing the ef-

fects of various process characteristics, as dead time, on controller response.

Chapter 8 covers the quality of automatic control, discussing such factors as stability and adjustment of controllers.

Chapters 9, 10, and 11 are Application of Control Engineering, Automatic Control Systems, and maintenance of Exact Control, respectively.

The book is extended with a number of references at the end of each chapter and a glossary of automatic control terms is included at the end.

Aviation Radio

By Henry W. Roberts, published by William Morrow & Co., 1945, 637 pages, $5.

A complete study of the subject usable both by the novice and the professional. The language is clear and concise, the text accurate but not technical. Anyone can read it and understand it well. The author gives a bright promise for the future when he says: "Most of the aviation radio apparatus now in existence, on the ground and in the air, will need to be changed to the new very high frequencies as soon as possible. That need will exist even if not one single airplane be built in the next ten years to come."

TELEVISION— Eyes of Tomorrow

By Capt. William C. Eddy, U. S. Navy (retired). Published by Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y., 1945. Cloth. 9 x 6 inches. 330 pages, 136 illustrations. Price $3.75.

Television's many-sided genius, Bill Eddy, here presents the whole story of television-studio production, both technical and program—with side excursions into television history, tele receivers, color television, television economics, and finally "tall tales from the studios."

Capt. Eddy is best identified, of course, as television director for Balaban & Katz, Chicago, whose station WBKB he built, "out of second-hand police transmitters, clothes-pins and rubber cement," although WBKB already ranks among the top stations of the country. Before going to Chicago in 1940, he was chief of video effects for NBC at New York and a leading television figure in the East.

Following Pearl Harbor, Capt. Eddy created and then commanded the Navy's huge radio and radar school at Chicago. In the course of this work, he invented and developed the famous "Eddy Test" for electronic students, which has

been used nation-wide to examine hundreds of thousands of applicants.

A graduate of Annapolis, Eddy was one of the youngest officers ever to command a submarine. During this period Eddy turned over to the Navy many inventions in submarine and underwater sonics. Submarine rigors, however, eventually led to the loss of his hearing, causing his retirement. Today stone-deaf, he nevertheless gets along easily in everyday life by a combination of lip-reading and the use of a concealed mike in his pipe, with bone-conductor attachment, so that few people ever suspect his hearing difficulties.

Six-foot-six Bill Eddy is also a practicing cartoonist with an original style of his own, and several cartoon characters to his credit. A number of special cartoons drawn by him, are used to illustrate his present volume on television.

Capt. Eddy's "Television" is the second book he has turned out in the wartime rush of instructing thousands of radar students for the Navy. The other was an erudite volume on higher mathematics made simple in the characteristic Eddy way under the title "Wartime Refresher in Fundamental Mathematics."

Fundamental Theory of Servomechanisms

By LeRoy A. MacColl, Ph.D., member of the Technical Staff, Bell Telephone Labs., Inc., published by D. Van Nostrand Co., Inc., New York, $2.25.

This is a thorough technical and mathematical study of the subject, suited to the use of persons familiar with the theory of the functions of a complex variable. It is scholarly and will well repay the expert or would-be expert for its study.

Principles of Radio for Operators

By Ralph Atherton, published by Macmillan, 1945. 344 pages, illustrations. Price $3.75.

This book resulted from the material prepared for a 16 weeks training course for radio operators, service technicians and maintenance personnel in a Navy training program and is based on the author's extensive experience in training men for communications work in the Armed Forces. The book is a highly practical, expertly organized, thoroughly illustrated training manual and handbook for radio operators, maintenance men, and those constructing equipment

for transmitting, receiving and testing.

It covers basic electrical principles and the theory of the commoner radio components and circuits, tubes, power supplies, receivers, transmitters, and antennas, and descriptions of commercial equipment now in use. It is written for those with no previous training, and contains all the materials needed either for classroom or self instruction. There are more than 500 illustrations in all. An Appendix includes a review of the necessary mathematics, characteristics of vacuum tubes, diagrams and other practical information on trouble-shooting a modern receiver.

Electric Circuits and Machines

By Eugene C. Lister, Supervisor of Electrical Theory Instruction, Iowa State College, published by McGraw-Hill Book Co., Inc., New York, 1945, 358 pages, $4.00.

In an effort to make the subject easily understandable, this very elementary introduction to practical electricity avoids mathematics beyond expressions involving fractions, nor are precise definitions of most concepts given. The book apparently presupposes a knowledge of many of the basic concepts and their interrelation.

The text deals with fundamental units, direct-current circuits, batteries, dc and ac motors and generators, electrical instruments and a 14-page chapter on electronic tubes, starting with thermionic emission and ending up with the cathode-ray oscillograph.

STRATOVISION ANTENNA

Shown upside down here, this 10-ft. shaft of aluminum will be hinged to the underside of one of the Stratovision planes from which Westinghouse will broadcast FM and television

Alignment Charts, Construction and Use

By Maurice Kraitchnik, published by D. Van Nostrand Company, New York City. 94 pages. Price $2.50.

This book reviews the basic methods for laying out nomographic charts and follows up their construction using the system of determinants. The first chapter briefly summarizes the mathematics involved in this work. Other chapters discuss the problem from the viewpoint of the appearance of the final chart, rather than by the formula upon which it is to be based. The illustrative charts serving as examples of the processes apply to the fields of chemistry, engineering, manufacturing and banking.

Weather and the E Layer

For many years Dr. Charles G. Abbot, of the Smithsonian Institution, has studied the apparent connection between fluctuations in the solar constant and the weather. Changes in the solar constant are small and difficult to measure, whereas variations in the thickness of the radio-reflecting "E" layer of the earth's atmosphere are easy to measure with modern radio techniques.

According to Science Service, Dr. Abbot believes that approximate predictions of peaks and troughs of local temperatures can be made a week in advance, provided daily reports of the E layer are obtained from a sufficient number of stations, and if means can be found to anticipate by a few days the date of the next approaching change in the solar constant. "There is," said Dr. Abbot, "a fair hope that such important dates as heavy frosts may become predictable a week in advance from solar observations by this method."

LONDON LETTER

Television Pattern Generator

E. K. Cole, Ltd., Southend-on-Sea, England, has developed a portable pattern generator to enable radio service engineers to check television receivers when there is no transmission. The rf range is 40-50 mc and the maximum output is 2 mv obtainable either via a short rod antenna or an 80-ohm cable. The antenna system, video and audio circuits may all be tested. The pattern appearing on the screen is composed of two vertical black bars, crossed by a horizontal grey bar, on a white background and enables the present controls, etc., of the video circuits to be adjusted correctly. Contained in a metal case, 12½ x 9½ x 8 ins., the instrument has a 7-tube circuit.

Supersonic Detection

The oscilloscope range-display familiar in radar technic has been applied to routine detection of cracks in metals. Henry Hughes & Son, Ltd., Illford, London, after three years development, has produced a compact equipment similar in appearance to a portable oscilloscope. The supersonic transmitter and receiver are an identical pair of 2.5 mc quartz crystals, about 2 cm diameter and 0.1 cm thick. For steel and most aluminum alloys the pair of crystals are in-

RADAR UMBRELLA

Westinghouse's version of the lightweight, portable "Beach Umbrella" radar antenna

clined slightly by wedges to give an included angle of about 16° in the beam. The crystals and metal surfaces are tightly coupled by films of oil or amalgam.

Pulse and mark intervals are adjustable to suit the thickness of the specimen. The time displacement between transmitted and reflected vibrations is indicated on the oscilloscope trace, and the depth of a crack or hole estimated by the scale length of the distinctive reflection from the far wall of the specimen. In very thick objects the pulse may be about 20 μsecs long and the marking time 20,000 μsecs. In steel the wavelength is 0.24 cm. Flaws can be detected at depths ranging from 0.5 in. to 12 ft., and an echo can be obtained from a crack less than 0.00001 in. thick, which is too small to be detected by X-ray examination.

Dielectric Heating

The general price of radio frequency heating equipment in Great Britain is put at about $400 per kilowatt of rf output for large sets, and about double this figure for small sets. In a report entitled "Capacity Current Heating" by T. H. Messenger and D. V. Onslow the published information is reviewed under three sections; theory, applications and equipment costs. About 240 literature references are given. The report is published by the British Electrical and Allied Industries Research Association, London, W.C.2.

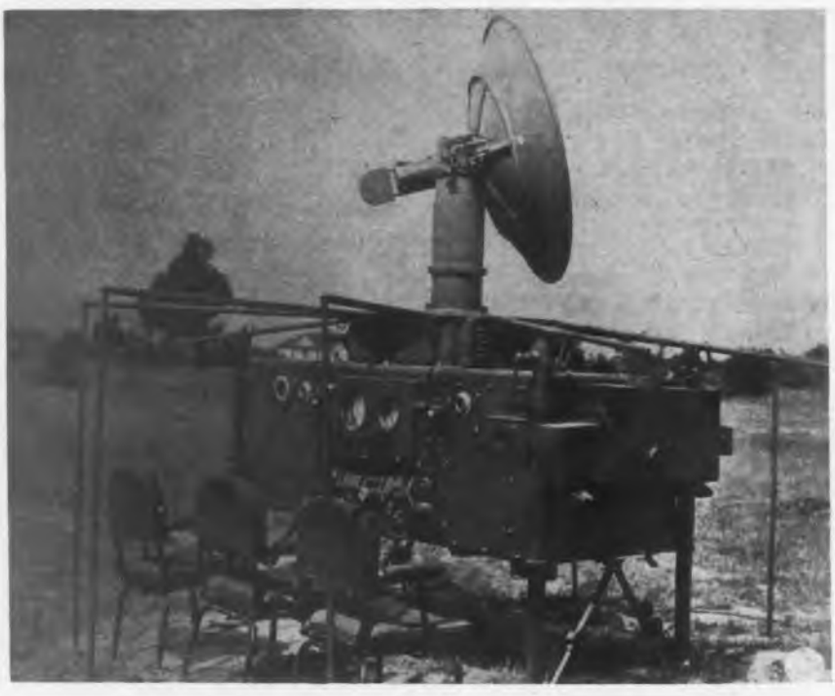
Most of the available British equipments operate at frequencies of 10-20 mc, and above 10 mc; tubes are not at present available for ratings greater than 50 kw. Tube life is said to average 5000 hours, and the overall cost of rf energy is likely to be 2½ cents per kilowatt-hour under continuous operation, with electricity at about a cent per kilowatt-hour. Examples of applications include the continuous vulcanizing of rubber covered wires and cables, and the manufacture of polyvinylchloride covered cables. The vulcanizing process for one eight-inch rubber-bonded abrasive wheel was reduced from 20 hours to 20 minutes, and the molding of a phonograph record from 20 minutes to 2 minutes.

Bell System Readies Television Networks

The Bell System is planning a nation-wide network of over 7,000

PORTABLE SEARCHLIGHT CONTROL RADAR

Lightweight radar equipment (AN/TPL-1) as it is rolled into operating position and below a view of the set with wheels removed and panels opened, shelter removed, ready for operation



miles of coaxial cables, with tie-in radio relay systems, that will bring television programs to all parts of the country. Experimental transmission of programs on the New York-Washington link of this proposed network is planned for early 1946 and construction work on the remainder of the network will be pushed as rapidly as possible. Work is also under way on a seven repeater station, microwave radio relay system between New York and Boston. These facts are graphically illustrated in a new booklet—Bell System Television Networks—just issued by American Telephone and Telegraph Co., New York City. Several interesting television milestone dates are shown, too;—back in 1927, the Bell Telephone Laboratories were transmitting television by radio between Whippany, N. J., and New York City and in 1941, Bell engineers were sending television programs over a demonstration circuit of 800 miles of coaxial conductors with very satisfactory results.

Electronic Research in the USSR

On July 6-9, 1944, a meeting on electronic problems was held in Moscow by the Physical Mathematical Department of the Academy of Sciences of the USSR, jointly with the All-Union Scientific Council for Radio Physics and Radio Engineering. Titles of papers listed below and read at this meeting are taken from the Journal of Physics, Vol. IX, No. 1, 1945.

(1) P. Lukirsky (Physical Technical Institute, Academy of Sciences of the USSR). Field-Emission of Electrons. The intensity of the field-emission current. The energy distribution of the field electrons. Field-emission from single crystals. (2) V. Vertzner (State Optical Institute). Electron Microscope of the State Optical Institute. (3) A. Andrianov. The Emission of Oxide-Coated Cathode under Impulse Excitation. (4) A. Vlasov (State Optical Institute). A Short Magnetic Lens with a Minimum Spherical Aberration. Calculation of Fields of the Simplest Electrostatic Lenses. (6) V. Lukoshkov. Some Electrostatic Properties of Grid Electrodes. (7) P. Timofeev (All-Union Electrotechnical Institute). The Role of Surface Charges in Electron Devices. (8) V. Sorokina (All-Union Electrotechnical Institute). Mechanism of the Operation of Kenotrons with Cold Emission. (9) P. Aranovich (All-Union Electrotechnical Institute). Electronic Devices with Effective Emitters of Secondary Electrons. (10) D. Zernov (Institute of Automatics and Telemechanics, Academy of Sciences of the USSR). On the influence of Strong Electric Fields on the Secondary Electronic Emission of Dielectric Films. (11) S. Lukianov (Physical Technical Institute, Academy of Sciences of the USSR). On the Secondary Electron Emission of Solid Bodies. (12) L. Kubetzky (Institute of Theoretical Geophysics, Academy of Sciences of the USSR). Some Results of the Application of Principle of Secondary - Electron Transformation. (13) E. Kormakova (All-Union Electrotechnical Institute). Electron Multipliers. (14) A. Vlasov (Moscow State University). Generalization of the Conception of Electronic Plasma (Vibration Properties, Crystalline Structure and Their Spontaneous Appearance in a "Gas"). (15) A. Kaptzov (Moscow State University). Variation of the Mobility of Negative Ions in

Strong Fields and the Influence of This Variation on the Characteristics of the Corona Discharge. (16) G. Spivak and O. Repkova (Moscow State University). Behavior of a Plasma in a Magnetic Field. (17) G. Gvosdover (Moscow State University). The Passage of High-Frequency Currents through Electronic Devices. (18) N. Khlebnikov. Complex Photoelectric Cathodes. (19) P. Morozov and M. Butslov. Physical Properties of Silver - Caesium - Oxide Cathodes. (20) A. Pyatnitzky (All-Union Electrotechnical Institute). Energy Distribution of the Electrons and Dependence of Photocurrent for Caesium-Oxide Cathodes on the Angle of the Incidence of Light. (21) N. Khlebnikov and A. Melamid. New Sb—Cs Photocells.

High Speed Switch

An electronic switch developed for transmitter-receiver antenna switching in radar completes its operational cycle in less than one millionth of a second; and it will repeat this switching job many times a second. The unit is a needle spark gap in a confined space containing gas at a definite pressure. When a pulse is sent from the radar transmitter into the antenna the high voltage causes the gap to break down, short-circuiting the receiver. When the transmitted pulse stops the low pressure gas space de-ionizes in about four millionths of a second removing the short across the receiver input permitting pickup of echoed signals. The gap being hermetically sealed eliminates variations in discharges that might be caused by altitude or humidity changes. These high speed electronic switches are made by Westinghouse Electric Co., Pittsburgh 30, Pa.

Measures "Ceiling" at Wichita Airport

Doing a spectacular job at the Municipal Airport at Wichita, Kansas, is the electronic "ceilometer," one of the few instruments of its kind in the country. It provides an automatic reading, in feet, of the night-time flight ceilings at the field, in any kind of weather.

A tiny but powerful (30,000 candlepower) light source sends a small beam skyward—a shaft of modulated light focussed so that its "spread" is negligible until it reaches 10,000 ft. At its side, a photo-electric mechanism on an automatic swivel "follows" the modulated beam upward by its tone, detecting its illumation on cloud formations. Thus by a process of triangulation the PE cell indicates the critical altitude.

The junior-sized light, which has only about the dimensions of an ordinary automobile headlight lamp, except for its artificial cooling system, enjoys considerable fame in the Wichita airport area because its thin blade of light can be seen for miles around.

Humidity Recording

The ideal of "bone dry" air to protect metallic and non-metallic materials from deterioration resulting from corrosion, mold, mildew, tarnish and other effects of humidity or moisture in the air has been a long-sought goal of air-conditioning scientists and engineers.

It has not yet been achieved—this perfect and perpetual "Sahara of air"—but recent progress in the field of "dehumidification"—the "dehydration" of air—is now playing an important part in plans for the economic and efficient preservation of America's sea power.

At the close of the first World War no adequate scientific equipment existed for protection of ships and their equipment and cargoes against the inevitable onslaught of humidity.

Shelter alone was not enough to prevent the water vapor in the air from seeping into the holds of ships to corrode metal surfaces, tarnish moving parts and "bright work."

Grease, liberally smeared over engines, exposed metal surfaces and ordnance equipment was generally employed as a major preventative of corrosion and rust.

As a result of this liberal use of heavy grease, the job of preparing the inactive naval vessel for return

to active status was a long and costly one, involving many thousands of man-hours spent mainly in removing the grease, and replacing deteriorated equipment.

This laborious and costly refitting process was necessary in the case of the 50 over-age destroyers, which were re-commissioned in 1940 and traded to Great Britain.

Since the early 1920's, the Navy Bureau of Ships, in continuous research and tests with industrial companies specializing in air-conditioning systems and devices for recording and controlling humidity, has sought efficient, economical methods for checking or eliminating deterioration caused by humidity.

Air drying

The most advanced "air-drying" methods, equipment and controls yet perfected are now being successfully incorporated by the Navy in the greatest ship preservation program in world history.

As a result of progress made in dehumidification, the Navy now is able to put into effect preservation measures which will economically maintain hundreds of ships in a "reserve fleet" that will be in a constant state of readiness for emergency action over a long period of years, perhaps 20 or longer.

Preservation by dehumidification means removal of moisture from the atmosphere. This is done by two methods: dynamic dehumidification, which employs machines to remove water vapor; and static dehumidification, which employs dessicants such as silca gel to take up moisture. Both methods have been tested and found effective by the Navy.

To insure that humidity in ships would remain below a constant "safe" level of 30%, an accurate controller-recorder was needed. Tests had determined that a relative humidity of less than 30% would keep atmosphere dry enough to resist rust and corrosion. How to take continuous remote recordings of relative humidity in many "drying stations" remained the major problem which had to be solved.

At the request of the Navy, the Friez division of Bendix Aviation Corp., with a background of more than 70 years of experience in the development and production of controls and meteorological equipment, tackled the problem more than a year ago. Successful joint

experiments were conducted aboard the Navy's experimental ship, AVC-v, in the Philadelphia Navy Yard, as part of lengthy tests of many preservation systems, materials and methods.

Friez engineers developed a controller-recorder which takes accurate humidity readings from 8 locations and transmits them to a central recorder station. Instead of being recorded on a graph, the humidity readings, station numbers, dry bulk temperature and times of readings are printed in numerals on a tape so that they can be easily understood by clerical workers. The printed numerals also form a permanent file record of air conditions within a ship. The Friez automatic controller-recorder also computes the relative humidity values of all 8 remote stations to indicate the average humidity within all areas recorded.

If the average humidity climbs above 30% , the "safe" level, the device then exercises its control functions by starting the dynamic dehumidifying machines. When an average humidity below 30% has again been achieved, the controller stops the dehumidifying equipment and resumes its continuous function as an automatic recorder.

Dielectric Heat Solves Bread Mould Problem

Uniform electronic heating to a temperature of 140 deg. kills instantaneously any mould spores that may be present in loaves of bread, yet does not affect vitamin or other food factors, according to Dr. William H. Cathcart, laboratory head of the Great A. & P. Tea Co.

Equipment used in the experiment was a standard Megatherm dielectric heating unit. Brown bread, particularly susceptible to mould, was treated for five seconds. At the end of three weeks, electronically heated loaves had developed no mould, although kept in moist, warm air. Control loaves, from the same batch of dough, showed signs of mould within three days. As a result, mould-proofing equipment will be installed at A. & P. bake-plants and the use of chemical retardants will be discontinued. An annual saving of $100,000,000 for all types of baked foods is forecast.

Electronic mould control is the outcome of experiments successfully conducted by Dr. Cathcart for the rapid defrosting of frozen foods. dielectric heating was found to re-

ELECTRONIC INDUSTRIES

Advertisers, February 1946

duce defrosting time from days and weeks to a matter of minutes and hours.

In the final installation, the process will begin after the bread is wrapped and on the conveyor belt. Five seconds of exposure will be used, as in the experimental runs. One hundred and fifty million pounds of bread will be saved per year, according to Dr. Cathcart.

Tube Exciters for Generators

Six ignitron tubes now are being used to supply complete field excitation for a large turbine generator installed at the Springdale station of the West Penn Power Co. This is the first time that electronic tubes have been used for such service and it is expected that the generator time out necessary for repairs and maintenance will be reduced to a minimum. The ignitron tubes are energized from a six phase diametrically connected rectifier transformer getting power from the generator busses themselves. Primer excitation, to be used in starting, is obtained from a separate motor-generator set.

Regulation of the generator output voltage is fast and sensitive with electronic field supply. Line to line voltage between all three busses is stepped down by potential transformers and converted into dc through rectox units to operate Silverstat regulators. These in turn vary the bias on thyratron tubes to control the firing time on the main ignitrons. A constant ac voltage is superimposed on this variable bias voltage. As this dc component is increased, the ac wave rides higher to cut the critical curve of the thyratrons earlier in each cycle, thus making the ignitrons pass current over longer portions of time. This increases the main generator field current to raise the generator output voltage.

Ignitron tubes can be replaced while the unit is in operation; in fact, any two diametrically opposite tubes can be removed simultaneously and the unit will continue functioning while new tubes are being installed.

Visual Signals for Accurate Cueing

A new optical system which permits visual signals to be set up for accurate cueing of recorded music and speech has been developed. Details were presented to the Technical Conference of the Society of Motion Picture Engineers by Garland C. Misener. A small light source is mounted back of the turntable, feeding a light ray through a condenser and objective lens to a mirror which is affixed to the pickup arm at its pivotal point. This mirror reflects the light beam against a signal bar installed on the opposite side of the turntable compartment. Movable signals with hairline indicators are slid along this bar to show the exact groove that the playback is to be started or stopped. Details of the light system provide that the horizontal travel of the light beam on the signal rail is five times greater than the horizontal movement of the pickup needle. Even in a recording disk using 100 lines to the inch, the movement on the rail is 0.05 in., for each groove of operation. No heavy attachments are made to the pickup arm and there is nothing to interfere with the easy handling of the disks. The visual signals are placed in correct position at the time of the first playing of the transcription. A horizontal micrometer screw under the pickup arm allows proper placement of the arm for spot cueing.

Schematic arrangement of the precision optical cueing equipment