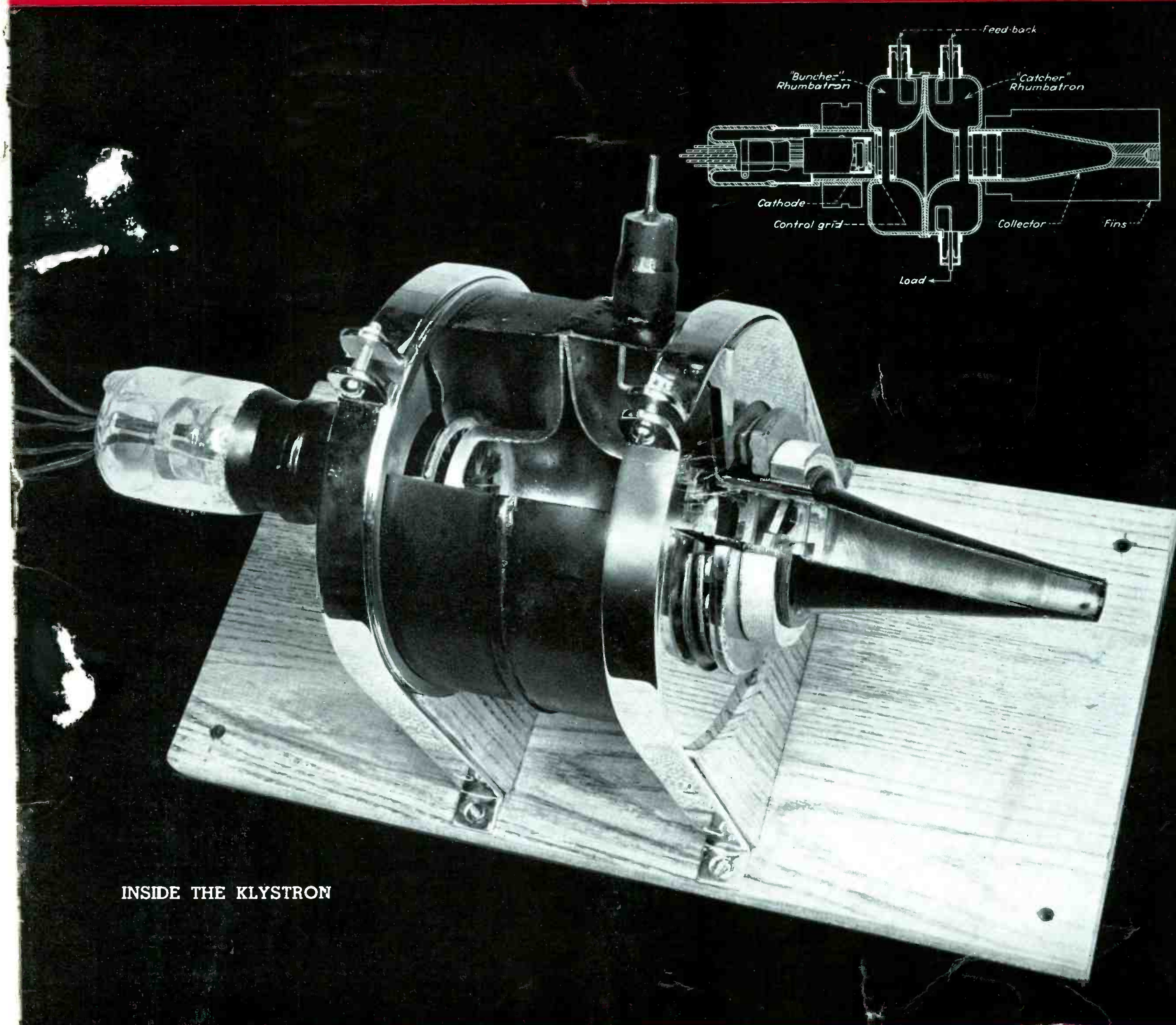
electronics

radio, communication, industrial applications of electron tubes . . . engineering and manufacture

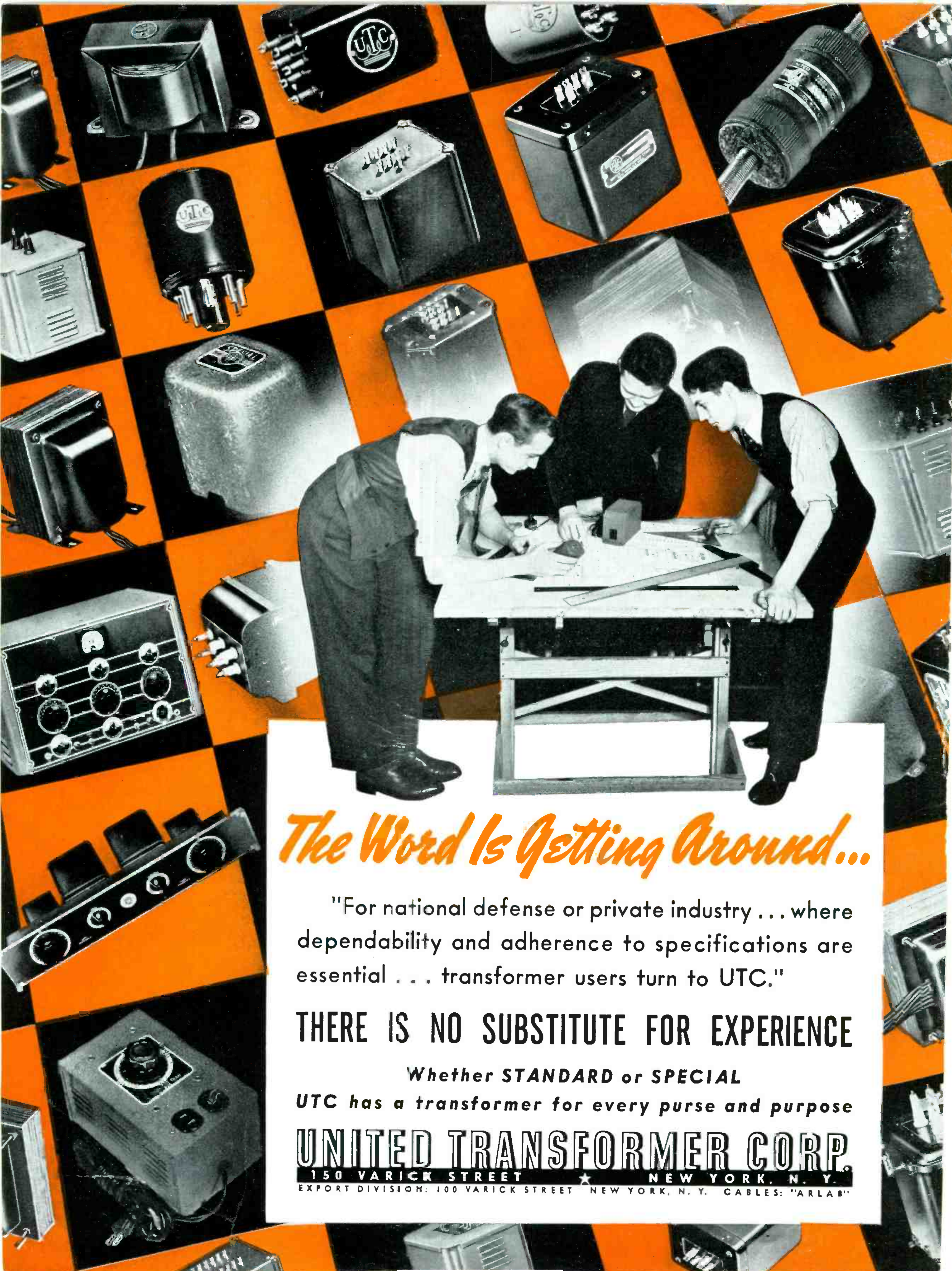


INSIDE THE KLYSTRON

McGRAW-HILL
PUBLISHING COMPANY, INC.

NOVEMBER 1940

Price 50 Cents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"For national defense or private industry . . . where dependability and adherence to specifications are essential . . . transformer users turn to UTC."
THERE IS NO SUBSTITUTE FOR EXPERIENCE
Whether STANDARD or SPECIAL
UTC has a transformer for every purse and purpose
UNITED TRANSFORMER CORP.
150 VARICK STREET ★ NEW YORK, N. Y.
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A McGRAW-HILL PUBLICATION

electronics

CONTENTS—NOVEMBER, 1940

DEPARTMENTS

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SHIFT METHOD OF MODULATION

THEREFORE . . . why is the phase-shift method not also the most dependable method for F-M broadcasting?

REL

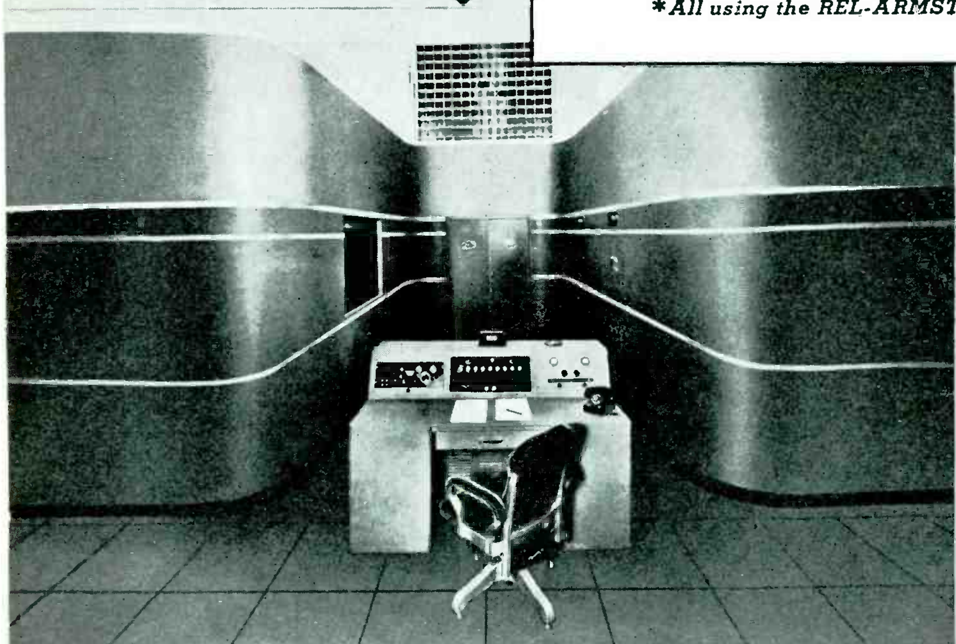
● Major E. H. Armstrong's 40 KW F-M station, W2XMN, at Alpine, N. J. — the pioneer F-M broadcasting station — with equipment built by REL in collaboration with Major Armstrong, has conclusively helped to prove that crystal control F-M maintains frequency stability through eliminating the possibility of control failure. Armstrong phase-shift crystal controlled F-M is the only method which cannot get off frequency.

The newest, largest and most powerful F-M station of all, W1XOJ (Yankee Network), at Paxton, Mass. This view shows the 50 KW REL Cat. 521 equipment (on the air since May, 1939 with 2 KW; since February, 1940 with 50 KW). This station is completely REL equipped.

F-M broadcasting stations serving the public daily*

Station	Location	Owned by	On the air continuously since
W2XMN	Alpine, N. J.	Maj. E. H. Armstrong	April, 1938
W2XAG	Yonkers, N. Y.	C. R. Runyon, Jr.	Nov., 1936
W1XOJ	Paxton, Mass.	Yankee Network	May, 1939
WEOD	Boston, Mass.	Yankee Network	April, 1939
W3XO	Washington, D. C.	Jansky & Bailey	Aug., 1939
W8XVB	Rochester, N. Y.	Stromberg-Carlson	Nov., 1939
W2XQR	Long Island City, N. Y.	J. V. L. Hogan	Oct., 1939
W9XAO	Milwaukee, Wis.	The Journal Company	Jan., 1940
W8XAD	Rochester, N. Y.	WHEC, Inc.	Jan., 1940
W9XZR	Chicago, Ill.	Zenith Radio Corp.	Jan., 1940

***All using the REL-ARMSTRONG phase-shift method**



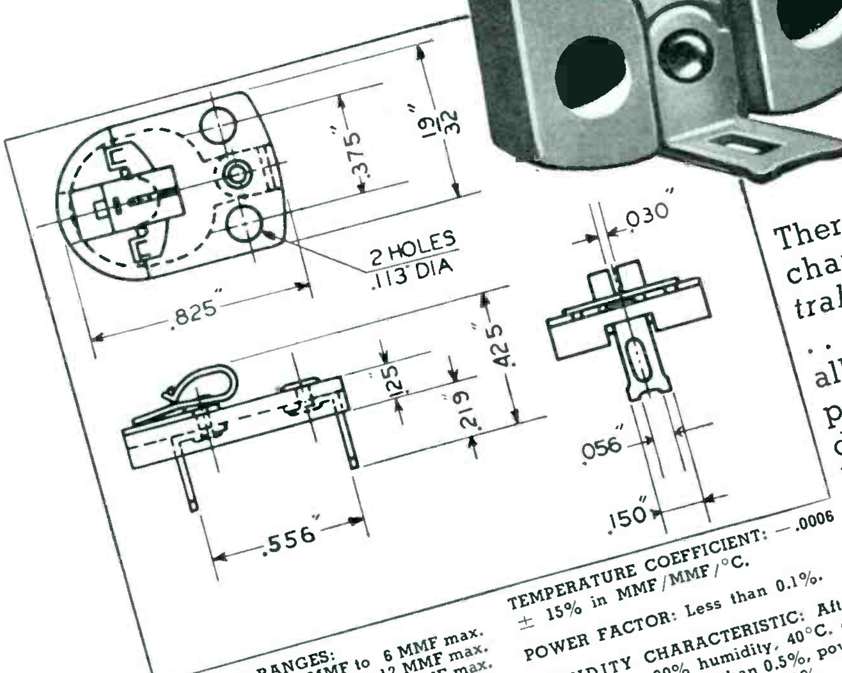
. . . And now read what Mr. Paul deMars says:

"I am pleased to report that this equipment, (REL 50 KW F-M transmitting equipment at STATION W1XOJ), which is the Radio Engineering Laboratories catalogue No. 521 50 KW transmitter, has not only maintained the high fidelity performance in daily operation that has been so often demonstrated as typical of the Armstrong system of phase modulation but has demonstrated that this equipment meets the high standards of dependability required in broadcasting service.

"I am sure that it is as great a source of satisfaction to you as it is to the Yankee Network to know that actual use and experience with this equipment has confirmed our judgment in selecting it for the world's first 50 KW F-M Broadcasting Station."

Paul A. de Mars

Vice-President, The Yankee Network



CAPACITY RANGES:
(a) Less than 2 MMF to 6 MMF max.
(b) Less than 3 MMF to 12 MMF max.
(c) Less than 7 MMF to 30 MMF max.
(d) Less than 60 MMF to 75 MMF max.
Other ranges may be manufactured if in demand.

RETRACKING: After repeated cycles of heating and cooling, capacity change is less than 0.5%.

TEMPERATURE COEFFICIENT: —.0006 ± 15% in MMF/MMF/°C.

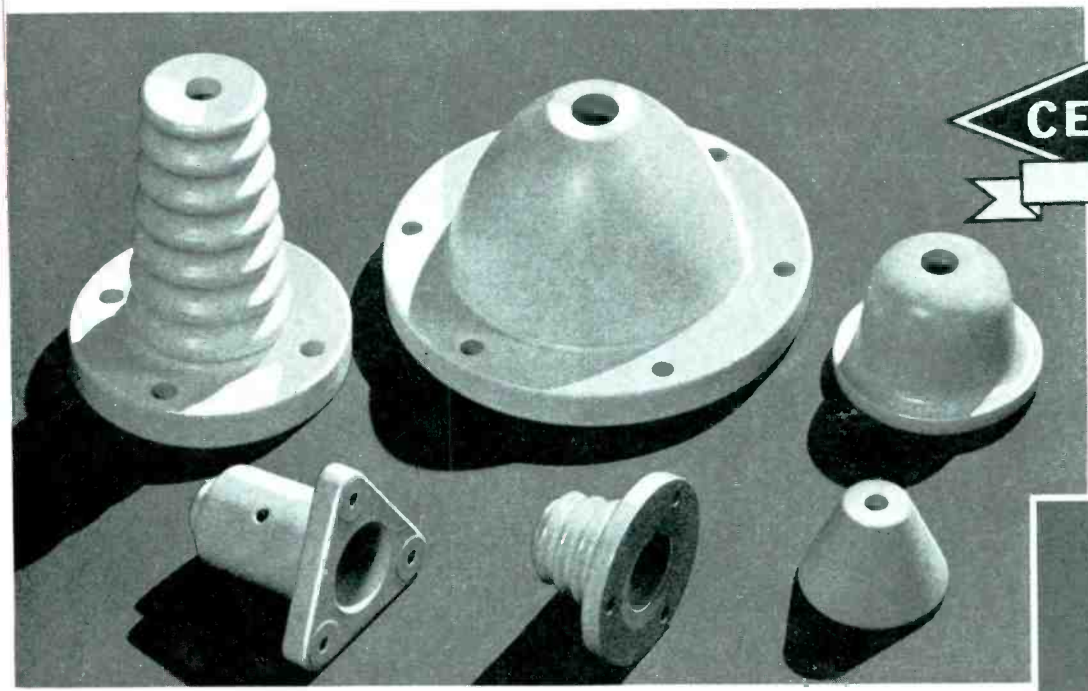
POWER FACTOR: Less than 0.1%.

HUMIDITY CHARACTERISTIC: After 100 hours at 90% humidity, 40°C. capacity change is less than 0.5%, power factor reading less than 0.15%.

There are no erratic capacity changes with the new Centralab Trimmer Condensers . . . the dielectric and base are all one piece moulded under pressure with a ceramic so dense that no temperature or humidity changes can affect it. The stationary plate is silver, bonded to the ceramic with no air film between. The movable plate is metal, rotatable on the flat ground surface of the ceramic . . . a worthy companion . . . and a new member of the famous CENTRALAB family.

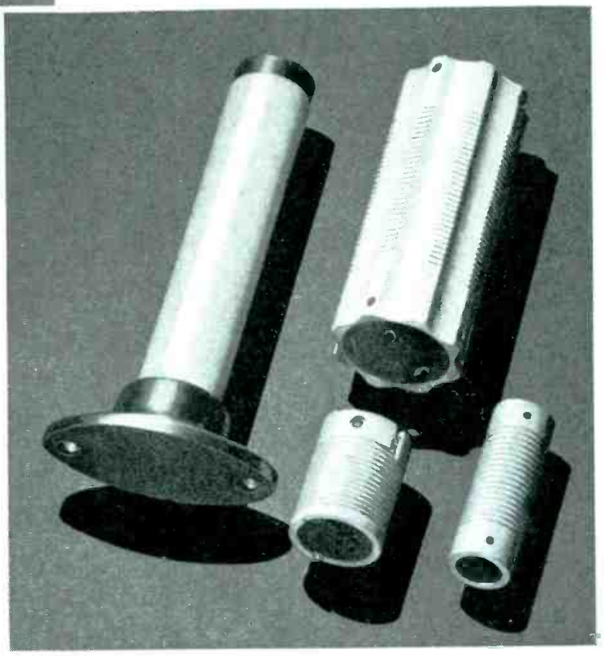
CENTRALAB Div. of Globe-Union Inc., Milwaukee, Wis.

Important today . . . a DEPENDABLE source of
STEATITE INSULATORS



GENERAL CERAMICS COMPANY INSULATORS

Typical General Ceramics die-pressed Steatite and Ultra-Steatite shapes. Note the deep pressed cored-out insulators . . . also the large beehive insulator, 4" high, and the lead-in bowl, which is 5¼" in diameter.



Extruded and machined coil forms and a metal-ended insulator with solid base.

Backed by up-to-date production methods, and a reputation for cooperative service and for keeping delivery promises, General Ceramics Steatite and Ultra-Steatite Insulators are widely used by leading radio and electrical manufacturers. Let us help you solve your insulation problems.

General Ceramics Company

RCA Building, 30 Rockefeller Plaza, New York

***Factory*, Keasbey, New Jersey**

• This catalogue illustrates standard insulator shapes. Send for it.

Steatite and Ultra-Steatite
INSULATORS

UNEQUALLED CHECK-UPS

eliminate the "*Doubtful Few*"

Some of the scientific check-ups in the 16-Point Quality-Control routine.

. . . when Parker-Kalon's Quality-Control Laboratory backs your fastening devices

You get an unequalled protection against time-wasting, cost-boosting "duds" among your fastening devices when you specify Parker-Kalon! For, in Parker-Kalon's plant, an unusual Quality-Control Laboratory stands guard over all production, to eliminate the "doubtful few" screws that slow-up assembly work and produce unsatisfactory fastenings.

Without counterpart in the industry, this scientific Laboratory sets standards of quality that could never be maintained without rigid quality-control of every production step from chemical analysis of the metal to micrometric check-up of finished dimensions. It insures that every Parker-Kalon Fastening Device is more than "good enough" in both accuracy and strength.

Take no chances in your assembly jobs . . . buy Hardened Self-tapping Screws, Socket Screws or other fastening devices that are made in the screw industry's most modern plant. Parker-Kalon Corporation, 192-194 Varick Street, New York.

COSTS NO MORE *to get this Parker-Kalon Quality-Control Guarantee with every box of . . . .*

Hardened Self-tapping Screws
Types, sizes, head-styles for every assembly of metal or plastics

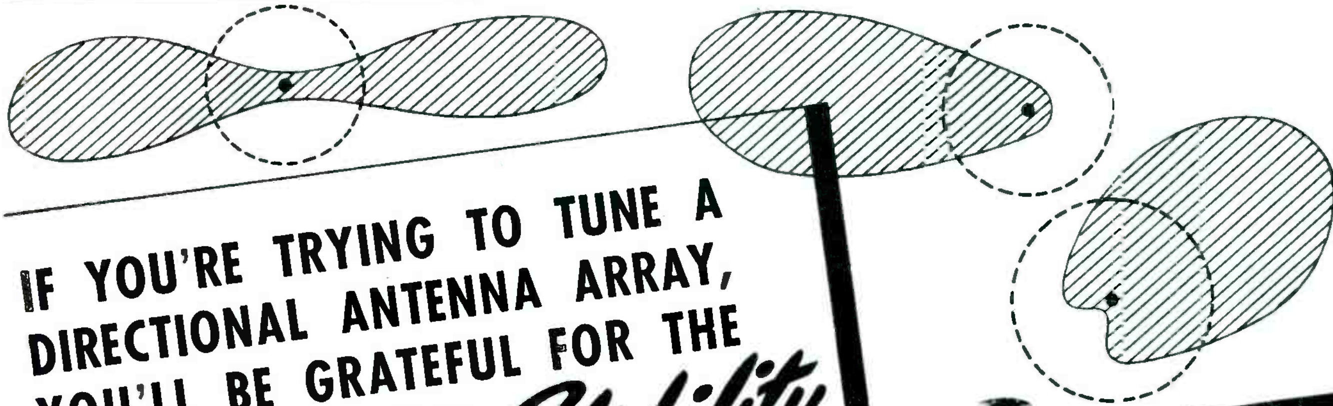
Cold-forged Socket Screws

Cap Screws, Set Screws, Stripper Bolts made to a new high standard of quality

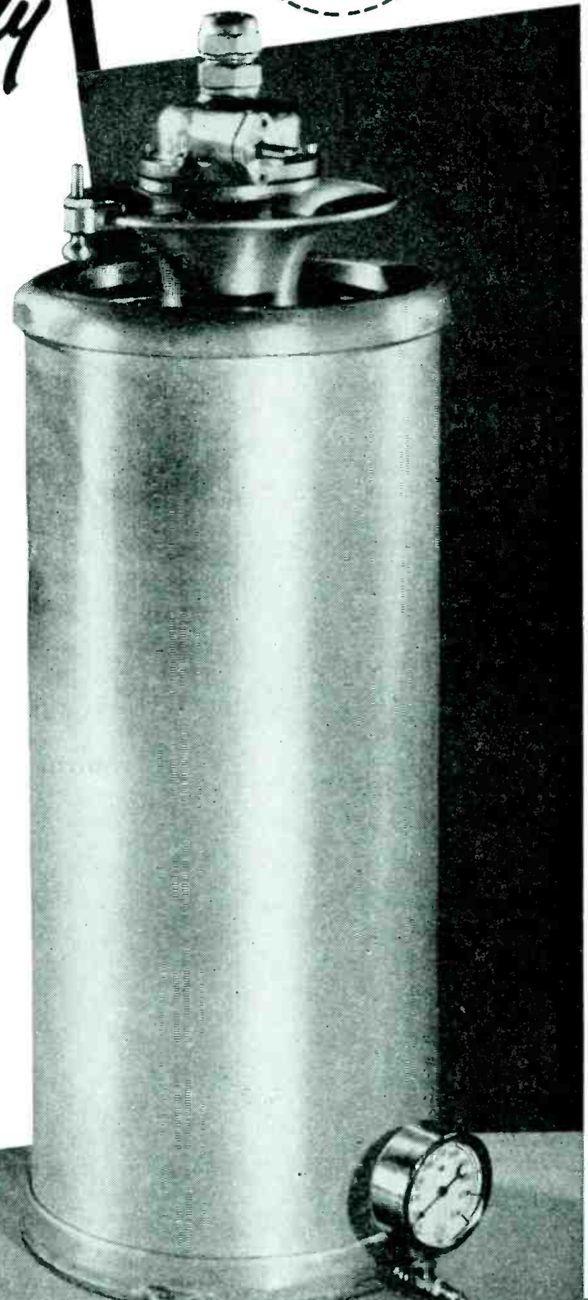
Wing Nuts-Cap Nuts-Thumb Screws
Cold-forged . . Neater, Stronger

SOLD ONLY THROUGH RECOGNIZED DISTRIBUTORS

Quality-Controlled PARKER-KALON Fastening Devices



IF YOU'RE TRYING TO TUNE A DIRECTIONAL ANTENNA ARRAY, YOU'LL BE GRATEFUL FOR THE LAPP CONDENSER'S *Stability*



For solving an interference problem with increased power, or for increasing signal strength over a desired area with no change in power, the modern directional antenna array offers a highly satisfactory solution.

The performance of the array depends, however, on a critically accurate and continuously maintained phase-relationship between various elements of the array.

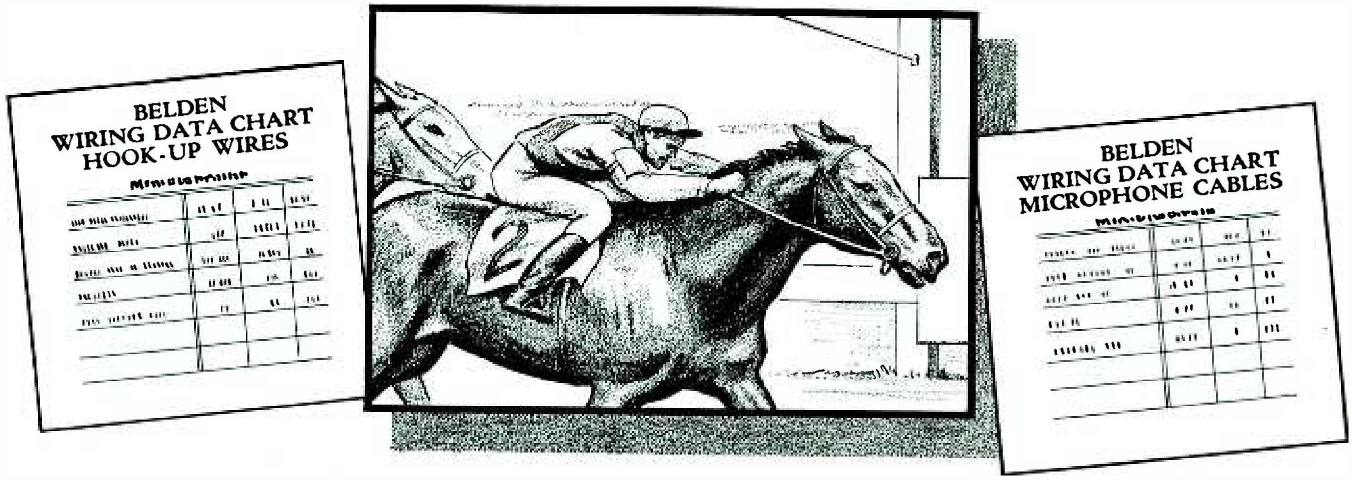
You're likely to find yourself in water over your head if you try the delicate job of tuning an array with condensers that vary in capacitance as they heat up in operation.

The safe way to proceed is to install Lapp gas-filled condensers in your antenna circuit. For these units offer capacitance at a constant value under any temperature change. Tuning adjustments are made with full power on. Besides, more power gets to the antenna (it's practically zero loss; the only solid dielectric is a porcelain bowl that carries the rotor); with no solid dielectric to puncture, you can operate at full rating for an indefinite time without failure; space requirement is an absolute minimum.

And aren't those the properties that make this condenser the best choice for just about any application?

Write for descriptive literature and list of sizes.

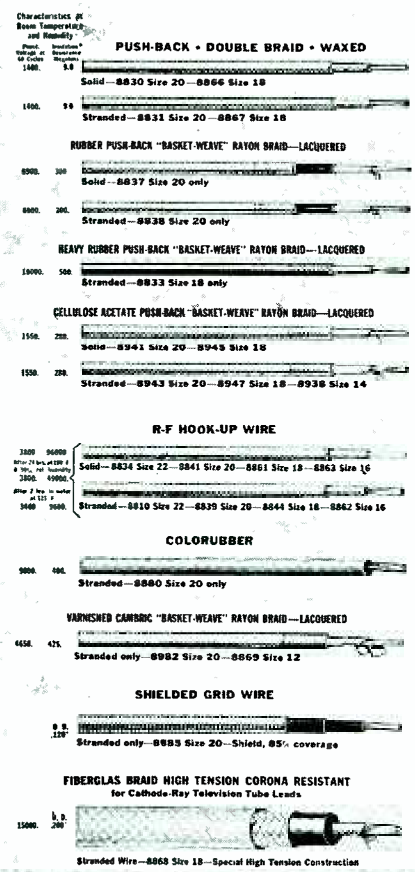
LAPP INSULATOR CO., INC., LEROY, N. Y.



WIRES have records, too

—and Winners are "bred" to win for you

These Hook-up Wires are Approved —they're made by Belden



*D. C. Insulation per ft. Immersed in Mercury

Don't gamble on wires when you put them to work in your products. Get their records—know their past performance—be sure they won't go "haywire."

How can you make this investigation?

Easy—when you depend on Belden. Case histories—complete performance records are available on Belden wires. You know before you start what each wire has been designed to do.

You know too that careful inspection maintains the vital characteristics in every foot of Belden wire. You have double assurance of satisfactory performance—fewer rejections.

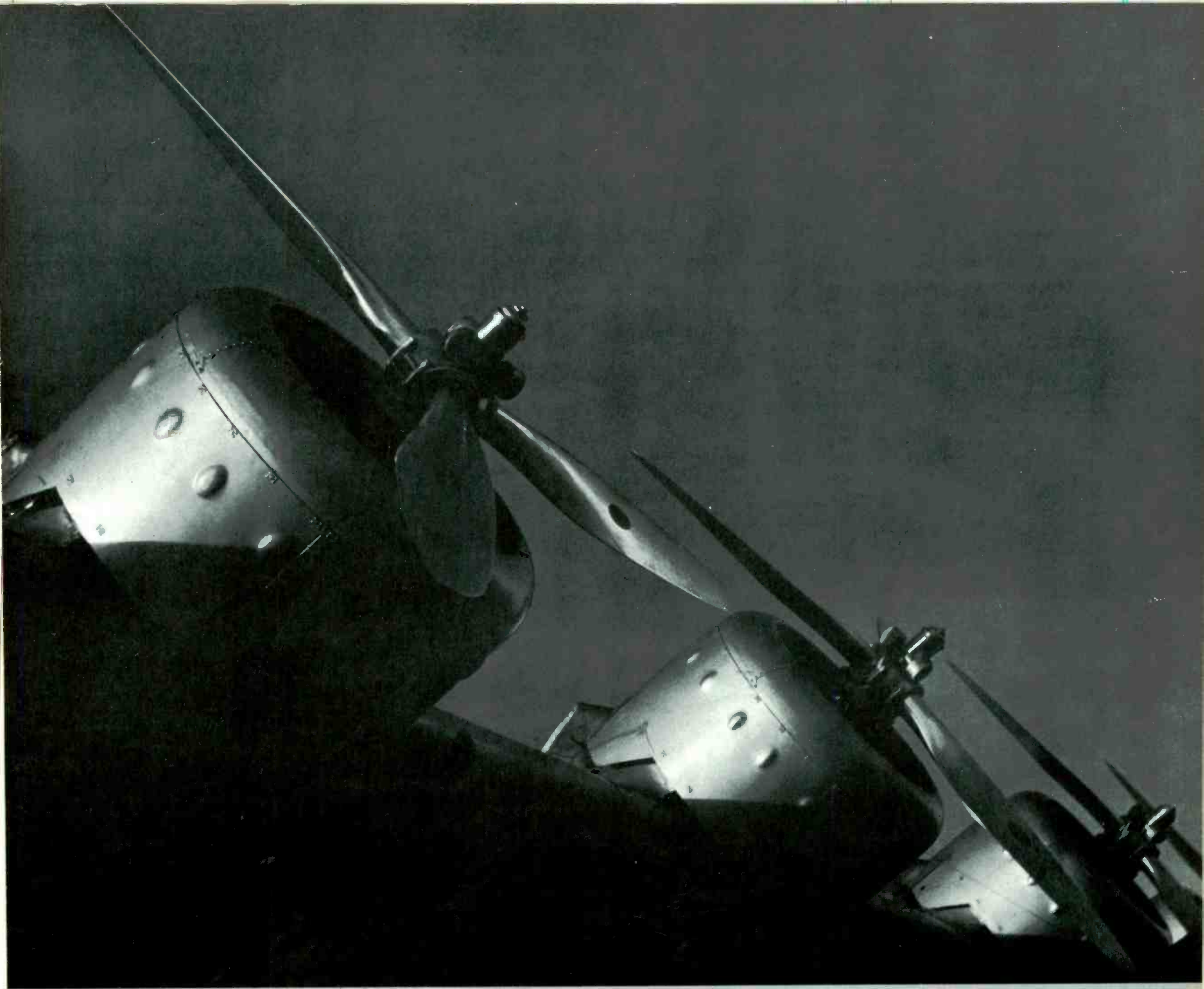
Use the right wire—the Winner—for every job. Specify Belden.

Belden Manufacturing Company
4625 W. Van Buren St., Chicago, Ill.

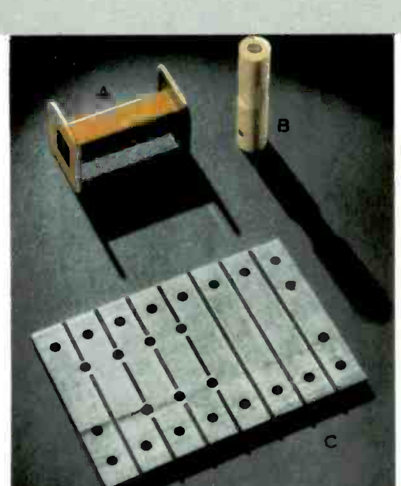
"Don't Go Haywire"

Go **Belden**

WIRES FOR RADIO AND COMMUNICATIONS



Insulation Earned Its Wings



A. Square tube coil form sanded to size; flanges milled, sawed and broached. **B.** Insulating tube, sawed, drilled, reamed, and milled. **C.** Sawed, milled and drilled Terminal Panel.

ONE type of airplane propeller hub alone contains forty parts punched and machined from Synthane Bakelite-laminated. The plane which last year dived to a world's record was literally filled with Synthane fittings. These and other aviation applications have come about because Synthane, usually thought of as an electrical insulator, is also light in weight, corrosion resistant, structurally strong and easy to machine accurately.

Less spectacular than the aviation examples, though equally important, are the every-day uses for Synthane, inspired by its combination of excellent insulating characteristics, light weight, denseness, structural strength, hardness and resistance to solvents, gases, petroleum products, water and many acids and salts.

In dozens of industries and hundreds of products, Synthane's combined properties are meeting combined specifications not completely satisfied by any other material.

If you are interested in improving performance, lowering costs, reducing weight or if you have a corrosion condition to overcome, let's see whether we can help you.

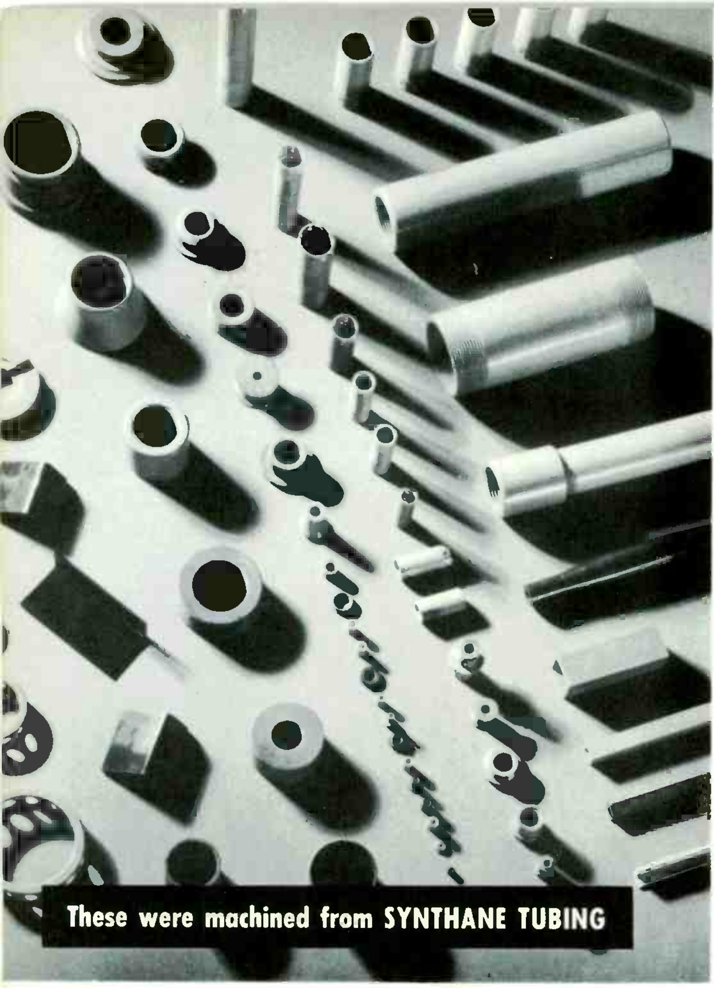
SYNTHANE CORPORATION, OAKS, PENNSYLVANIA

SYNTHANE

Bakelite — laminated

TECHNICAL PLASTICS

SHEETS · RODS · TUBES · FABRICATED PARTS · SILENT STABILIZED GEAR MATERIAL



These were machined from SYNTHANE TUBING

Inside diameters from 1/8" to 22"
Circular and special sections

Ease of machining and combined properties of SYNTHANE [Non-Metallic] TUBING account for its thousands of uses

SYNTHANE Bakelite-laminated tubing is light in weight and non-metallic yet it is hard, dense, structurally strong, easy to machine, resistant to the corrosive action of oils, and many chemicals, gases and water, and one of the best of electrical insulators.

WHO USES IT, AND WHY YOU MAY—Synthane has many more properties in combination, therefore it is used for thousands of parts, by the aircraft, automotive, radio, electrical, chemical, textile, petroleum and other industries.

Any part which is tubular in character or any part which can be machined from a section of tubing is a likely application of Synthane tubing—especially if a combination of many properties is desired. Examples: Chemical piping, sleeves, ferrules, bushings, valve seats, ball bearing retainers, piston rings, washers, bobbins, coil forms, fuse cases and explosives containers.

STANDARD AND SPECIAL SHAPES — Synthane tubing is made in standard lengths from 1/8" to 22" *inside* diameter, and in wall thicknesses according to your specifications. Special shapes are also available—oval, square, rectangular or irregular variations of them. Certain irregularly shaped parts can be produced by a combination of molding and laminating, instead of machining, at an attractive saving.

IDEAL FOR AUTOMATIC SCREW MACHINE WORK—Many parts can be readily machined in your own shop—or we'll machine them for you. Synthane tubing is ideal for turning out small parts in large quantities because of the speed at which it can be worked.

ARE YOU THE NEXT TO BENEFIT!—Synthane finds its best applications where manufacturers are able to make economies by utilizing its electrical, mechanical, and corrosion-resistant properties. If you think Synthane tubing may be helpful to you, why not tell us your application, or send for a sample?

SYNTHANE CORPORATION, OAKS, PA.

Gentlemen:

☐ *Please send me a sample of Synthane tubing.*

☐ *Mail me a copy of your folder "Synthane Bakelite-laminated Tubing."*

NAME ____________________

COMPANY ____________________

ADDRESS ____________________

CITY ____________________ STATE ____________________

SYNTHANE

Bakelite — laminated

TECHNICAL PLASTICS

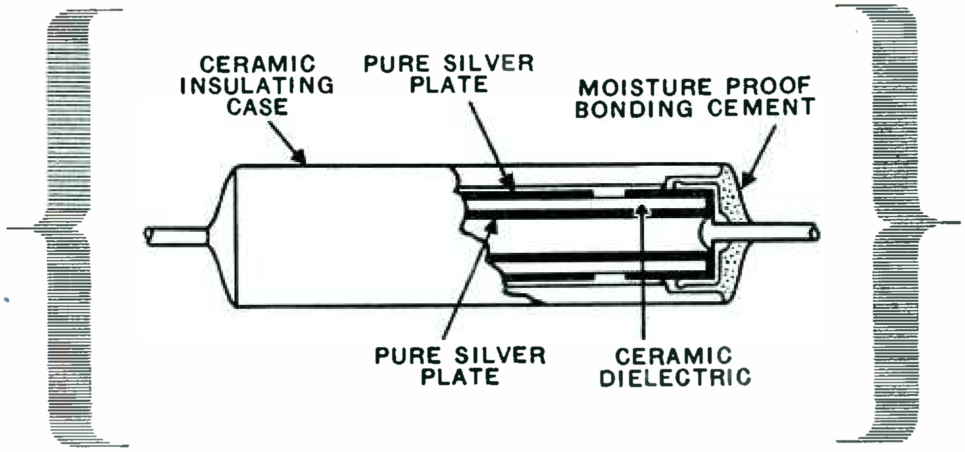
SHEETS · RODS · TUBES · FABRICATED PARTS · SILENT STABILIZED GEAR MATERIAL

Representatives in principal cities

TIMELY INFORMATION TO ENGINEERS

ABOUT Erie Ceramicons

REG. U.S. PAT. OFF.



Cross section of Insulated Erie Ceramicon

PERMANENCE OF CAPACITY Erie Ceramicons, due to the unique method of applying plates directly to the surface of the dielectric, are inherently stable in capacity. A change of less than ¼ of 1% will be found after subjecting these condensers to repeated heating and cooling cycles of 200 hours at 250° F. and 200 hours at —40° F.

250° F. is recommended as a maximum safe operating temperature.

EFFECT OF HUMIDITY Increase in power factor is less than 20% and change in capacity is less than ¼ of 1% after 100 hours at 100% relative humidity at 40° C. Leakage resistance after this same test, measured at 1000 volts D.C., is over 1000 megohms.

EFFECT OF TEMPERATURE Condensers of the P120 type have a positive temperature coefficient of capacity of 120×10^{-6} per degree C. The N680 type have a negative coefficient of 680×10^{-6} per degree C. These values correspond to a rise of .36% and a drop of 2.1% respectively as the temperature is raised from 30° to 60° C. Single unit Ceramicons can be supplied on special order having any desired temperature coefficient between these limits. Tolerance on temperature coefficient is $\pm 40 \times 10^{-6}$

POWER FACTOR The power factor of all Ceramicons will increase slightly as the temperature increases. For example, a 20% increase in power factor will result from a change in temperature from 30° to 60° C.

FINISHING TESTS Erie Ceramicons are conservatively rated at 500 volts D.C. Test voltage is 1300 volts D.C. Leakage resistance at 1000 volts D.C. is over 10,000 megohms.

All Ceramicons are individually checked for capacity and power factor at 1 megacycle before shipping. Capacity tolerance is set to customer's specification. Power factor limit is .08%.

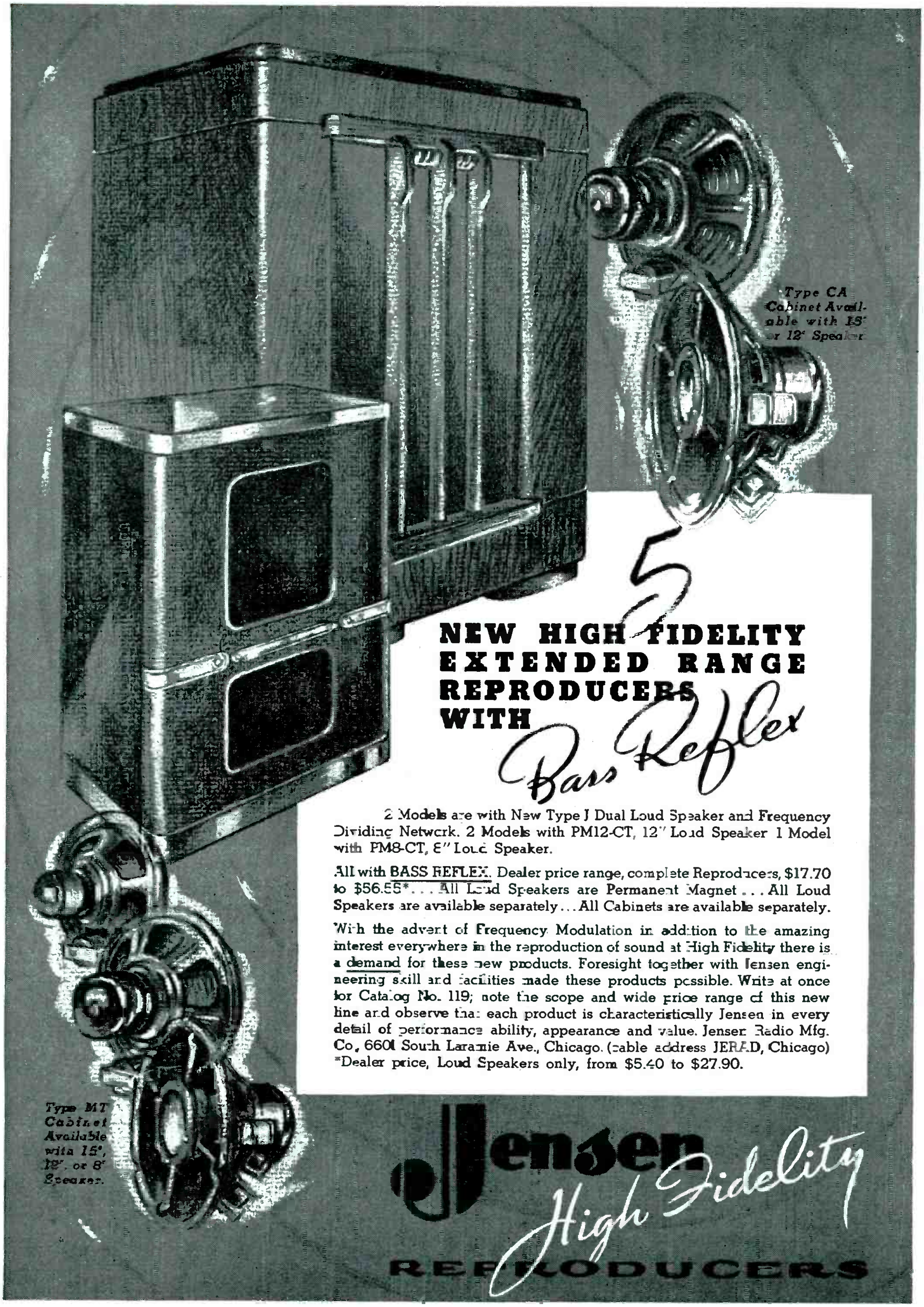
Reprints of this data for your files will be sent on request

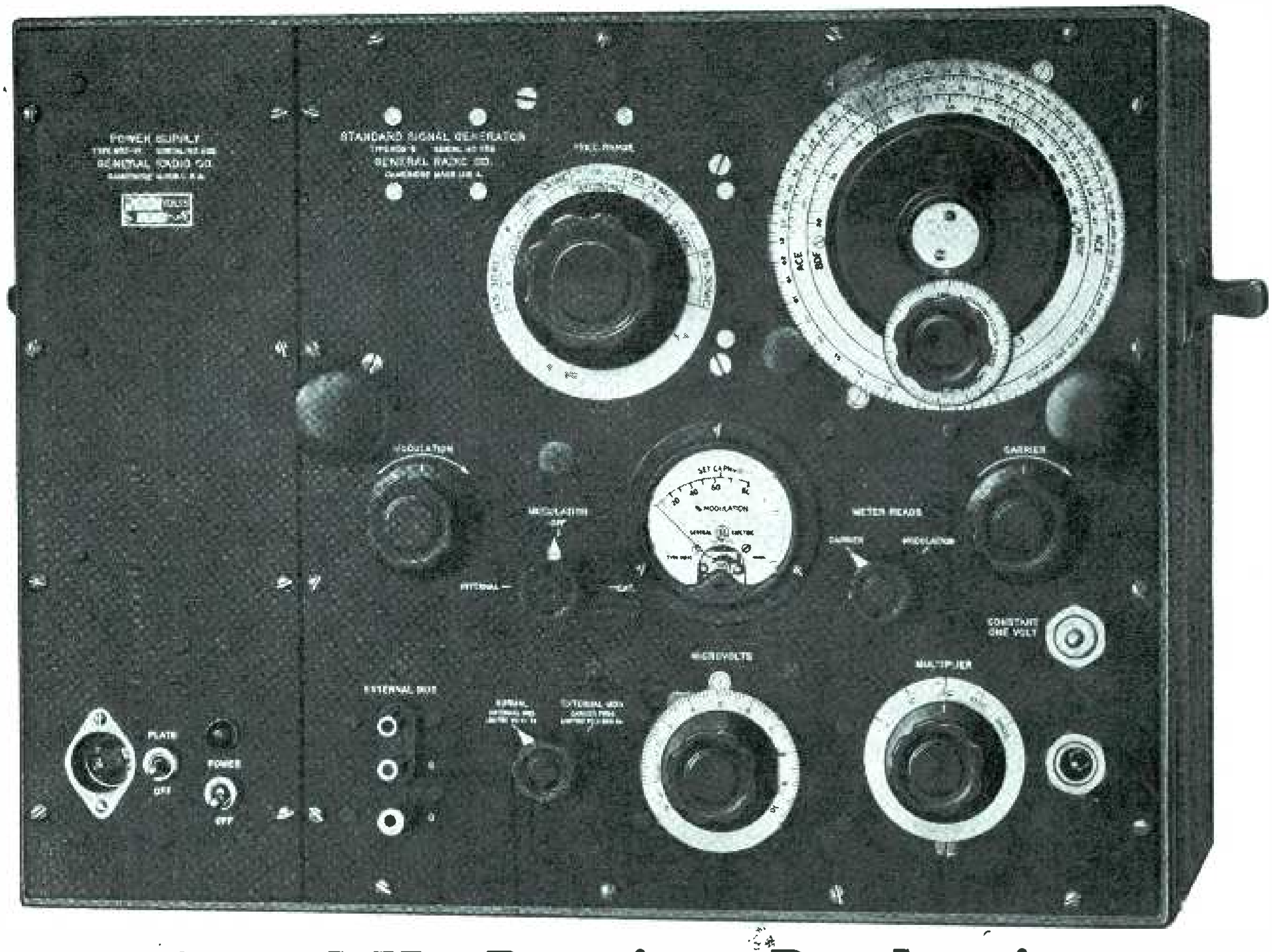
RESISTORS
SUPPRESSORS
CERAMICONS
SILVER-MICA CONDENSERS

Erie RESISTOR CORPORATION, ERIE, PA.

TORONTO, CANADA • LONDON, ENGLAND • PARIS, FRANCE-J.E.CANETTI CO.

MOLDED BEZELS
PUSH BUTTONS AND KNOBS
POLYSTYRENE COIL FORMS


Type CA Cabinet Available with 15" or 12" Speaker
5
NEW HIGH FIDELITY EXTENDED RANGE REPRODUCERS WITH
Bass Reflex
2 Models are with New Type J Dual Loud Speaker and Frequency Dividing Network. 2 Models with PM12-CT, 12" Loud Speaker 1 Model with PM8-CT, 8" Loud Speaker.
All with BASS REFLEX. Dealer price range, complete Reproducers, $17.70 to $56.55*... All Loud Speakers are Permanent Magnet... All Loud Speakers are available separately... All Cabinets are available separately.
With the advent of Frequency Modulation in addition to the amazing interest everywhere in the reproduction of sound at High Fidelity there is a demand for these new products. Foresight together with Jensen engineering skill and facilities made these products possible. Write at once for Catalog No. 119; note the scope and wide price range of this new line and observe that each product is characteristically Jensen in every detail of performance ability, appearance and value. Jensen Radio Mfg. Co., 6601 South Laramie Ave., Chicago. (cable address JERAD, Chicago)
*Dealer price, Loud Speakers only, from $5.40 to $27.90.
Type MT Cabinet Available with 15", 12", or 8" Speaker.
Jensen
High Fidelity
REPRODUCERS



Speed Up Receiver Production with this Standard-Signal Generator

Accurate • Convenient to Use • Gives the Answer Quickly

ALL of the basic receiver characteristic measurements can be made very simply and quickly with the G-R Type 605-B Standard-Signal Generator, so simply in fact that any technician can supervise the obtaining of the following measurements with assured accuracy:

- **SENSITIVITY**
- **SELECTIVITY**
- **DISTORTION**
- **TUNING RANGE**
- **TUNING CALIBRATION**
- **FREQUENCY RESPONSE**
- **INTERFERENCE**
- **OUTPUT**
- **TUNING TRACKING**
- **I. F. ALIGNMENT**
- **AVC CHARACTERISTICS**
- **AFC CHARACTERISTICS**

WRITE FOR BULLETIN 649 FOR COMPLETE DATA

A number of the design features of the G-R Signal Generator are exclusive; all of its features combine to make it the best standard-signal generator on the market at the moderate price of $415.00.

OPERATING FEATURES

DIRECT-READING CARRIER RANGE: 9.5 kc to 30 Mc
EXTRA CARRIER RANGE: 30 to 50 Mc
LOGARITHMIC FREQUENCY DIAL: with geared slow-motion, smooth action incremental dial reading to 0.02% for selectivity measurements
OUTPUT CONTINUOUSLY ADJUSTABLE: 0.5 μv to 0.1 v
SEPARATE ONE-VOLT OUTPUT JACK
MODULATION CONTINUOUSLY ADJUSTABLE to 80%
INTERNAL MODULATION: 400 cycles ± 5%
EXTERNAL MODULATION: flat from 30 cycles to 15 kc
NEGLIGIBLE FREQUENCY MODULATION
NO ATTENUATOR REACTION ON FREQUENCY
EXCELLENT SHIELDING
A-C OPERATION with built-in voltage regulator

GENERAL RADIO COMPANY
CAMBRIDGE, MASSACHUSETTS
Branches in New York and Los Angeles

You Need This Catalog

of *Approved* Precision Products

For Your Industrial Electronic Requirements

Your engineering and designing departments should know that this Mallory Catalog is available. It is a handy reference for electronic parts—and especially may save hours of inquiry and long correspondence delays.

It may be a replacement needed for plant equipment.

—Or it may be a specified part for test or experimental work in your engineering laboratory.

—Or it may be a part that will become a fundamental of some product you plan to put into production.

Mallory manufactures a complete line of approved precision products that have innumerable applications in the aeronautical, automotive, electrical, geophysical, radio and industrial fields. It would be impossible to enumerate these products here but they are ready for reference when you have the Mallory Catalog at your elbow.

Speedy service awaits you. Mallory's organization of 253 selected distributors is well equipped to supply your needs. Each distributor is a leader in his community, maintains adequate warehouse stocks and has a staff well trained to serve you.

Write today for the Mallory Catalog of Approved Precision Products. It will be sent promptly, along with the address of the distributor nearest you.

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MALLORY

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Serves the Aeronautical, Automotive, Electrical, Geophysical, Radio and Industrial Fields with . . . Electrical Contacts, Welding Electrodes, Non-Ferrous Alloys and Bi-Metals . . . Rectifiers, Dry Electrolytic Capacitors, F. P. (Fabricated Plate) Capacitors, Vibrators, Vitreous Resistors, Potentiometers, Rheostats, Rotary Switches, Single and Multiple Push Button Switches, Electronic Hardware.

CROSS TALK

▶ **MICRO** . . . Certain writers of scientific papers and editors have raised with the National Research Council the question of whether there should be postponement of publication of papers which may have some bearing on national defense. The Council appointed an advisory committee to consider this matter and in accordance with this committee's recommendations a Reference Committee on Micro-Wave Radio Developments has been set up to consider manuscripts dealing with micro-waves. Dr. Alfred L. Loomis, Tuxedo Park, N. Y., is chairman and any editor or author of a potential paper dealing with u-h-f research may consult him as to whether it is wise to publish such a paper at the present time. If such an article is withheld from publication and appears later, after the needs of the defense organizations have been met, proper acknowledgment of the author's public spirit will be made.

▶ **LOSS** . . . Autumn of this year saw the ranks of pioneers in electronics depleted by two names of preeminent recognition: Paul Nipkow and Sir J. J. Thomson.

The scanning disc of Nipkow was invented in 1884, far ahead of any possible use in television, but upon so fundamental a concept was it based that only the electron displaced it as a scanner.

The work of "J. J." is best known to every modern physicist for the discovery of the electron. His achievements are rivalled by his success in teaching younger men to carry on research of high order and to take their rightful places in the great universities.

Both men were in their 80's. Sir J. J. Thomson died in Trinity College; Dr. Nipkow in Berlin.

▶ **SECOND CLASS MAIL** . . . We are amused and sympathetic with the plaint of Mr. Charles Williams of Seattle who says: "I am very busy. I hope radio parts manufacturers are busy too, but some of them appear to be striving desperately after more business. They send me all sorts of literature; big, little, good, not so good. I can't imagine what I am to do with it. I can't plaster my walls with it, I can't read it all, most of it I can't file and a lot of it I can't find after filing. The "X" company sends me big folded sheets; the "Y" News is too big by an inch in each direction to go anywhere except in the wastebasket, "Z" sends me little folded sheets, two others put out nice catalogs and most of them are of uniform size, but I can't tell which are the latest issues. They don't number or date the catalogs.

"All manufacturers should number their catalogs, date them and tell which supersedes the others and in what respects. Most of them also lose sight of the fact that the consumer has to refer to old catalogs for numbers of parts that require replacement. Usually they can't be found in the new catalog and the new issue doesn't tell what new item will be suitable as a replacement.

"Years ago I worked in the architectural profession where the same conditions were encountered relative to literature on building materials. The architects couldn't use it or file it. The American Institute of Architects printed thousands of postcards and distributed them to members. They read in substance: 'Dear Sirs: Your advertising matter has been received and consigned to the waste basket. It does not conform to standard sizes etc. prescribed by the A.I.A.' Perhaps if parts manufacturers knew what happened to their advertising matter they would make a change."

▶ **EYES FRONT** . . . It seems that National Union has been making radio tubes for quite a spell—ten years or more. Recently one of the staff competed at Atlantic City in a Miss America bathing beauty contest after having won over the state of New Jersey candidates. National Union sent us a photo of Miss New Jersey and while we don't lay any claims to being expert at such matters we might as well come right out and say that National Union has something pretty nice right in its factory.

But—the release says, "While the officials of National Union are very pleased with this latest development, they want it clearly understood that as far as they are concerned female beauty is secondary to the production of quality radio products."

The Defense Set-up for the Communications Industry

A news report from Washington, concerning the activities of the Federal Communications Commission, the National Defense Research Committee, the National Inventors Council, the Patent Office and the Defense Communications Board—agencies on which the industry and its engineers must depend for guidance in the defense program

THE readers of ELECTRONICS are only too well aware of the general effect of the national defense effort on civil life. The prospect of greatly increased taxes, the conscription of men into the armed services, the rapid acceleration of business activity—all these are only too evident. What is not so evident, but equally important to members of the electronics community, is the effect on the profession and the business of communications.

Here are a few startling examples:

In the three months period from July 10th to October 10th, the U. S. Army and Navy awarded contracts for communications equipment (radio transmitting and receiving equipment and components, for the most part) to the extent of $38,786,982.10 (see table on page 98).

The Federal Communications Commission has one allocation of $1,600,000 and a supplementary appropriation of $175,000 to extend and improve their facilities for monitoring the ether spectrum.

The F.C.C. also has obtained the fingerprints and proof of the citizenship of more than 100,000 commercial and amateur radio operators, out of a total of 110,000 such operators licensed by the government. Similar information on from 30,000 to 50,000 operators in telephone and telegraph companies has been requested from the land-wire companies, and is being collected rapidly.

The U. S. Patent Office is now exercising its authority, granted this year by Congress, to withhold the issuance of patents and to swear the inventor to secrecy, if an invention has direct value in national defense.

The Institute of Radio Engineers, acting in cooperation with the National Resources Planning Board and the Civil Service Commission, has appointed a Preparedness Committee. This Committee has prepared a questionnaire to be sent out by the government to the I.R.E. membership list, which will list the special abilities and experience of its members. Practically every other professional society in the country has offered its services in a similar way, to aid in preparing a "National Roster of Scientific and Specialized Personnel."

All this is news of the greatest importance to radio engineers and others in the electronics field—so much so in fact that your editors have thought it advisable to present this report based on an intensive newsgathering expedition to Washington. The report is necessarily sketchy in spots, because secrecy is one of the primary attributes of the present activity.

The Six Government Agencies Now at Work

In addition to the defense activities of the Army, Navy and Coast Guard there are now actively at work six government agencies whose work bears on the communications field: The Federal Communications Commission, The National Defense Research Committee, The National Inventors Council, the Patent Office Defense Committee, the Defense Communications Board, and the National Roster being compiled by the Civil Service Commission. On its face this long list of agencies looks like traditional governmental bureaucracy, but such is not the case. Each agency has its special functions, each is cooperating with the others. There is practically no duplication of effort. And all are hard at work.

The first named agency, the F.C.C., is familiar as the regulator of all non-federal interstate communication in the country. Its defense activities are those of policing the ether, in active cooperation with the Federal Bureau of Investigation, to track down unlicensed or otherwise suspicious transmissions, and to prevent the use of licensed transmitters for subversive purposes. To carry out this program the F.C.C. needs an extensive ether-monitoring set-up.

One of the problems is foreign language broadcasting. There are about 200 broadcast stations in the United States, which broadcast at one time or another in one of 30 foreign languages. The opportunity for improper alien activity is obvious, so the F.C.C. makes a practice of spot-checking such broadcasts by instantaneous recording.

Since there are some 70,000 licensed transmitters in the United States, the question of monitoring signal strength and frequency is a major one. To aid this work, the President allocated $1,600,000 of his $100,000,000 defense fund to the F.C.C. to extend its monitoring facilities. The plan, now in the latter stages of completion, calls for 11 primary monitoring stations, 100 secondary base monitor stations, at least one in each state, and 80 mobile units, all manned by a staff of 500 men. Each station, including the mobile trucks, contains a field-strength and frequency measuring set covering the entire spectrum from long waves to ultra-short, a direction finder, and instantaneous recording equipment. The mobile units contain two-way f-m communication equipment for coordinating the actions of two trucks in tracking down the location of signals under investigation. Foreign sources of programs, from shortwave stations abroad, are also scrutinized with the same care.

When the F.C.C. discovers evidence of espionage, sabotage, violation of neutrality, or other subversive activities, it turns over the data to the F.B.I., which is responsible for the prosecution of such matters under Federal regulations. Not the least important aspect of this work is the fact that a large body of radio investigators is being trained, which in time of war will be of the greatest value to the Army and Navy in their own counter-espionage work.

The Defense Communications Board

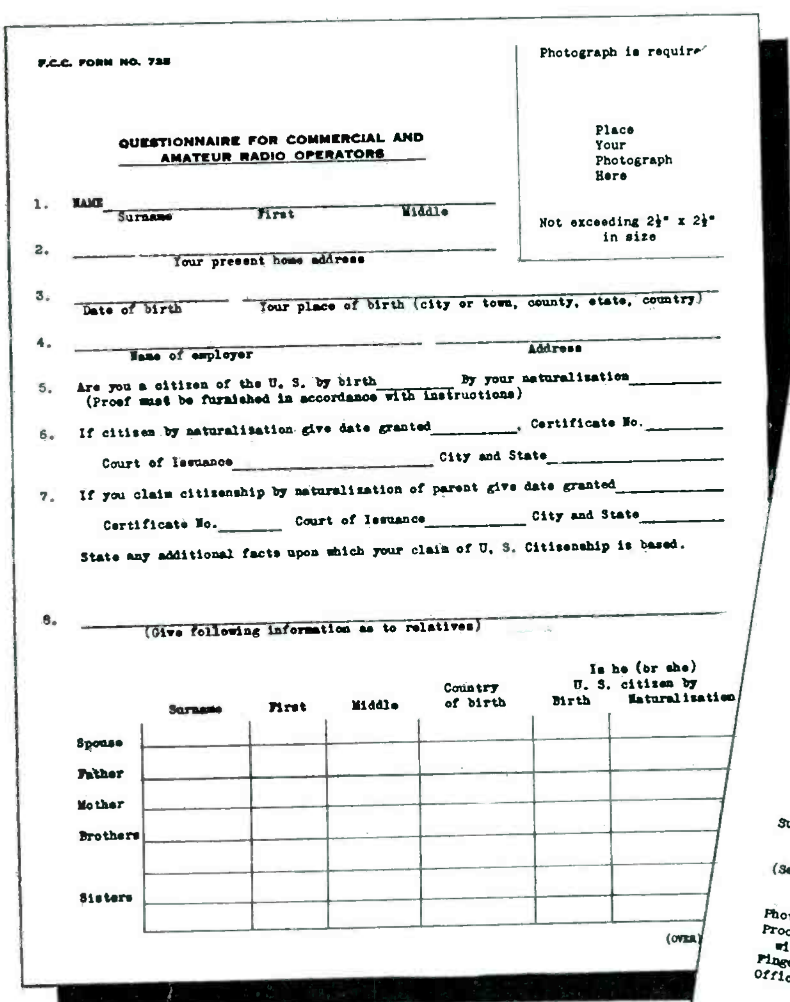
On September 24th, the President established the Defense Communications Board, "to determine, coordinate and prepare plans for the national defense, which plans will enunciate for and during any national emergency." These plans have to do with the needs of the armed forces, the allocation of governmental and non-governmental radio, wire, and cable facilities as may be required for their use, and the control of communications to meet defense requirements. The Board is specifically prohibited from considering plans for censorship, and it has no power to make any final disposition of the matters studied, but will simply report on them. The committee is thus a fact-finding and planning board. Its reports will be submitted to the President who will take final action on them, in a national emergency, through one of his executive assistants. The members of the Board are James L. Fly, Chairman, (Chairman of the F.C.C.), Major General J. O. Mauborgne (Chief Signal Officer of the U. S. Army Signal Corps), Rear Admiral Leigh Noyes (Director of Naval Communications) Breckenridge Long (Assistant Secretary of State in charge of international communications) and Herbert E. Gaston (Assistant Secretary of the Treasury in charge of the Coast Guard). At the time of writing the board had met three times but had made no announcements. It is understood that specialized subcommittees will be appointed, but from the very nature of its work, most of their recommendations will remain in closed files until the need for using them arises. If a state of war or national emergency arises, the importance of the work of this group can hardly be overestimated. Beyond that, little of a definite nature can be stated, at least for the present.

The Direction of Research Work

It appears to be an axiom of modern warfare that the strongest army is the one backed by the most

(*Continued on page 93*)

This form, designed to establish the citizenship of commercial and amateur radio operators, has been filled out to date by over 100,000 of the 110,000 operators licensed by the F.C.C. Fingerprints and birth certificate (or equivalent proof of citizenship) are also on file in each case


F.C.C. FORM NO. 735

Photograph is require

Place Your Photograph Here

Not exceeding 2½" x 2½" in size

QUESTIONNAIRE FOR COMMERCIAL AND AMATEUR RADIO OPERATORS

1. NAME ____ Surname First Middle

2. ____ Your present home address

3. ____ Date of birth ____ Your place of birth (city or town, county, state, country)

4. ____ Name of employer ____ Address

5. Are you a citizen of the U. S. by birth ____ By your naturalization ____ (Proof must be furnished in accordance with instructions)

6. If citizen by naturalization give date granted ____, Certificate No. ____

Court of Issuance ____ City and State ____

7. If you claim citizenship by naturalization of parent give date granted ____

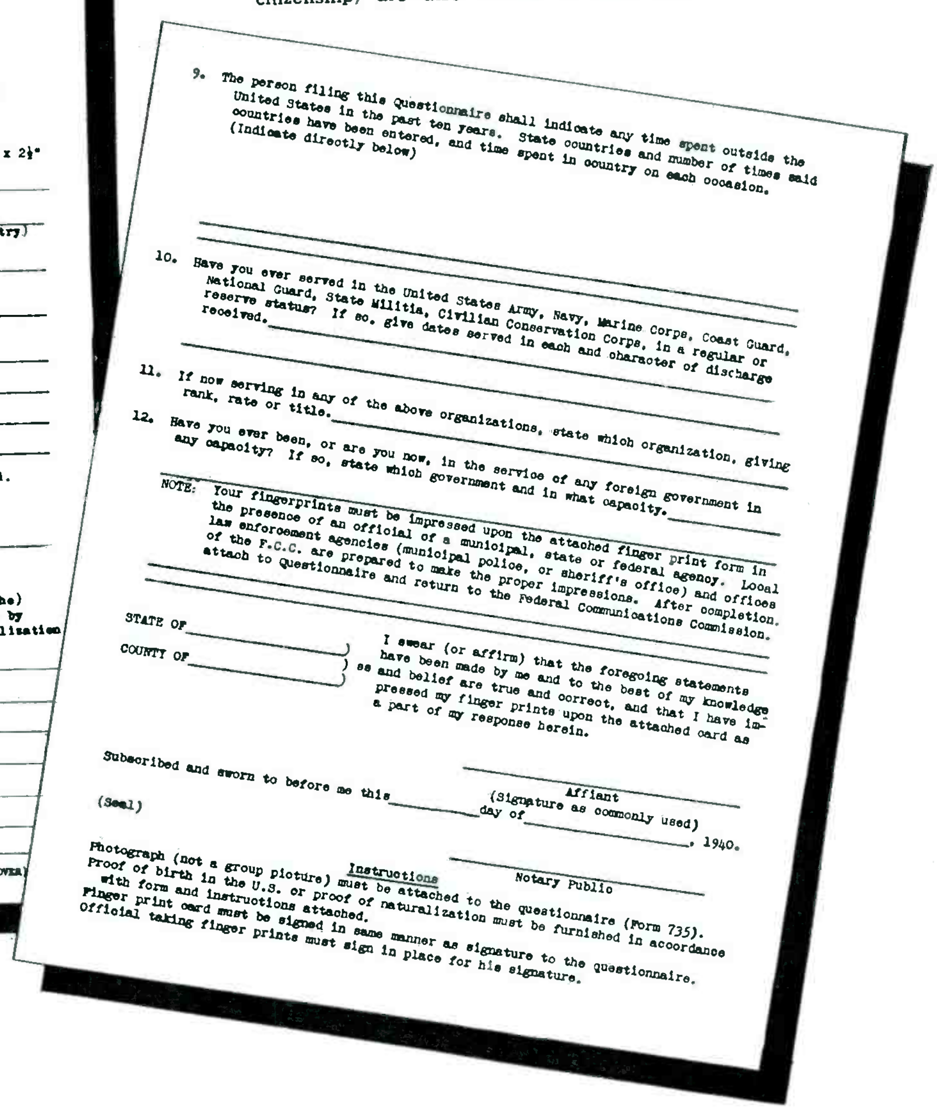
Certificate No. ____ Court of Issuance ____ City and State ____

State any additional facts upon which your claim of U. S. Citizenship is based.

8. ____ (Give following information as to relatives)

	Surname	First	Middle	Country of birth	Is he (or she) U. S. citizen by Birth	Naturalization
Spouse						
Father						
Mother						
Brothers						
Sisters						

(OVER)


9. The person filing this Questionnaire shall indicate any time spent outside the United States in the past ten years. State countries and number of times said countries have been entered, and time spent in country on each occasion. (Indicate directly below)

10. Have you ever served in the United States Army, Navy, Marine Corps, Coast Guard, National Guard, State Militia, Civilian Conservation Corps, in a regular or reserve status? If so, give dates served in each and character of discharge received. ____

11. If now serving in any of the above organizations, state which organization, giving rank, rate or title. ____

12. Have you ever been, or are you now, in the service of any foreign government in any capacity? If so, state which government and in what capacity. ____

NOTE: Your fingerprints must be impressed upon the attached finger print form in the presence of an official of a municipal, state or federal agency. Local law enforcement agencies (municipal police, or sheriff's office) and offices of the F.C.C. are prepared to make the proper impressions. After completion, attach to Questionnaire and return to the Federal Communications Commission.

STATE OF ____)
COUNTY OF ____) ss

I swear (or affirm) that the foregoing statements have been made by me and to the best of my knowledge and belief are true and correct, and that I have impressed my finger prints upon the attached card as a part of my response herein.

____ Affiant (Signature as commonly used)

Subscribed and sworn to before me this ____ day of ____, 1940.

(Seal)

____ Notary Public

Instructions

Photograph (not a group picture) must be attached to the questionnaire (Form 735).
Proof of birth in the U.S. or proof of naturalization must be furnished in accordance with form and instructions attached.
Finger print card must be signed in same manner as signature to the questionnaire.
Official taking finger prints must sign in place for his signature.

A STATE-WIDE F-M POLICE NETWORK . . . I

The application of frequency modulation's advantages to emergency communication is well illustrated in this description of the equipment installed by the State Police of Connecticut, a complete two-way system on 40-kc channels, using the wideband system

By
DANIEL E. NOBLE

Formerly Assistant Professor of Electrical Engineering University of Connecticut

WHEN the writer undertook to develop a state-wide emergency radio-telephone system for the Connecticut State Police in July 1939, the statement of the requirements did not specify whether one-way, two-way, intermediate frequency, ultrahigh frequency, amplitude modulation or frequency modulation was to be employed, but it was understood that the use of fm for the system would be investigated immediately. The problem may be clarified by a few facts about the operating conditions which must be met by the proposed system. The State is approximately ninety miles long by sixty miles wide with very rough hilly terrain over the entire area. Hills vary in height up to 2400 feet and the elevation changes are frequent and often precipitous. The heavy lines on the map of Fig. 1 divide the State into troop areas showing that the ten troop units, or barracks, police the State with each unit operating from its own headquarters. Headquarter locations on the map are designated by capital letters. Obviously the headquarter locations and the troop areas were not selected with a view to the requirements of emergency service radio installations.

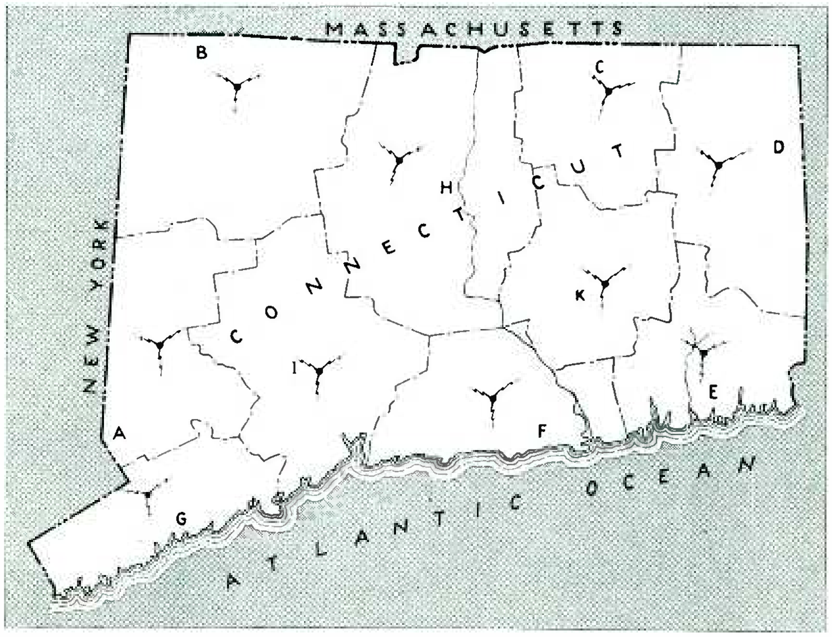


Fig. 1—Division of the State of Connecticut into troop areas, each served by a separate 250-watt fixed f-m station (locations shown by jagged lines)

One plan submitted by a commercial organization proposed the conventional one-way system utilizing one of the low frequency channels assigned to State Police emergency service. There are serious objections to such a proposal. To list a few: (1) High cost of the high powered installations required. (2) Limitations set upon the use of the system by sky wave interference from out-of-state transmitters. (3) Interference caused by atmospheric static. (4) Poor adaptability to two-way operation. Objection number 4 is the most important of all since it is universally agreed that the maximum efficiency of police radio service is not possible without a two-way system.

The use of ultrahigh frequencies for one or two-way operation is possible with conventional amplitude modulated wave equipment but the service would necessarily be spotty and secondary in character. This statement is not based upon conjecture since the writer designed the Connecticut State Forestry radio system which makes use of conventional short wave equipment. Reasonably satisfactory two-way service, adequate for forest service requirements, is possible over distances up to thirty miles where both receivers are in quiet locations. However, reliable service is impossible in heavy traffic where the ignition noise level is high. Such limited operation would not be satisfactory for police work.

The Proposed Solution

An outline of the system proposed includes the following: (1) The use of ultrahigh frequencies and fm. (2) The selection of fixed transmitter and receiver sites in high, quiet

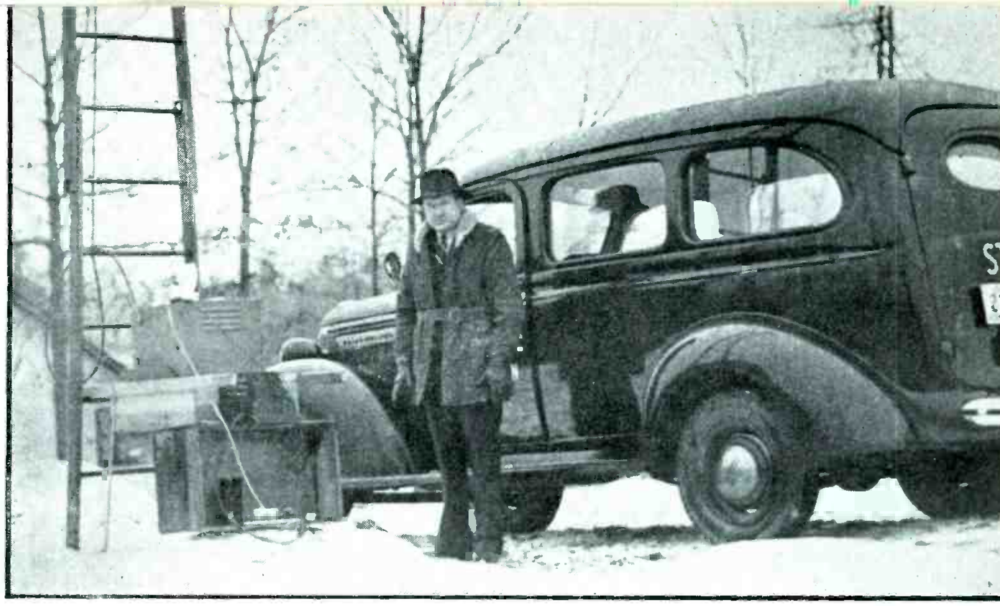


Fig. 2—Right, the original exploration transmitter, used for testing proposed sites in each troop area

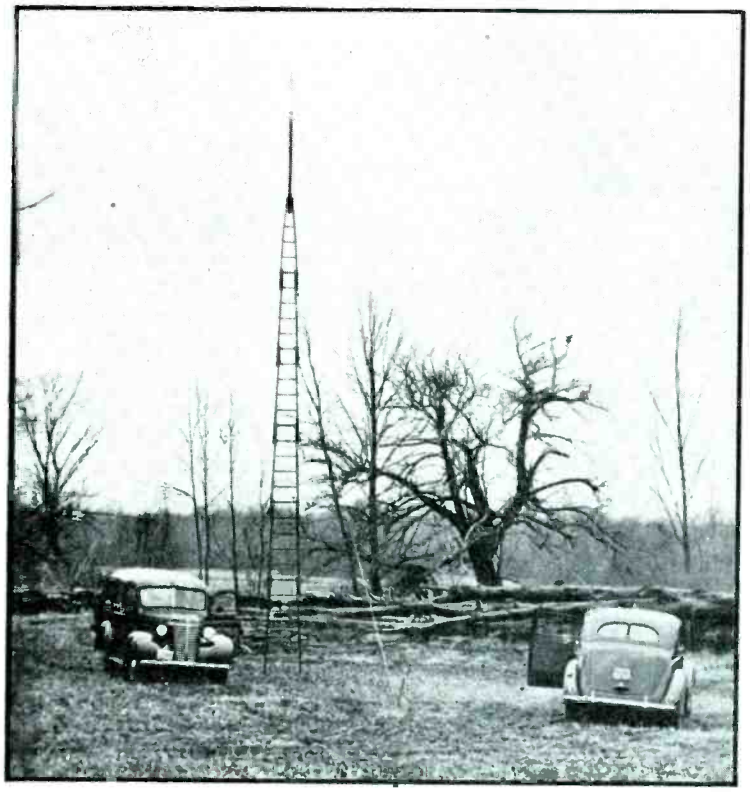
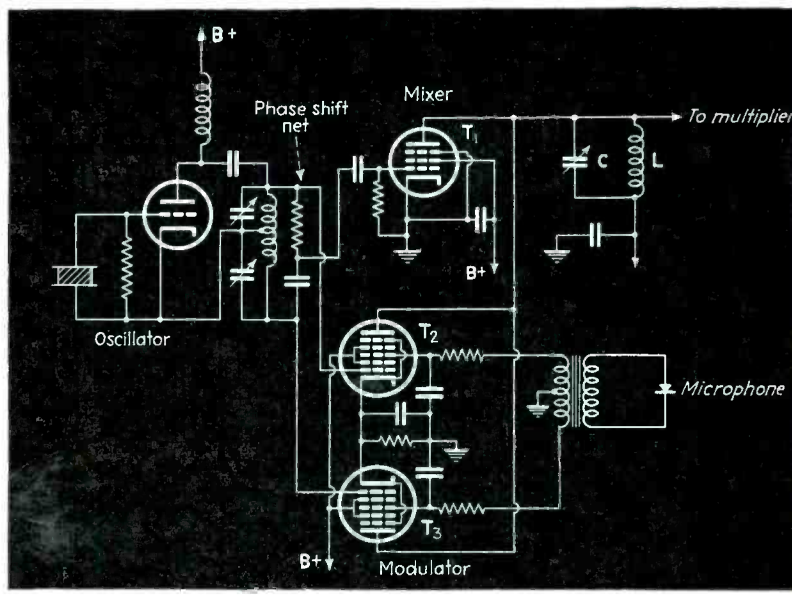


Fig. 3—Below, a later version of the exploration transmitter was mounted in the radio service truck

Fig. 4—Below, the phase-modulator circuit employed in the mobile transmitters, a modification of the Armstrong balanced-modulator scheme



locations near the center of each patrol area. (3) The use of a 250 watt f-m fixed transmitter for each patrol area with remote control at each headquarters. (4) The use of two frequencies (as eventually determined) 39400 kc for the fixed transmitters and 39180 kc for the mobile transmitters. (5) The locations selected for a maximum required two-way communication of twenty-four miles. (6) Design with generous factor of safety for reliable communication.

While the reasons for adopting some of the specifications in the outline are obvious, more information on the design procedure will clarify the details as the paper proceeds.

Mobile or portable mobile f-m equipment was designed to conduct proving-out tests and to survey the proposed transmitter sites. At the beginning of the work the conventional field strength survey was used but this approach was abandoned in favor of listening surveys when it was discovered that strong ignition noise made it impossible to interpret field strength measurements in terms of intelligibility of received signals. The testing procedure was simple: A fifty-watt fixed transmitter, shown in Fig. 2, was installed at the proposed fixed site in the area and the mobile unit then traveled throughout the area to be served while observations were made to determine the reliability and intelligibility of the received signals. Later a standard mobile unit installed in the Radio Service truck, Fig. 3, was used at the fixed locations under test and two-way communication maintained as the mobile unit travelled over the area. The speedometer of the mobile unit accumulated a mileage total of twenty thousand miles during the investigation and a fair estimate indicates that the writer carried on communication from the moving car while travelling more than two thousand miles. The results of the tests will be summarized in Part II of the article.

Design of Equipment

Since no commercial emergency service frequency-modulation equipment was available at the time the design of the system' was undertaken, the development of the specialized apparatus became the first requirement. To facilitate the construction of the new test units the services of F. M. Link were enlisted. With the construction of specialized amplitude-modulated mobile equipment already developed by this organization it was only necessary to introduce the new f-m circuit requirements to produce units which were satisfactory both electrically and mechanically.

The transmitter modulator circuit which proved to be most effective is shown in Fig. 4. This circuit, which is an adaptation of E. H. Armstrong's original circuit, had been previously used successfully by the writer in the University of Connecticut's experimental f-m transmitter W1XCS which was placed in operation in 1938. The writer also used a similar circuit in the design of the WDRC f-m broadcast station W1XPW.

Note that the phase shift network is arranged to feed T_1 with a carrier potential ninety degrees out of phase with the voltage on T_2 and T_3. The voltages from T_2 and T_3 are 180° out of phase. Tubes T_2 and T_3 form the balanced modulator whose output for our purpose may be expressed as

$$i = A_2 \sin(\omega t + \mu t) - A_2 \sin(\omega t - \mu t) \quad (1)$$

Since the carrier voltage to tube T_1 is 90° out of phase according to usual amplitude modulation sideband relationships the voltage supplied by this component is

$$i_c = A_3 \sin \omega t \quad (2)$$

Assuming the plate tank LC circuit to present linear characteristics, Eqs. 1 and 2 may be combined thus:

$$i_f = i_c + i = A_3 \sin \omega t + A_2 \sin(\omega t + \mu t) - A_2 \sin(\omega t - \mu t), \quad (3)$$

which may be reduced to

$$i_f = A(t) \sin(\omega t + K \sin \mu t) \quad (4)$$

Equation 4 is the expression for a phase-modulated wave with the amplitude-modulated component $A(t)$. Limiting in the subsequent multiplier stages of the transmitter removes the amplitude variation so that the equation may be written

$$i_f = A_1 \sin(\omega t + K \sin \mu t). \quad (5)$$

Equation 5 is useful in the determination of design factors.

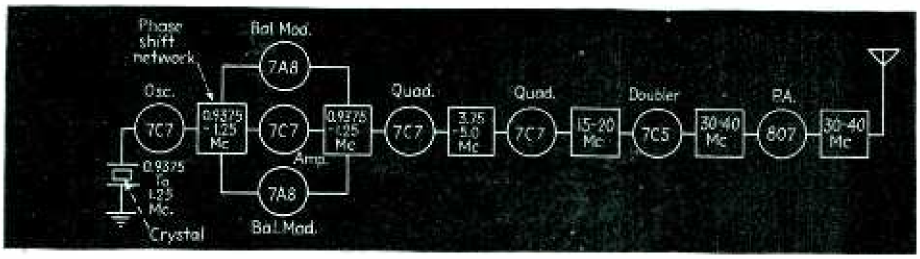


Fig. 5—Block diagram of the mobile transmitter. A frequency multiplication of 32 times is employed following the phase modulator output

Fig. 6—Front view of the mobile transmitter with cover removed. Note the coaxial jacks at the left for the antenna and connecting cable to the receiver

$$\text{Let } \theta = \omega t + K \sin \mu t \quad (6)$$

$$\text{Then } \frac{d\theta}{dt} = \omega + \mu K \cos \mu t \quad (7)$$

The derivative $\frac{d\theta}{dt}$ is by the usual definition the instantaneous angular velocity of the phase modulated wave or $\frac{d\theta}{dt}\frac{1}{2\pi}$ is the instantaneous frequency. From this it can be seen that μK represents the maximum change in the angular velocity during modulation and $\frac{\mu K}{2\pi}$ maximum instantaneous frequency deviation. Thus $\frac{\mu K}{2\pi} = \Delta f$ (8)

where K is the maximum angular displacement in radians, and μ is the angular velocity of the modulating wave. For a modulating frequency of 500 cps and an angular displacement of one radian the maximum instantaneous frequency deviation is, from Equation (8) 500 cps. In practice, a displacement of one radian at the modulator in the type of modulation under discussion will introduce distortion but fortunately this distortion will be confined to low frequencies. It can be shown that so long as the angular displacement at the modulator remains small the distortion will be small. The deviation may then be increased to the required degree by the use of multiplier stages.

The ultrahigh frequency channels assigned to the emergency services are 40 kc apart, therefore, the emission from the f-m transmitters must not occupy bandwidths greater than 40 kc. The design of the transmitters used in the Connecticut system is based upon the modulation requirements introduced by the average male voice. Satisfactory results may be achieved in the design if this voice is assumed to possess characteristics presenting the greatest average power production in the region between 500 and 1000 cps with a substantial reduction in average power above 1000 cps. While it is true that individual voices and certain words will produce frequency spectrums with high amplitude components in the region above 1000 cps, the small number of such components and their short duration result in reducing their importance to adja-

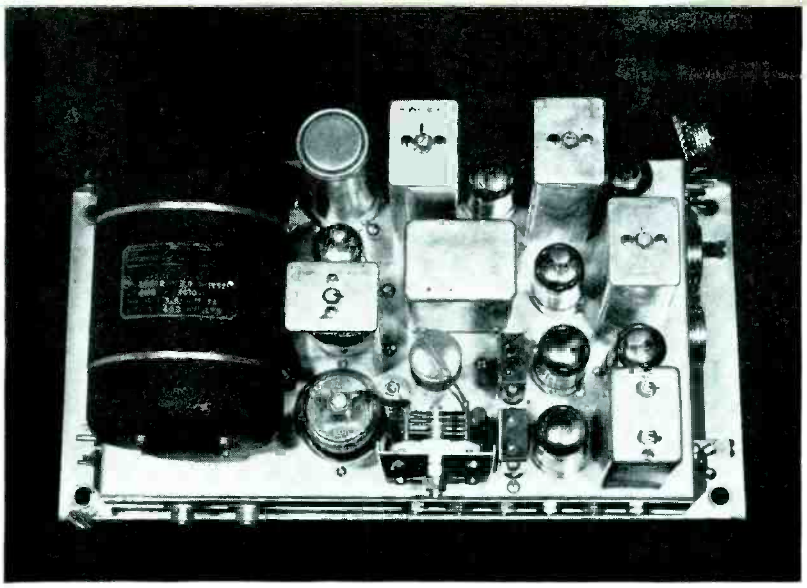


Fig. 7—Top view of the mobile transmitter. Eight tubes, with a type 807 in the final, supply 25 watts output in the 39-Mc band. The battery drain is 23 amperes

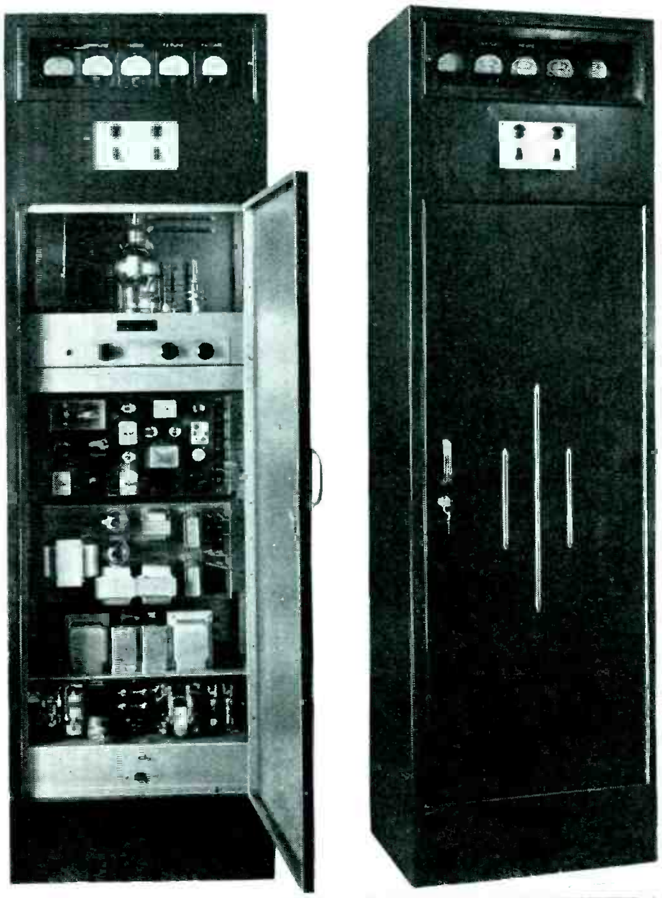


Fig. 8—Right, the 250-watt fixed station transmitter originally used to prove-out the system. The units now in use are similar except that space is provided in the cabinet for two receivers

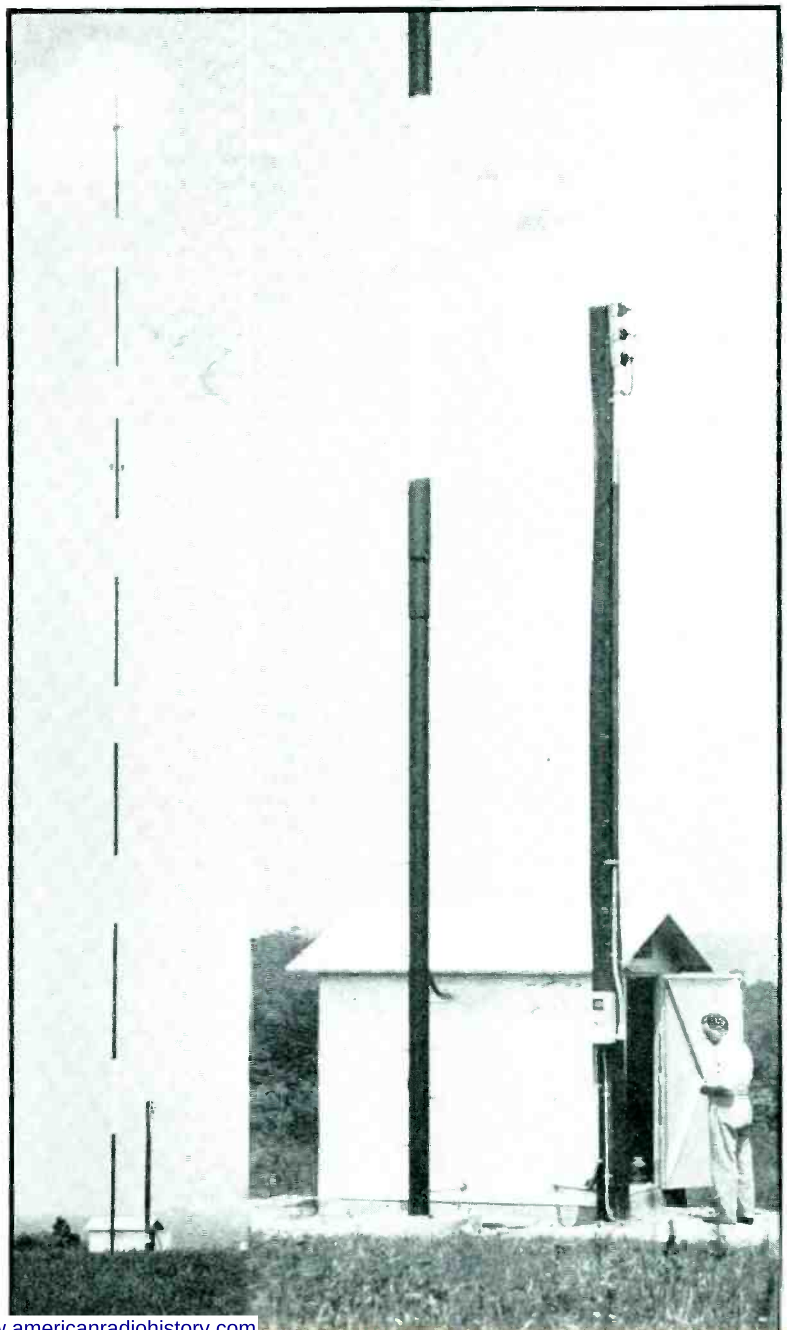


Fig. 9—Below at right, two views of the fixed station at Westport, Conn. All of the equipment is remotely controlled by telephone line connections

cent channel interference. In practice, pre-emphasis of approximately twelve decibels from 600 to 3000 cps permits a substantial extra gain in signal-to-noise-ratio without sacrificing any noticeable voice quality requirements. In the receiver the correction network is adjusted for best intelligibility. In other words, a slight high-frequency emphasis is retained to give the received voice quality the sharpness required for high intelligibility. Figure 5 is the block diagram of the mobile transmitter. Figures 6 and 7 show the mobile transmitter unit used in the Connecticut system. Figure 5 shows that a total of 32 times multiplication is used. The modulator is designed to produce a deviation of approximately 400 cps for full modulation with a 500 cps signal. The maximum deviation at the output of the transmitter under these conditions would be 12,800 cps, which is ample for the purpose and allows the sidebands to extend beyond the maximum frequency deviation. The output of the transmitter is 25 watts at a storage battery drain of 23 amperes. This is approximately a two-to-one power gain over the demands of the usual amplitude-modulated mobile unit when the

Fig. 10—The control unit at headquarters. The transmitter is put in operation when the operator pushes a button on the handset. Transmission occurs on 39,500 kc, reception on 39,180 kc

transmitter outputs are compared in terms of the primary power drain. Figure 8 shows the 250 watt f-m test transmitter which was used in the initial installation to prove-out the system. The f-m portions of the transmitter are contained in the two upper sections. The lower sections hold the power units and control relays. Two 807 tubes in parallel are used in the output stage of the exciter and their grids are fed by a 6L6 tube, otherwise this unit differs very little from the mobile transmitter. The exciter stage feeds the grid circuit of a single 250TH tube. Although the transmitter will deliver more than 250 watts output, it is conservatively rated on the basis of continuous operation with a 500 watt input to the plate of the output amplifier. The transmitter units installed permanently were similar to the one shown in Fig. 8 but with increased height of the cases to permit the installation of two receivers. Figure 9 shows the Westport unit, a typical fixed station installation. A 180 foot guyed pole supports a coaxial antenna. At the base of the pole an 8 ft by 8 ft by 8 ft welded steel building houses the 250 watt f-m transmitter and the two receivers. An automatic voltage regulator of the magnetic type insures reliable voltage regulation. Telephone connections between the transmitter house and the barracks office are used to control the apparatus. Figure 10 shows a control unit in position. The circuit arrangements permit flexible operation. Normal operation with the handset on the hanger permits the operator to listen to both receivers. That is, he may receive messages from the mobile units operating on 39,180 or from the fixed stations operating on 39,500. If a call comes in from a mobile unit, the operator may cut off the audio system of the fixed station receiver by means of a relay switching operation which automatically takes place when he lifts the handset from the hanger. The message from the mobile unit is then heard by means of the ear phone and the fixed stations cannot be heard until the hanger is held down by hand or by the weight of the handset. Provision is also made for automatically opening the squelch of the mobile receiver when the handset is removed from the hanger. Such an arrangement permits perfect reception from mobile units operating far beyond the normal range of the system. Remote control of the transmitter is accomplished with the usual push-to-talk button on the handset. A two-stage amplifier, detector and vacuum tube voltmeter circuit in the control unit indicate relative field strength at the control point so that a direct check on the transmitter output is available to the operator every time the control button is pressed. The control unit may be identified as the sloping panelled louvered unit with the two meters. The operator is shown in the act of using the radio handset. The other units in the picture are not associated with the radio communication system. This control cabinet, the only unit installed at the barracks operating position, is connected by telephone lines to the fixed station. The highest available sites near the center of the patrol areas were selected as locations for the fixed stations.

The receiver is a triple detection superheterodyne with double crystal control. The design factors may be summarized briefly. The essential design elements are:

(1) 40 kc band pass at lowest signal level.

(2) Sufficient gain so that the fluctuation noise in the first tube or first converter circuit will saturate the second limiter tube.

(3) Sharp audio cutoff beginning at 3000 cps.

(4) Sensitive squelch action with a high degree of carrier to noise discrimination.

(To be concluded)

A PRE-SELECTOR CIRCUIT for TELEVISION RECEIVERS

By employing two tuned circuits between the antenna and the first tube grid, it is possible to obtain constant gain and constant bandwidth on all television channels from 50 to 108 Mc without sacrificing performance.

By BENJAMIN F. TYSON

Hazeltine Service Corporation

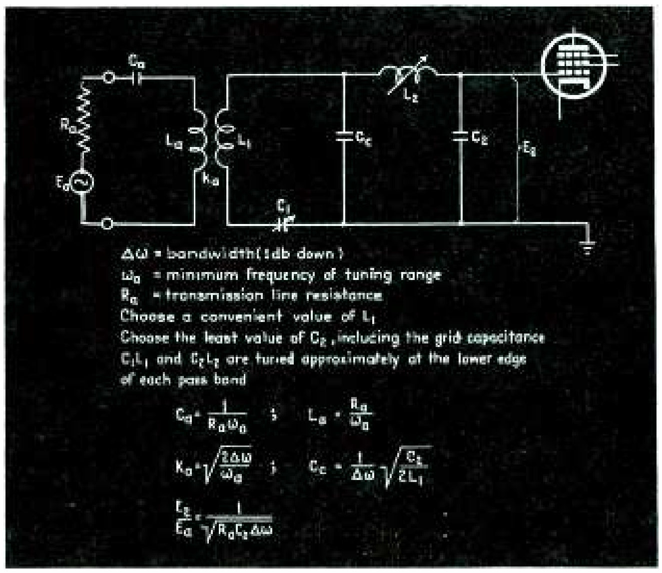


Fig. 1—Basic preselector circuit and equations for calculating the values

BEFORE the r-f signal picked up by a receiving antenna reaches the first tube in a television receiver, it passes through an input circuit or preselector which couples the antenna transmission line to the tube grid. There are four principal requirements that the preselector should meet. First, the frequency response should be wide enough to pass the television picture carrier and its sidebands to the extent they are transmitted, plus the accompanying sound carrier and its sidebands, and at the same time should be substantially flat over the desired pass band to avoid the complication of amplitude correction in subsequent circuits of the receiver. Second, good selectivity is important if undesirable cross-modulation products are to be suppressed and high image and i-f response ratios obtained. Third, the circuit gain or voltage step-up from the transmission-line terminals to the first grid should be as high as possible. This is vital in obtaining a high signal-to-noise ratio. Fourth, the bandwidth and gain of the preselector should be uniform, regardless of the mid-band frequency, if the fidelity and receiver sensitivity are to be the same for each television channel.

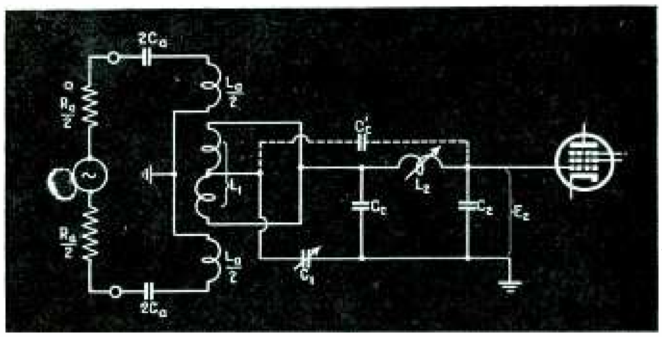


Fig. 2 — Variation of the circuit in Fig. 1 for connecting a balanced-to-ground transmission line to a single-ended grid

The first three requirements, pertaining to the shape of the response characteristic and the amount of circuit gain, may be met quite well by two tuned coupled circuits. A greater number of tuned circuits might be more effective but would be too complicated for practical use. The fourth requirement of uniform bandwidth and gain may be met with two tuned coupled circuits with the arrangement of Fig. 1.

A transmission line of resistance R_a and open-circuit voltage E_a is inductively coupled to the capacitance-tuned first resonant circuit C_1L_1 which in turn is capacitively coupled by C_c to the inductance-tuned second resonant circuit C_2L_2. The capacitance-tuned first resonant circuit uses fixed inductance and thereby circumvents the difficulties of switching transformers or adjusting the inductance of a transformer winding. The inductance-tuned second resonant circuit uses only the inherent fixed input capacitance of the first tube and thereby allows maximum impedance and hence always allows maximum voltage to be built up at the grid.

The preselector bandwidth, regardless of the mid-band frequency, is uniform when the coefficient of coupling between the two tuned circuits varies inversely as the frequency, and the damping resistance is constant in the tuned circuit with fixed inductance (C_1L_1). The generalized coefficient of coupling between any two circuits is the ratio of the coupling reactance over the geometric mean of the circuit reactances,

$$k = \frac{X_c}{\sqrt{X_1X_2}} \qquad (1)$$

In this preselector, the inverse variation is obtained with a capacitive coupling reactance inversely proportional to frequency and with the tuned circuits having opposite variation of reactance so the geometric mean reactance is constant. Thus

$$k = \frac{\frac{1}{\omega C_c}}{\sqrt{\omega L_1 \cdot \frac{1}{\omega C_2}}} = \frac{1}{\omega C_c}\sqrt{\frac{C_2}{L_1}} \qquad (2)$$

The expression for the coefficient of coupling then contains only one variable term, the frequency in the denominator, and the remaining constant terms C_c, C_2, and L_1. The derivation of the coefficient of coupling neglects the reactance of C_c, but the expression is a very good approximation when C_c is much greater than C_1 and C_2 as it is in practice.

The maximum gain from line to grid is obtained by relying on the line resistance R_a for all the damping. The resistance in the coupling circuits is minimized. This method of design requires that the coefficient of coupling between the two tuned circuits be

$$k = \sqrt{2}\,\frac{\Delta\omega}{\omega} \qquad (3)$$

in which $\Delta\omega$ is the bandwidth (at 1 db down) and ω is the mean frequency of any band. Therefore the required coupling capacitance is

$$C_c = \frac{1}{\Delta\omega}\sqrt{\frac{C_2}{2L_1}} \qquad (4)$$

which is the same for every band, since C_2 and L_1 are not variable. C_c is completely determined since $\Delta\omega$ depends on the desired bandwidth, C_2 is the input capacitance of the tube, and L_1 depends on the minimum obtainable value of C_1 and the highest frequency to which L_1C_1 is to be tuned, in the 108 Mc band.

This method of design requires also that the resistance reflected from the line into the first tuned circuit, C_1L_1, should be

$$r_1 = 2L_1\Delta\omega \qquad (5)$$

This is the same for every band; it means that the bandwidth from the line to the first tuned circuit, with the second tuned circuit removed, should be $2\Delta\omega$ at 3 db down. It is assumed that the transmission line presents a resistance R_a which is substantially constant, by virtue of the matching of the line with the antenna at the far end of the line. Also the attenuation in the line smooths out its resistance variation.

The condition of constant damping resistance in the first tuned circuit is obtained when L_1 is made the secondary of a transformer having a broadly tuned primary circuit connected with the antenna transmission line. This circuit is resonant at a frequency ω_a at or below the minimum frequency of the tuning range. It is designed to be half-critically damped by the line resistance R_a, so it reflects in series with L_1 a resistance which is nearly constant over the tuning range. This resistance is adjusted to its desired value r_1 by the coupling k_a. The circuit equations for obtaining these relations are given with Fig. 1.

A straightforward analysis of the preselector with the values of its components just derived shows the gain at mid-band to be

$$\frac{E_2}{E_a} = \frac{1}{\sqrt{R_aC_2\Delta\omega}} \qquad (6)$$

The gain is independent of the actual operating frequency and is a function of only the antenna resistance, the tube input capacitance, and the bandwidth.

It may be of interest to mention that this same circuit configuration may be used with equal damping of the two tuned circuits. The second tuned circuit is damped by adding across the tube capacitance C_2 a conductance G_2 of value $C_2\Delta\omega$. Also the coefficients of coupling k_a and k are reduced in the ratio $1/\sqrt{2}$, the latter by increasing C_c in the ratio $\sqrt{2}$. This gives the same shape of resonance curve. The desirable preselector properties of uniform bandwidth and constant gain over the tuning range are retained but the amount of gain is reduced by one-half.

Theoretically, when two tuned

TABLE OF CIRCUIT VALUES

Δf = 6 Mc = bandwidth (1 db down)
R_a = 100 ohms = transmission line resistance
f_a = 50 Mc = resonant frequency of antenna circuit
C_a = 32 $\mu\mu$f
L_a = 0.32 μh
k_a = 0.49
L_1 = 0.24 μh
C_2 = 18 $\mu\mu$f (including grid of 6AC7 modulator)
C_c = 160 $\mu\mu$f
L = 0.1 μh = inductance inserted in screen lead of 6AC7

Band (Mc)	C_1 ($\mu\mu$f)	L_2 (μh)
50- 56	42	0.56
60- 66	29	0.39
66- 72	24	0.32
78- 84	17	0.23
84- 90	15	0.20
96-102	11	0.15
102-108	10	0.14

NOTE: These values must be adjusted by trial to correct for variations in wiring and other incidental effects.

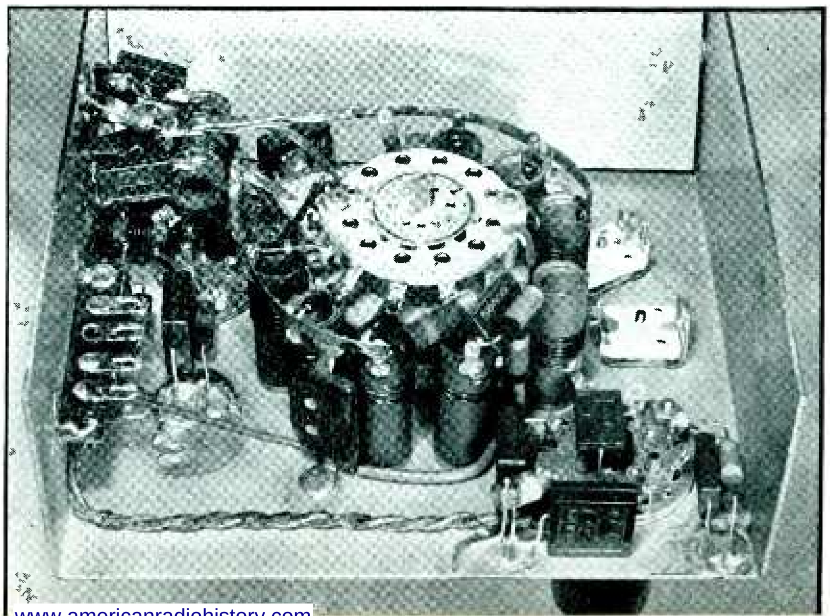


Fig. 3—Construction of a typical preselector circuit based on Fig. 2, for the two highest and three lowest channels in the 44-108 Mc range

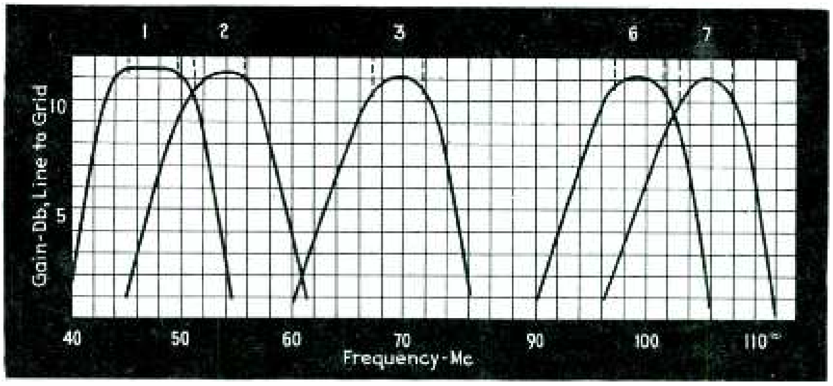


Fig. 4—Actual response curves of the preselector shown in Fig 3. Less than 2 db variation in gain is obtained over the full range of channels

circuits of the types used in the preselector are coupled by a fixed condenser C_c, the resulting bandwidths should be equal at all frequencies within the tuning range. Practically, however, the inherent series inductance of the coupling condenser C_c and inherent shunt capacitance of the inductance L_1 both tend to reduce the coupling at higher frequencies. This effect is cancelled by the small additional coupling capacitance C_c' connected as in Fig. 2. Its value is most easily determined by trial. The inherent shunt capacitance of inductance L_2 tends to reduce the coupling in a constant ratio. This effect is cancelled by slightly decreasing C_c from its calculated value to increase its coupling reactance. Here also, the correct value is best determined by trial.

The theoretical design formulas derived above are an aid in getting the approximate magnitudes of the circuit elements; exact adjustments must be made by experiment when the preselector is under construction.

Practical Form of Pre-selector

The circuit diagram of Fig. 2 shows the transformer coupling the transmission line to the first resonant circuit in a practical form with balanced-to-unbalanced arrangement. To demonstrate the utility of the preselector, the model shown in Fig. 3 was constructed to cover the two highest channels and the three lowest channels of the seven which were tentatively assigned at that time in the region between 44 and 108 Mc. Tuning from channel to channel was done by switching the proper values of the variable elements C_1 and L_2 into their resonant circuits. The present assignment of seven channels between 50 and 108 Mc will simply reduce the range which must be covered.

The photograph of the selector in Fig. 3 shows the arrangement of the parts around a rotary switch. The coils in the foreground are those of the superheterodyne oscillator. The coils and condensers around the switch in back are the adjustable elements of the preselector, switched from band to band. The coils for the oscillator and for L_1 of the preselector are adjustable by copper cores. The cores are mounted on screws whose heads are accessible on the other side of the base. The inductance of leads is minimized by connecting lugs directly or using copper strip. The oscillator tube is in the right foreground and the modulator tube in the left rear. Of the two sections of the switch, the one not visible is connected with the condensers C_1. The one visible is connected on the far side with the selector grid coils L_2 and on the near side with the oscillator coils, the coupling from the oscillator to the modulator grid being furnished by the capacitance in the switch rotor. One section of the switch is shielded from the other by a metal disc.

The transformer L_a, L_1 deserves special attention. It is a balanced-to-unbalanced transformer along the lines of that described by H. A. Wheeler in the April, 1928, *I.R.E. Proceedings*. It is the extra coil seen in the upper left corner of Fig. 3. The symmetry is maintained between balanced primary circuit and unbalanced secondary circuit by making the secondary of two coils wound in opposite directions and connected oppositely in parallel as shown in Fig. 2.

The accompanying table shows the circuit values computed for a design covering the new channel allocation. They are adjusted by trial to take care of inherent inductance and capacitance of the parts and wiring.

The preselector coupled a 100-ohm transmission line to a 6AC7 modulator. At these frequencies the input conductance of this tube is so great that optimum performance, with no damping in the second tuned circuit, cannot ordinarily be obtained. To correct this defect, regeneration was introduced by means of a small inductance in the screen-grid circuit. This is the small coil visible in Fig. 3 near the modulator socket. The negative feedback conductance and the positive input conductance vary as the square of the frequency so they cancel and the operation is stable over the entire frequency range. More details on this subject appear in an article by R. L. Freeman in October 1939 ELECTRONICS.

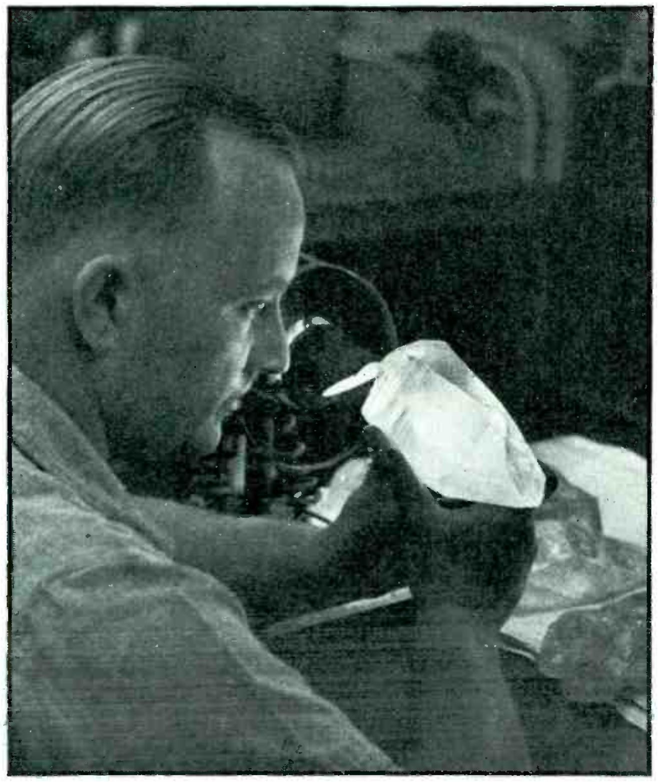
The actual response characteristics of the unit are those of Fig. 4. The bandwidths at 1 db down are about the same for all five channels and the gain is nearly constant at 11 db. Taking the bandwidth as about 5 to 6 Mc and the capacitance C_2 of the second tuned circuit as about 18 $\mu\mu$f, the computed gain is 12 db, a good check with the measured results. The curves show that this preselector meets the requirements of selectivity, high constant gain, and uniform wide bandwidth.

This selector has given excellent performance in both laboratory sets and commercial television receivers. It has been used both with rotary switches and push-button switches. The rotary switch gives shortest leads; it can be operated by push-buttons through the medium of a motor drive, which allows the selector to be mounted in the most convenient location in the chassis.

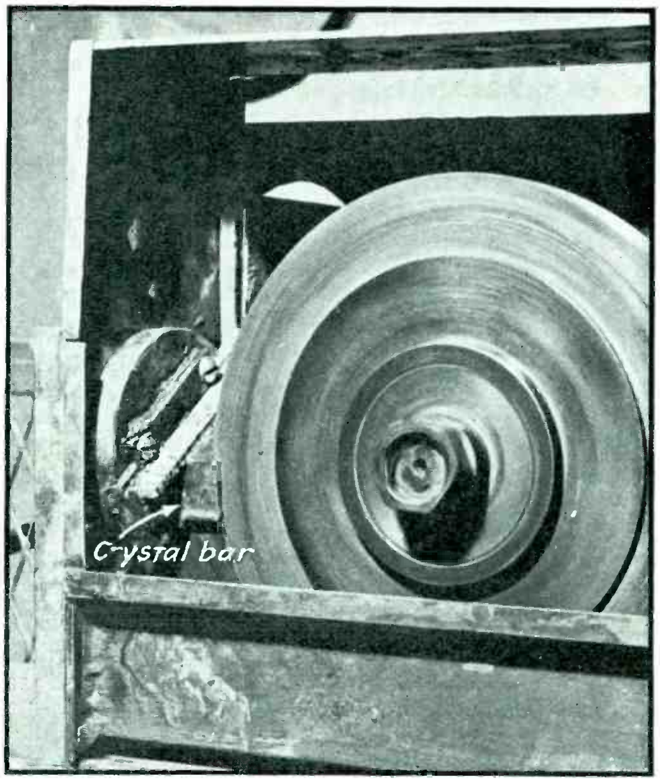
The constant-bandwidth preselector circuit was devised by H. A. Wheeler; it is the subject of U. S. Patent No. 2196881, to which reference is made for further information on its theoretical basis. This subject was presented by the writer before the New York meeting of the I.R.E. on May 1, 1940.

QUARTZ . . . from RAW STOCK to FINISHED CRYSTAL

These pictures, taken at the crystal laboratory of the General Electric Company, disclose optical and mechanical operations not generally known to radio engineers, but highly essential to the precision and reliability of the product



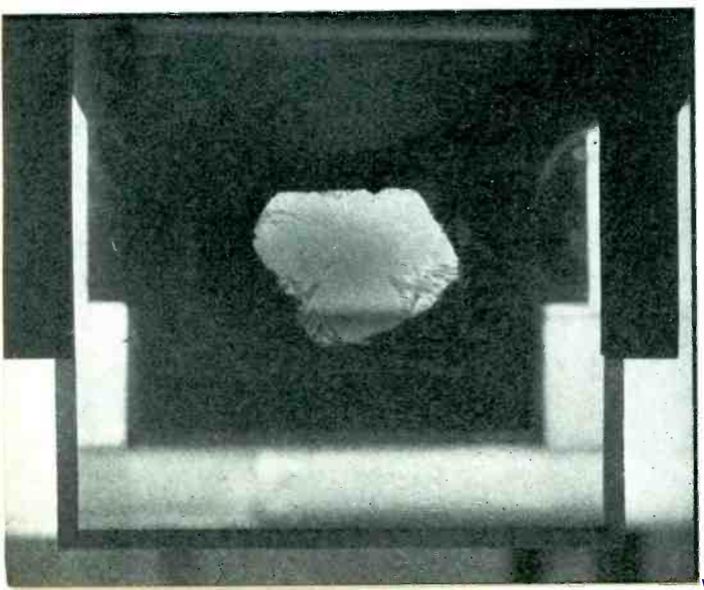
Raw Brazilian quartz crystals, averaging six inches in length and six pounds in weight, are subjected to arc-lamp examination for imperfections and "needles." The imperfections are marked on the raw quartz preliminary to cutting operations

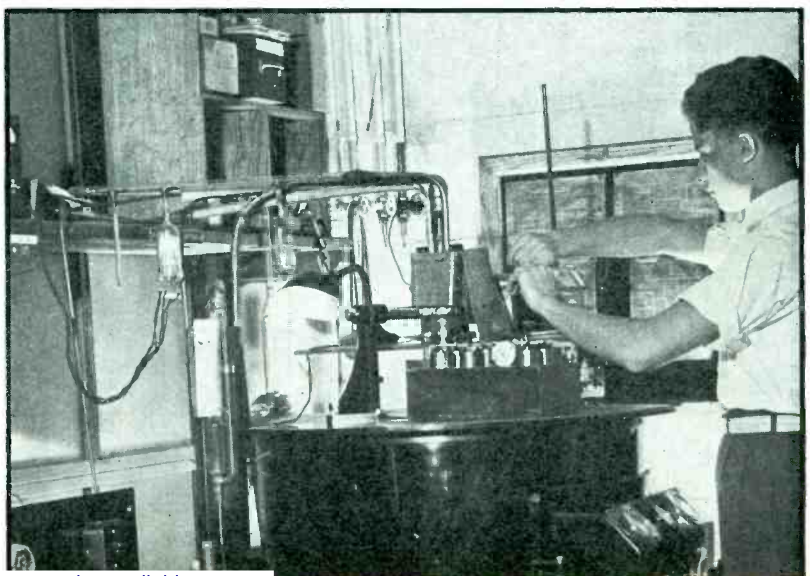


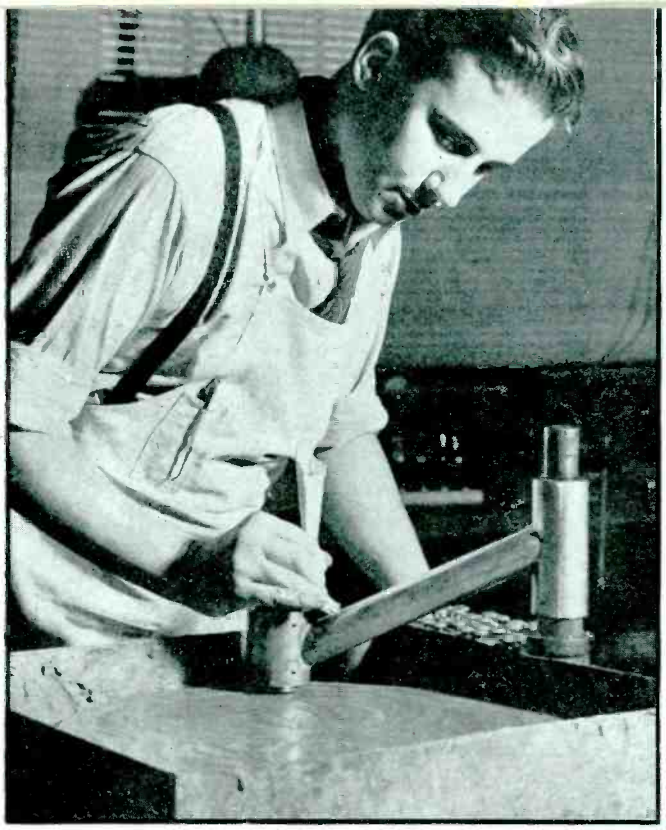
The raw quartz crystals are first cut into bars and then into thin slices called "blanks" at approximately the desired angle, with a gang-saw cutting machine using carborundum abrasive. Great care must be taken to maintain the correct angle

This hexagonal cut is being inspected by polarized light revealing what is called "twinning." Twinning may not prevent oscillation of the crystal, but it will almost invariably show up in impaired performance at some temperature, or in reduced life. All "twinned" quartz is rejected

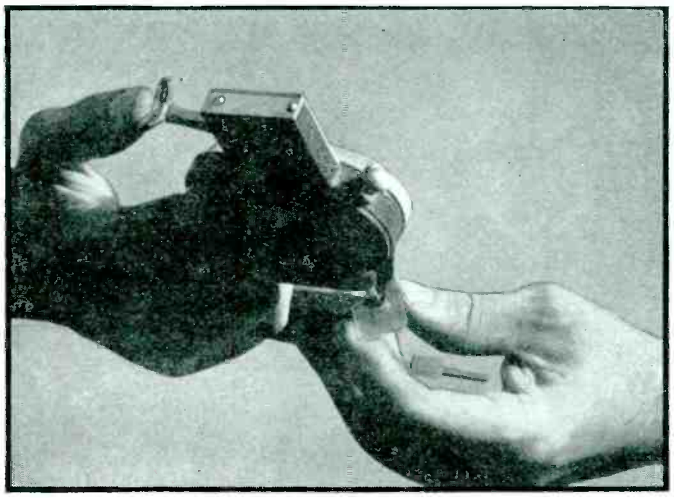
Adjustable cylindrical fixtures hold the blanks in position on x-ray equipment so that the technician can orient them by means of x-ray reflection. Such orientation makes it possible to produce crystals whose frequency remains constant to less than 0.0001 per cent per degree Centigrade change in temperature





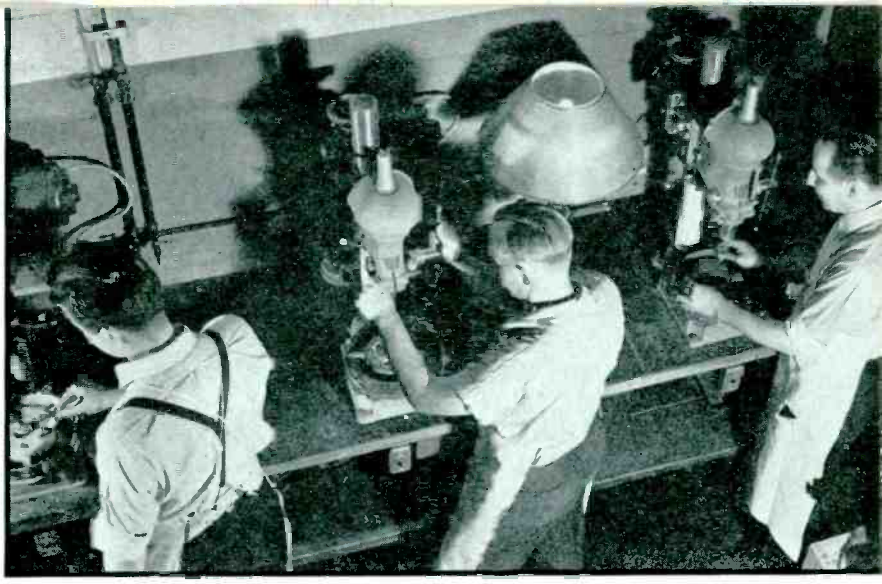


Once the correct reference face has been established by the X-ray process, the crystal, still held securely at the base of the adjustable cylinder, is ground to the correct angle on a manually operated grinding spindle. After a number of crystals have been ground on one face to the correct plane, several are placed on flat plates and the entire lot ground parallel on a grinder

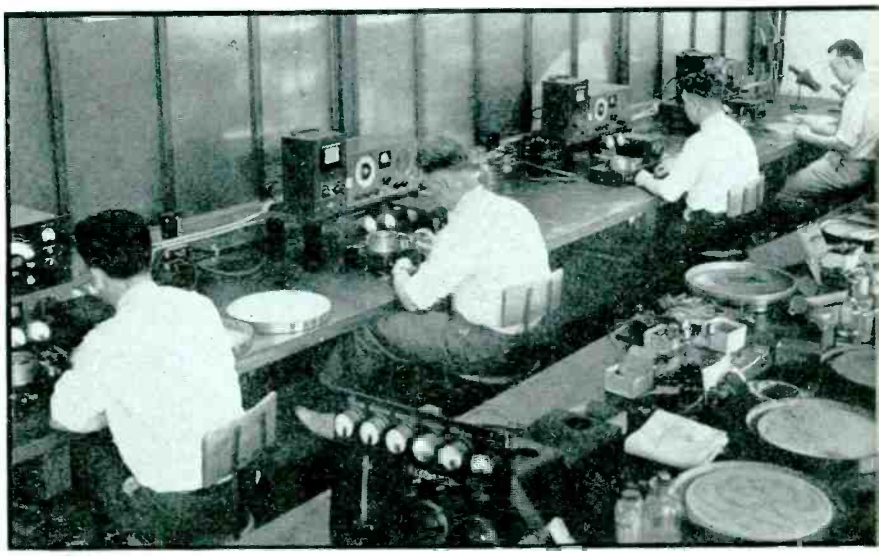


At times performance of the crystal at the finisher's bench may lead to doubts as to whether the crystal is parallel. In such cases parallelism is checked with a small thickness gauge by measuring the thickness of the crystal at various points

Final test of the complete crystal units before being cataloged for shipment takes place when several units at a time are placed in a crystal circuit for testing performance over a wide temperature range. Completed units can be seen in the tray to the right of the technician and several others in the circuit immediately in front of him

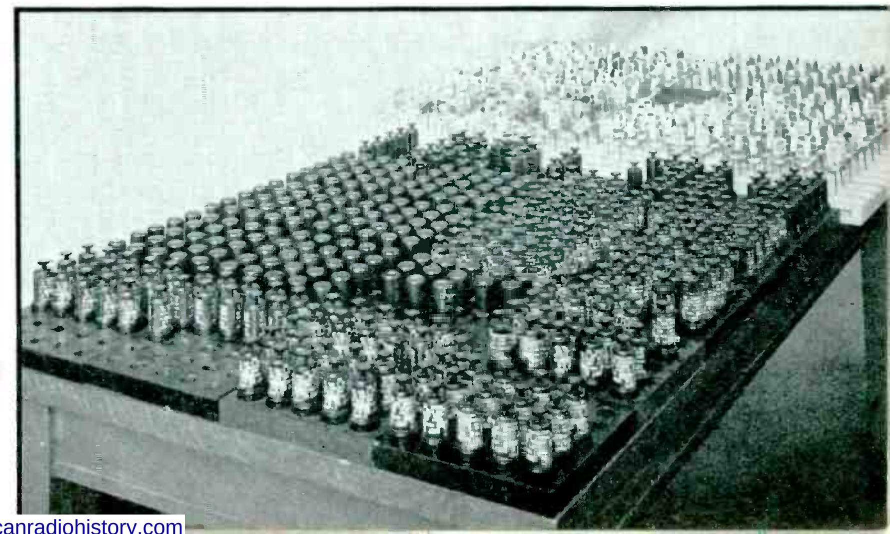


Preliminary to the more precise work of hand finishing, the thickness of the crystals is reduced by machine lapping. Each machine handles eight crystal blanks at once, lapping as close to the correct thickness as is economical in this stage of manufacture. Time-switch mechanisms control this operation



Crystal finishing demands skilled operators who are supplied with a test oscillator, lapping plates, and metal blocks for varying the temperature of the crystal during the operations. Tests of the crystal in conjunction with an audio frequency meter or audio oscillator indicate just how much the frequency must be raised. Expert finishers then know approximately how much lapping down of the crystal is necessary to bring it to that frequency. Frequency limits are so close that physical thicknesses must be controlled to a few millionths of an inch, and ordinarily the amount to be taken off will be between 0.0005 and 0.0001 inch. At the same time, finishers must be on the alert for frequency jumps and variations in crystal activity

More than 750 crystal units lined up waiting for test. In the front are completely metal-clad units and in the rear are others in stages of partial assembly



THE CHRONOSCOPE

An electronic interval timer originally developed to test the velocity of rifle bullets, but widely applicable in the measurement of intervals from one to 200 milliseconds with one per cent accuracy. Employs two thyratrons in connection with a ballistic galvanometer

By C. I. BRADFORD, *Remington Arms Company, Inc.*

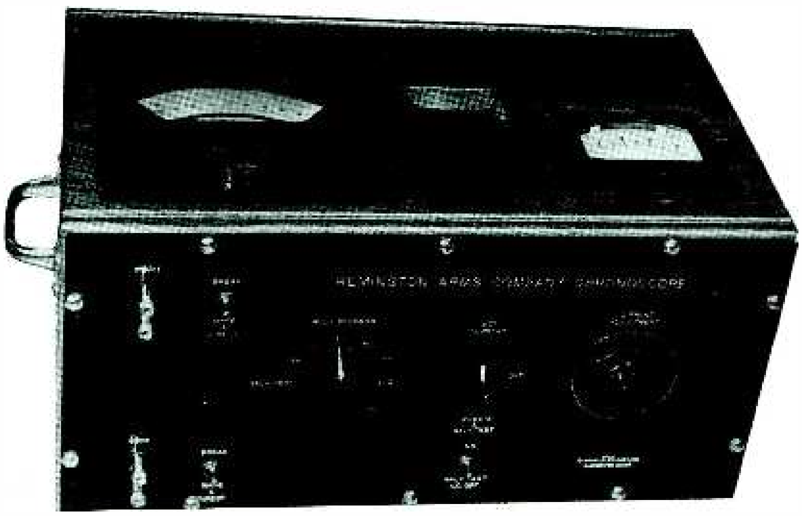


Fig. 1—External view of the chronoscope, showing controls for setting the calibration and meters for reading the time interval and the charging current

An essential test on all small arms ammunition is that of the measurement of velocity or time of flight of the projectile. The device here described is an interesting application of electronic tubes to a new instrument for the measurement of time intervals in the range encountered in most ballistic tests. This device, which has been called a Chronoscope,* measures intervals between one millisecond and two hundred milliseconds (0.001 to 0.200 seconds) on five different ranges with an accuracy within one per cent of full scale. It is completely self-contained and portable and has provision for internal calibration. Because of these features and the versatility of the device, it should be of interest to ELECTRONICS' readers in applications other than the one for which it was developed.

The requirement of an accuracy within one per cent on intervals of approximately ten milliseconds automatically ruled out the use of methods previously developed.[1, 2, 3] The principle of operation used in the Chronoscope is a very old, yet simple one, brought up to date through the use of modern tubes and circuit applications. It consists merely of passing a known current through a ballistic galvanometer during the time interval to be measured. If the length of time required for the meter to swing up scale is long compared to the time during which current flows, (the unknown interval) the maximum deflection will be directly proportional to the time interval.

The galvanometer used is of special design and in appearance resembles a conventional portable indicating meter. It is equipped with an illuminated scale and special pointer to facilitate reading the maximum swing. The period is approximately five seconds. The galvanometer current is supplied by self-contained batteries and the switching operation is performed electronically. The complete instrument is contained in a cabinet 9x12x19 inches as shown in Fig. 1.

Galvanometer as an Indicator of Time Intervals

The general equations for a ballistic galvanometer show that the angle of deflection θ is directly proportional to the quantity of electricity Q that has passed through the instrument. That is

$$\theta = kQ \qquad (1)$$

where k includes all the instrument constants.[4]

When a galvanometer is used as a Chronoscope, a circuit is closed at the beginning of the time interval allowing a current I to flow through the galvanometer. At the end of the interval the circuit is opened. Then during the interval T

$$Q = IT \text{ (See Fig. 2)} \qquad (2)$$

The galvanometer deflection resulting will be

$$\theta = kIT \qquad (3)$$

Then if k and I are known the time interval is

$$T = \frac{\theta}{kI} \qquad (4)$$

The constant k can be determined in the following manner. If a condenser of capacity C_c is charged to a potential E_1 the charge is $Q = C_cE_1$ (see Fig. 3). If the condenser

* Applications for the U. S. patents on the device are pending.

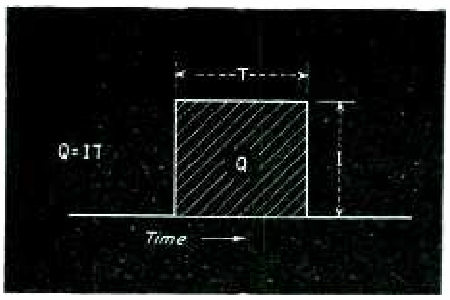


Fig. 2—Basic relationship of charge, time and current, on which ballistic galvanometer measurements are based

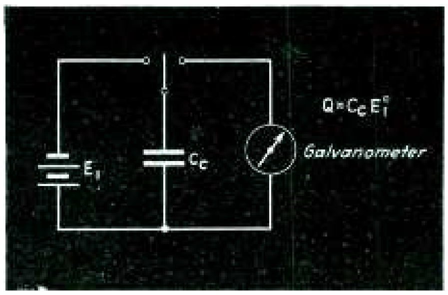


Fig. 3—Basic galvanometer calibration circuit which stores and then discharges a known quantity of charge

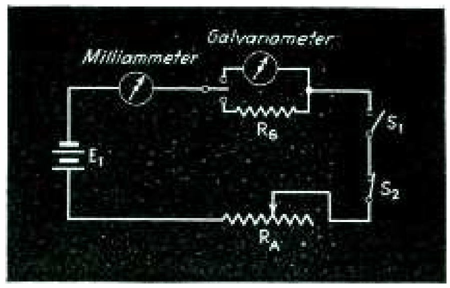


Fig. 4—Basic chronoscope circuit. Switch S_1 closes at the beginning and S_2 opens at the end of the timed interval

is then discharged through the galvanometer and the deflection D observed,

$$D = kC_cE_1 \text{ or } k = D/C_cE_1 \quad (5)$$

The current I can be determined by steady state measurements as follows (see Fig. 4): The switching circuits used in making the time measurements are left in the closed position. A key is used to switch a resistance R_G into the circuit equal to the resistance of the galvanometer, and a milliammeter is provided in the circuit. The current indicated by the milliammeter will be the current I which flows through the galvanometer during the time T. Hence from equations (4) and (5)

$$T = \theta \frac{(C_cE_1)}{ID} \quad (6)$$

Let K, the multiplying factor to convert deflections θ into time T be given by $\frac{C_cE_1}{ID}$. For convenience K should be some integer. I can be adjusted by means of a series resistance R_A to the desired value of

$$I = \frac{C_cE_1}{KD}$$

Thus the range of the instrument may be varied over wide limits by setting the current to the proper values.

Operation of the Chronoscope

The simplest diagram for operation of the Chronoscope is shown in Fig. 4 in which switch S_1 closes at the beginning of the time interval and S_2 opens at the end. For measuring time intervals between 0.001 and 0.1 second it is necessary to resort to electronic tubes to perform the function S_1 and S_2 in order to reduce the switching time and minimize this source of error.

Consider Fig. 5 in which tubes V_1 and V_2 are gas filled thyratrons. With no voltages applied to the inputs no current flows through the tubes because of the negative voltage applied to the grids through R_g from E_3. An impulse on number 1 input at the beginning of the interval breaks down thyratron V_1 allowing a known current I to flow from E_1 through R_A, the galvanometer G and tube V_1. The impulse on number 2 input at the end of the interval breaks down V_2 connecting E_1 and E_2 in series through R_A and V_2. The resulting increase in voltage across R_A lowers the potential of the anode of V_1 to the point where it extinguishes, thus cutting off the current through the galvanometer.

This type of thyratron switching circuit has been used instead of the conventional plate to plate capacity coupled circuit for two reasons. First, the current I which flows through the galvanometer during a time measurement can be set in steady-state without regard to transient current. Secondly, the circuit locks out so that after the galvanometer current has been cut-off, subsequent impulses on No. 1 input cannot re-ignite V_1 until the circuit through V_2 has been broken. Experience has indicated that when switches are used on the inputs, the chatter time is of such time as to cause V_1 to re-ignite if this arrangement is not used.

In order to provide a complete and convenient instrument the basic circuit of Fig. 5 requires numerous additions and refinements. Protection must be provided for the galvanometer in case of failure of the impulse on No. 2 input, otherwise a current would continue to flow through the galvanometer many times that required for full scale steady-state deflection and would result in the destruction of the meter. Internal means must be provided for checking the ballistic constant of the galvanometer. A milliammeter and resistors must be included for adjusting the current

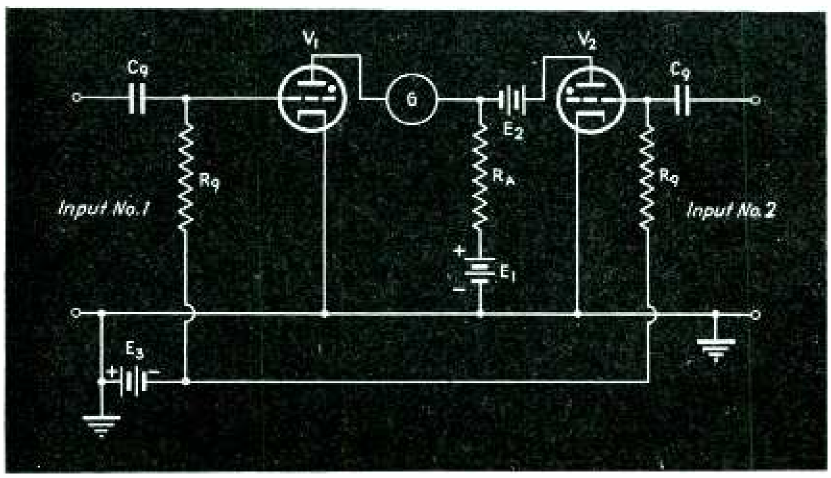


Fig. 5—Simplified chronoscope circuit with electronic switching elements. Tubes V_1 and V_2 perform the functions of the switches of Fig. 4.

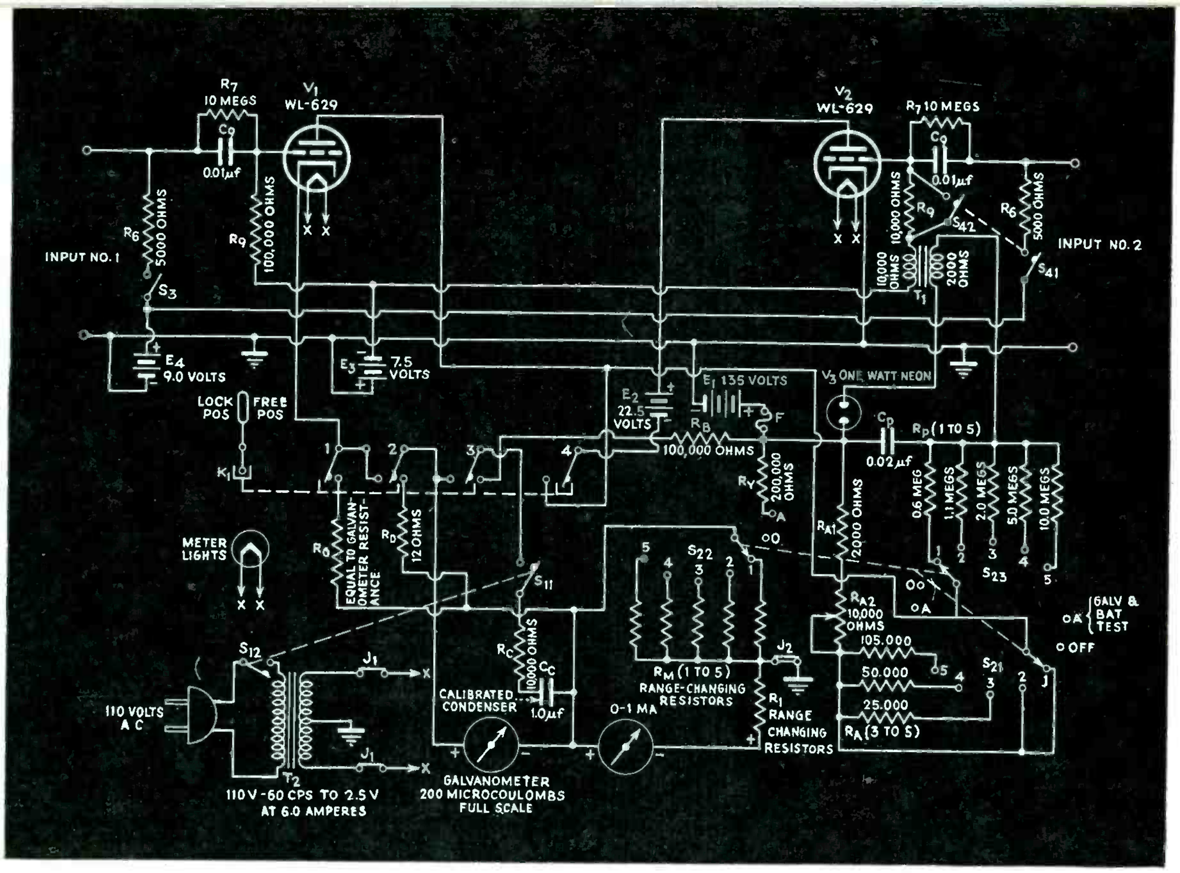


Fig. 6—Complete circuit diagram of the chronoscope, including meter-protecting circuit

to the proper values for the various scales. It also has been found desirable to provide the input circuits with an arrangement whereby they can be operated directly from either a make or a break circuit as well as from an amplifier.

Operation of Complete Instrument

The basic circuit as well as the above features are shown in the diagram of the complete instrument in Fig. 6. First, consider the circuit for checking the ballistic constant of the galvanometer. With key K_1 in the position shown, the galvanometer is damped by the resistance R_D. With S_{22} on position A and S_{11} closed, condenser C_c charges to the voltage E_1, and the milliammeter is connected through R_v to read the voltage of E_1. When K_1 is thrown to the right, C_c discharges through the galvanometer and the ballistic constant k can be determined.

In order to set the current I, the switch S_{11}-S_{12} is thrown to the right thereby disconnecting the calibrating condenser and energizing the filament supply. With the selector switch S_{21}-S_{22}-S_{23} on positions 1 to 5 and with K_1 thrown to the left a circuit is provided from the battery E_1 through R_A, through V_1 when it is broken down, through R_G, and through the milliammeter circuit. This makes it possible to set I by means of R_{A2} to the proper value for the desired multiplying factor. The circuit provided by S_{22}, R_M, and R_1, changes scales on the milliammeter in accordance with the time scale selected.

In regard to the input circuits, consider input number 1. The grid of V_1 is always biased to cutoff from E_3 in steady state. If S_3 is open, and a make circuit is closed across the input, current flows from $+E_3$ through the external circuit to charge C_9 through R_9. This voltage developed across R_9 applied to the grid is sufficient to cause V_1 to ignite. The resistance R_7 is extremely high and serves to discharge C_9 slowly in order to reset it for the next operation. Also with S_3 open, any voltage applied to the input from an external source will appear directly on the grid of V_1 and will cause it to ignite. With S_3 closed the input circuit operates directly on a break as follows: The input is normally closed, and when the break occurs the voltage E_4 appears across the input terminals and through C_9 to the grid of V_1 causing it to ignite. The operation of input number 2 is identical to that of number 1.

Referring again to Fig. 6 the protective circuit consists of R_p, V_3, C_p, S_{23} and T_1. The action is as follows: When V_1 breaks down, a voltage appears across R_A which is impressed on R_p and C_p in series. C_p continues to charge until its voltage reaches the breakdown voltage of the gas filled tube V_3. The discharge of C_p through V_3 through the transformer T_1 produces a positive kick in the secondary and trips off V_2 to turn off the galvanometer current. The length of time required for C_p to charge to the breakdown voltage of V_3 is selected by means of S_{23}. These values are so adjusted that the protective circuit operates on any interval longer than that required for full scale deflection regardless of range.

Figure 1 shows the external ap-

(*Continued on page 60*)

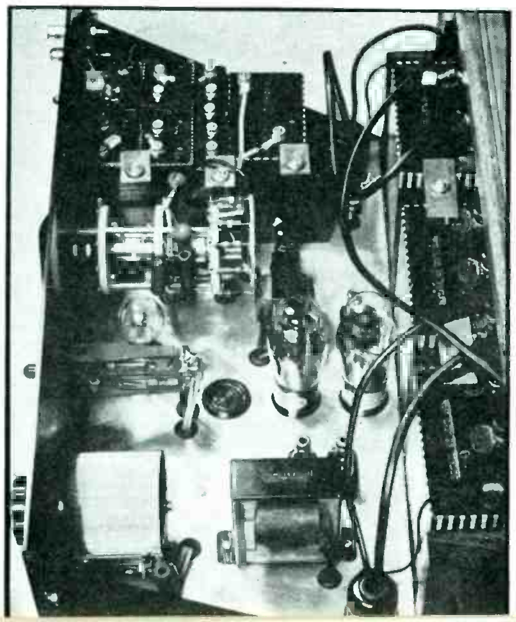


Fig. 7—Internal view of the chronoscope unit. The self-contained battery supply insures accuracy of calibration

A HIGH-SENSITIVITY PHOTOTUBE CIRCUIT

By using a pentode as the high resistance load for a phototube, the percentage change in voltage across the phototube is made greater than the percentage change in light. The sensitivity of the circuit is thereby made considerably greater than that of the conventional circuit

By H. S. BULL and J. M. LAFFERTY

University of Michigan

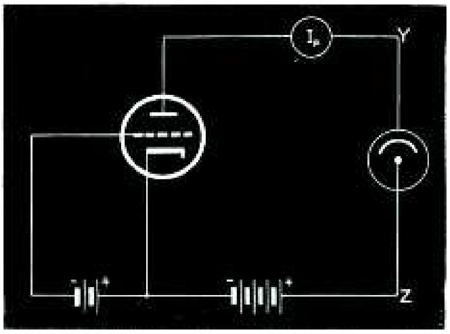


Fig. 1—Circuit showing the principle of operation. The plate circuit battery supplies voltage for the plate of triode as well as the phototube in series with it

THE possibility of using a thermionic tube as a high-resistance load for a phototube has already been recognized. Of the articles describing applications of this principle which have appeared from time to time in technical literature, the one by F. H. Shepard, Jr.[1] deserves special mention. It is the purpose of the present article to describe a similar circuit which may be expected to give consistently good performance without requiring unusual precautions against leakage. It should be noted in passing that the experimental work of the writers which led to the development of this circuit was carried on without previous knowledge of Mr. Shepard's contribution.

For the purpose of reviewing this interesting action consider the illustrative circuit shown in Fig. 1. A phototube of the vacuum type is connected in series with the plate of a triode whose grid is negatively biased, but not to the point of cut-off. The battery in the plate circuit supplies somewhat higher voltage than would normally be used for the triode alone. With the phototube dark, $I_p = 0$. If the phototube is illuminated with light of unvarying intensity a steady current will be established in the circuit and the drop in potential from Z to Y, Fig. 1, may be expressed as

$$V_{zy} = E_{bb} - E_p$$

where E_{bb} is the battery voltage and E_p is the voltage drop in the triode.

An increase in light intensity will cause an increase in current. This will increase the value of E_p and thereby cause V_{zy} to decrease. If a triode of very high plate resistance is available, a comparatively small percentage change in light intensity will produce a large percentage change in the value of V_{zy}.

To obtain a practical benefit from this phenomenon we need merely to use the voltage V_{zy} as the input to an amplifier. That is, let the voltage drop across the phototube change the grid potential of an amplifier tube. By so doing, a small percentage change in light intensity may be made to produce a large percentage change in the plate current of the amplifier.

After careful consideration of tube characteristics a pentode, the 6K7, was chosen for the experimental studies of this circuit. Its plate characteristic curves are quite flat, the voltages required for biasing the grids are moderate, it has a remote cut-off, and it is inexpensive. The phototube is a Westinghouse type VB, and the output voltage, V_{zy}, is supplied to the grid of a 6C5 to provide a convenient means of measuring the circuit response.

Figure 2 shows the relationship between output current and light intensity on the cathode of the type VB phototube for three selected anode voltages. The line marked E_{28} was obtained by applying 28 volts to the anode and varying the light intensity over the indicated range. It is typical of the performance to be expected for all anode voltages above the saturation level. For voltages below saturation the phototube sensitivity is decreased, as evidenced by the position of the lines E_{10} and E_5, for anode voltages of 10 and 5 volts respectively.

Figure 3 shows several plate characteristic curves for the 6K7. For

[1] Some Unconventional Vacuum Tube Application. F. H. Shepard, Jr. *RCA Review*, Vol. 2, Oct. 1937.

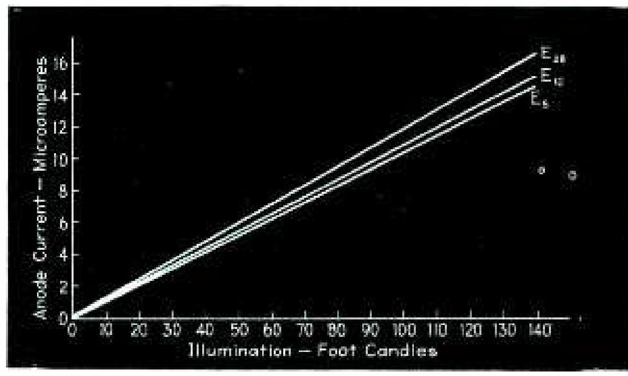


Fig. 2—Light-current characteristic of type VB phototube. The curve for 28 volts represents the current at saturation

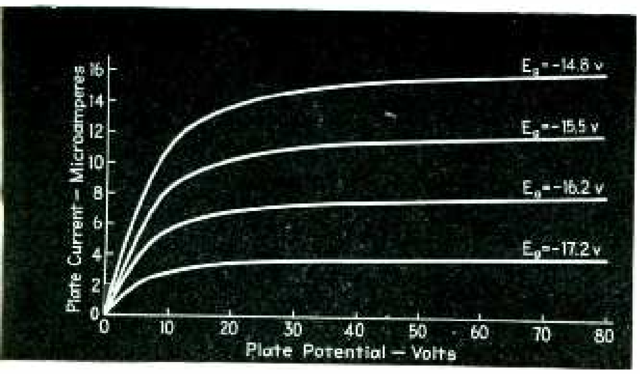


Fig. 3—Plate characteristics of the 6K7 tube. $E_h = 6.3$ v $E_{c2} = 40$ v $E_{c3} = -6.5$ v

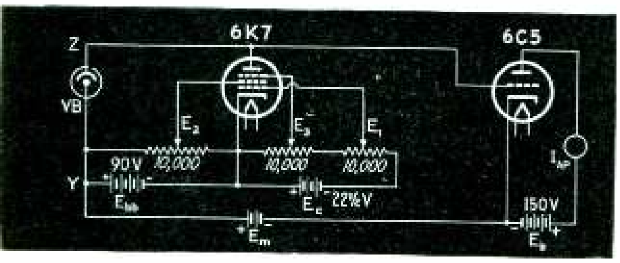


Fig. 4—Diagram of the high sensitivity phototube circuit. The value of E_m is about 30 volts when the phototube is operating above the saturation voltage

a suppressor grid potential of -6.5 volts and a screen grid potential of 40 volts the curves become very nearly flat, so that large changes in plate potential accompany small changes in plate current.

The experimental circuit is shown in Fig. 4. An understanding of its operation can best be gained by examining Fig. 5. The line marked E_s in Fig. 5A indicates the relationship between phototube current and light intensity on the phototube cathode when its anode voltage is sufficiently high to produce approximate saturation. The line E_{us} represents the phototube behavior with a somewhat lower anode voltage. The curve of Fig. 5B is typical of the relationship between I_p and E_p for the 6K7 as used in the experimental circuit, except that the slope has been exaggerated. In Fig. 5C, the intensity of light on the phototube is plotted against V_{zy}, the voltage affecting the bias of the 6C5 amplifier tube.

Now let a definite amount of light (F', Fig. 5A) strike the phototube cathode, with the values of E_{bb} and the control grid bias of the 6K7 so selected as to insure operation of the phototube above the saturation level. A current I' will be emitted by the phototube (this being the ordinate of point a on line E_s). Because of the series connection this current will become the plate current of the 6K7, and the value of the plate voltage can be determined by passing a horizontal line through point a and extending it until it cuts the curve of Fig. 5B. The output voltage, V'_{zy}, will be determined by the equation, $V'_{yz} = E_{bb} - E'_p$ and may be plotted as the ordinate of the point m, Fig. 5C.

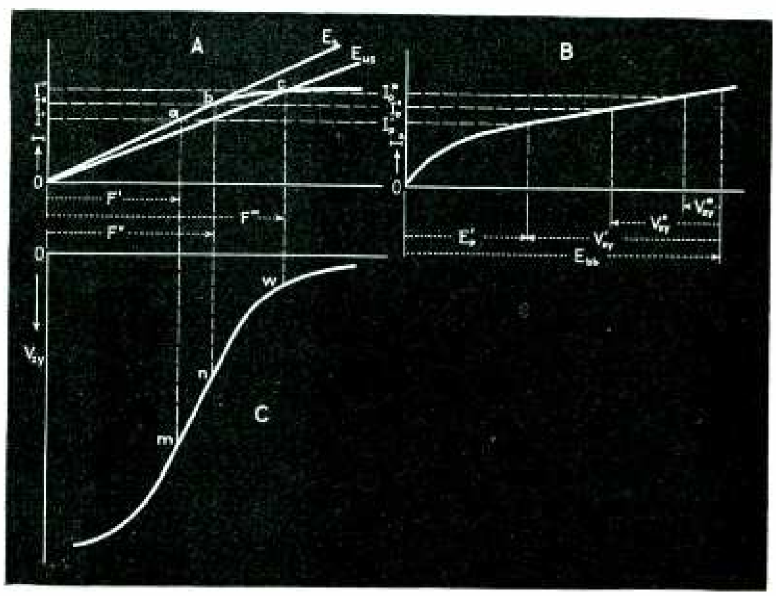
For a somewhat greater light intensity, F'' the phototube current becomes I'', the plate current is $I''_p = I''$ and the output voltage is V''_{zy}, which appears in Fig. 5C as the ordinate of n. It will be noted that the percentage change in the value of V_{zy} is much greater than the percentage change in light intensity.

For light intensities greater than F'' (assuming no change in control grid voltage), the phototube current can no longer be found by projecting to the line E_s, because the voltage V_{zy} across the phototube is insufficient to saturate it, and the current is now dependent upon the values of both E_p and V_{zy}. Nevertheless there will be a perfectly definite current for a given light intensity which must lie on the 6K7 characteristic and at the same time create a voltage drop in the phototube that will satisfy the equation, $V_{zy} = E_{bb} - E_p$. For example, assume the light intensity is F'''. There will be a point c lying on some phototube characteristic E_{us} which satisfies the requirements just mentioned and produces an output voltage V'''_{zy}, Fig. 5B, which is plotted as the ordinate of w in Fig. 5C.

It is desirable to apply the voltage V_{zy} to the grid circuit of the 6C5 in such a way that an increase in light will cause an increase in its plate current. In so doing it will usually be found that a positive biasing battery (E_m, Fig. 4) will be needed to produce partial neutralization of V_{zy} and prevent the 6C5 from being biased too far beyond cut-off when the cell is dark. It is then possible to adjust the bias so that, for an initial light intensity (such as F', Fig. 5A), the biasing voltage, $-V'_{zy} + E_m$, is just right to produce cut-off. Then a very small increase in light is sufficient to cause quite a reduction in V_{zy}, the grid will become more positive and an appreciable plate current will flow.

This circuit is particularly useful for detecting small changes in light identifying numbers at the side three typical runs are shown. The identifying numbers at the side of each curve indicate the initial value of the light intensity for which the plate milliameter of the 6C5 was adjusted to zero. Thus in obtaining the curve marked 7 foot candles the control grid bias of the 6K7 and the bias of the 6C5 were so ad-

Fig. 5—These curves are used to analyze the circuit of Fig. 4. *A* is the light-current curve of the phototube, *B* is the plate characteristic of the 6K7 and *C* is the curve of light intensity vs voltage across the phototube



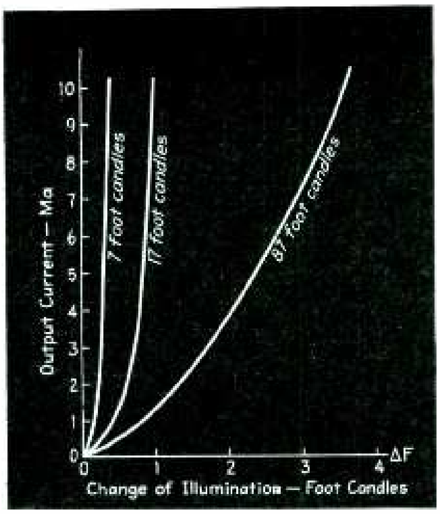
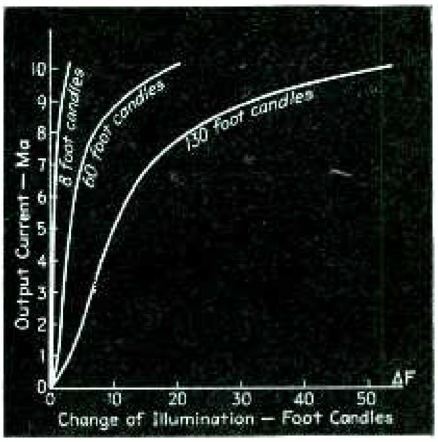


Fig. 6—Curves showing the output current of the 6C5 vs the change of illumination at several levels of light intensity. Phototube is operated above saturation voltage

Fig. 7—Same curves as Fig. 6 but with phototube operated below saturation voltage. Note that the sensitivity is not as high as when operated at saturation



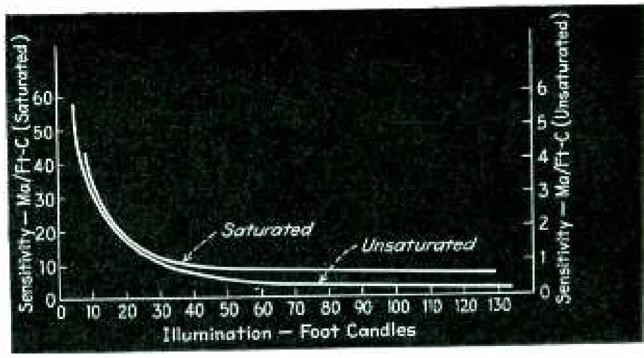


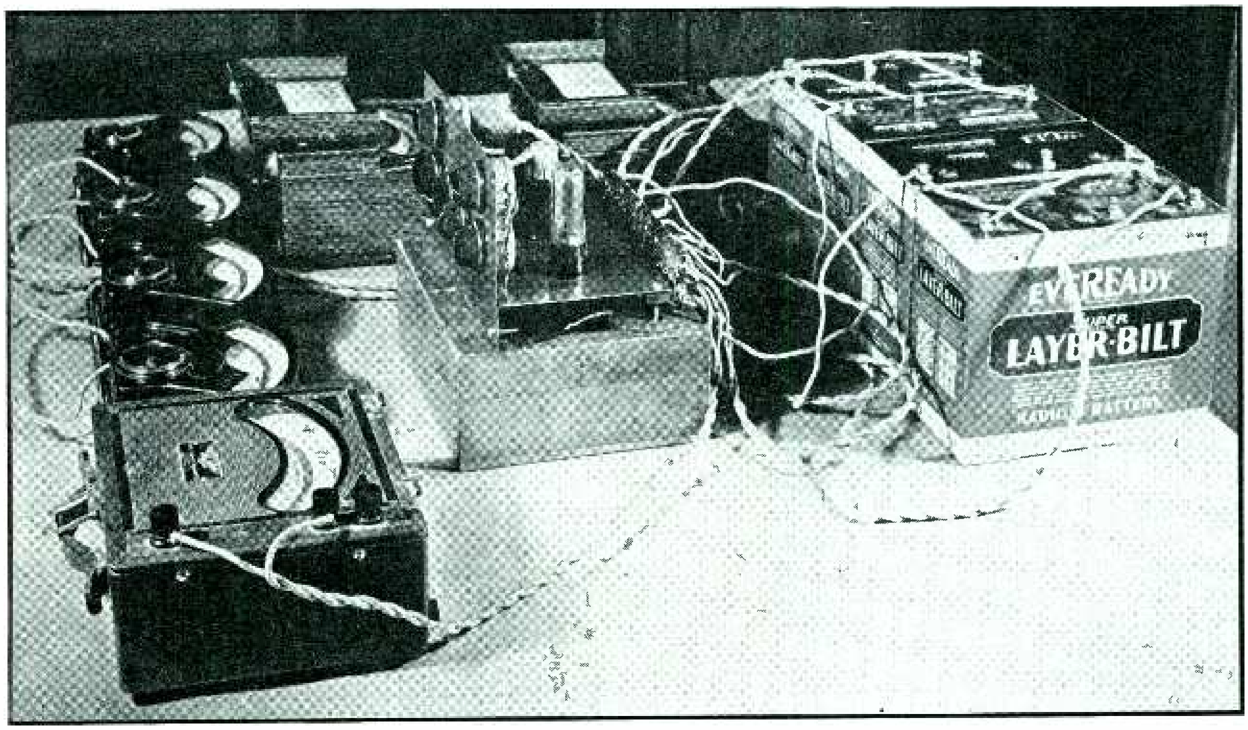
Fig. 8—Sensitivity curves for the saturated and unsaturated conditions. The circuit is approximately 10 times as sensitive when the phototube is operated at saturation

justed that the plate current of the 6C5 was zero when the phototube was exposed to a steady light intensity of 7 foot candles. Then the light intensity was increased in small increments and the output current was plotted against ΔF, the change in light intensity. Note that the range of operation in these runs was restricted to that portion of the 6K7 characteristic for which the phototube remained saturated.

A similar set of curves showing the performance of the circuit when the phototube becomes unsaturated is shown in Fig. 7. Note that the overall sensitivity, though still high, is not nearly as good as is obtained with the phototube saturated. This is illustrated more effectively in Fig. 8 where curves of sensitivity are plotted against light intensity. In general a sensitivity ratio of about 10 may be expected for saturated as against unsaturated operation.

The authors believe that this circuit will prove valuable for many phototube relay and measurement applications which have heretofore required multi-stage amplification (with its attending difficulties) in order to obtain suitable sensitivity. Although it has been discussed as a d-c circuit it is evident that satisfactory half-wave operation may be expected from 60 cps voltages on the various supply terminals if careful attention is paid to instantaneous polarities. It should be noted that this circuit does not work well for initial light intensities below about one foot candle.

Experimental setup of the high sensitivity phototube circuit. The instrument is particularly valuable in the measurement of small changes in light intensity



TESTS OF FM FOR AIRCRAFT COMMUNICATION

An account of flight tests conducted in the vicinity of Schenectady, N. Y., comparing frequency- and amplitude-modulation on the same frequency, as well as investigating the effects of interference between two stations. F-m offers 50 per cent increased range

By I. R. WEIR

General Electric Company

AIRCRAFT navigation depends so completely on radio communication that it is almost a necessity for aircraft to have the best radio communication available. Since frequency modulation has demonstrated many advantageous characteristics in broadcasting, it was felt this method of modulation should contribute to improve aircraft communication. The full significance of applying wide-band frequency modulation to airplanes can be appreciated if we measure the signal-to-noise ratio of a frequency-modulation signal in comparison with an amplitude signal. It can also be appreciated by the small size of the interference area between two common-frequency f-m stations compared with that between two common-frequency a-m stations under the same conditions.

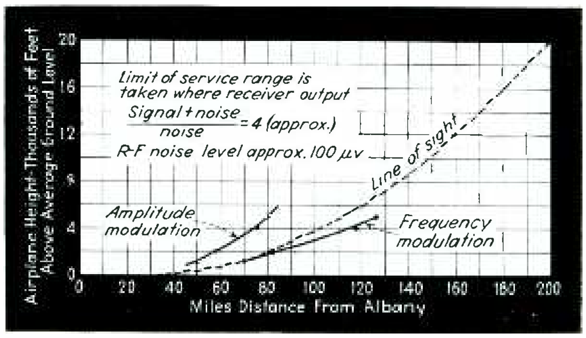


Fig. 1—Service range vs height of airplane, for 150-watt 41-Mc transmissions from Albany

Test Equipment

A 150-watt (W2XOY) frequency- and amplitude-modulated transmitter was located on an office building in Albany, N. Y. The transmitter was so designed that it could be frequency or amplitude-modulated by throwing a switch. When the transmitter was 100 per cent amplitude-modulated the antenna power was 225 watts (600 watts peak). The carrier power for fm remained constant at 150 watts with all percentages of frequency modulation. This difference in power level for 100 per cent modulation for a given transmitter for the two types of modulation gives a corresponding advantage to am. The carrier frequency in each case was 41 Mc.

The receiver, described in the May, 1939 issue of *G. E. Review*, used in taking all amplitude- and frequency-modulation comparison measurements consisted of a double-conversion type of superheterodyne designed to receive both amplitude and frequency modulation. A switch was provided to change the receiver from a plain diode detection for am to f-m detection using a limiter. The audio system of the receiver measured ±2 db of 400-cps response from 60 to 10,000 cps. The selectivity of receiver was 220 kc wide at twice down and 530 kc wide at one thousand times down.

The antenna for the 150-watt transmitter consisted of vertical "J" type of antenna mounted 390 ft above the surrounding ground level. The receiver antenna was installed in an airplane and connected to a vertical "whip" antenna about six feet high.

All possible elements in the frequency- and amplitude-modulated systems were kept the same in order to compare them under nearly identical conditions. The same elements in the receiver were used for the two types of modulation except the detectors. The same transmitting and receiving antennas were used.

The signal-plus-noise to noise ratio was measured by a two-scale copper-oxide voltmeter connected across the output of the receiver. The ratio of the audio output voltage of the receiver when receiving a modulated signal to the audio output voltage when receiving an unmodulated signal of the same carrier strength is the "signal-plus-noise to noise ratio".

Field Tests of Transmissions from Albany

A constant transmitter plate voltage and plate current were maintained on the output stage for both frequency- and amplitude-modulation. The Albany transmitter was 100 per cent amplitude-modulated with a 700-cps tone and periodic voice announcements of call letters (W2XOY).

A plane proceeded west at 2,000 feet altitude until the intelligibility became poor. This was estimated as signal-plus-noise to noise ratio equal four to one. Higher altitudes were

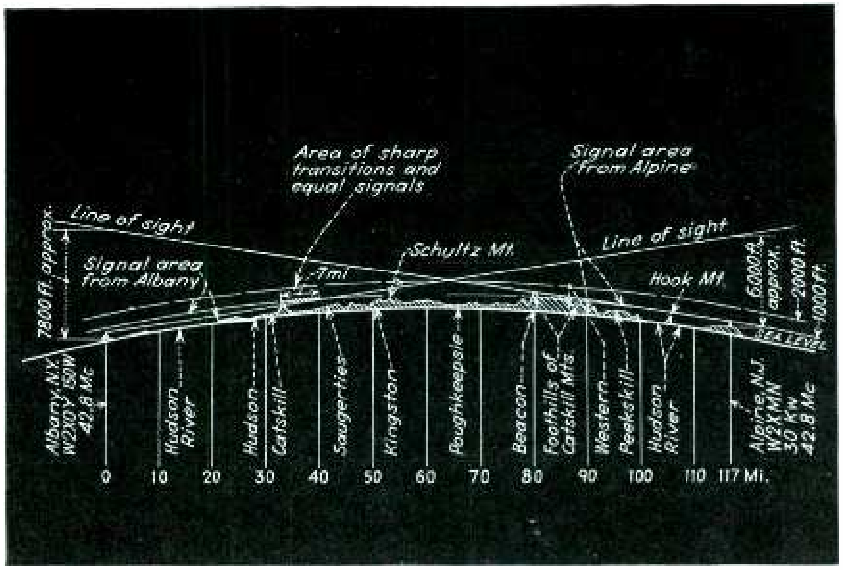


Fig. 2—Profile of terrain between Albany and Alpine, N. J., showing areas of signal control beyond line of sight

then tried and the plane proceeded west until intelligibility became poor. The plane then returned to the vicinity of Albany and the above procedure was repeated for frequency modulation. During this test the Albany transmitter utilized approximately ±75 kc swing as 100 per cent modulation.

A slight directivity of the plane's antenna was observed in favor of the forward direction. Thus the signal improved slightly each time the plane headed back toward Albany. The results of these tests are shown in Fig. 1. It is quite evident that frequency modulation service range is about 50 per cent greater than amplitude modulation.

Operation of Two Stations

The Albany transmitter and Major Armstrong's station W2XMN at Alpine, N. J., operated on the same carrier frequency of 42.8 Mc and both were frequency-modulated. A different program was fed to each transmitter so each station might be identified by the program it carried. Station W2XMN had an output of about 30 kw and was modulated with high-fidelity phonograph records. W2XOY was frequency modulating a 150-watt carrier with a studio program.

A plane proceeded south from Albany at 1,000 feet. Interference with Albany reception was first noted about 3 miles south of Catskill, which is 33 miles south of Albany. The Alpine Station was in control at Saugerties, N. Y., which is 40 miles south of Albany (Fig. 2). On the return trip from Alpine, Albany started taking control a little further south, indicating some forward directivity in the receiving antenna, as noted above. No carrier beat or "flutter" was observed as would be the case with two amplitude-modulated transmitters on the same frequency.

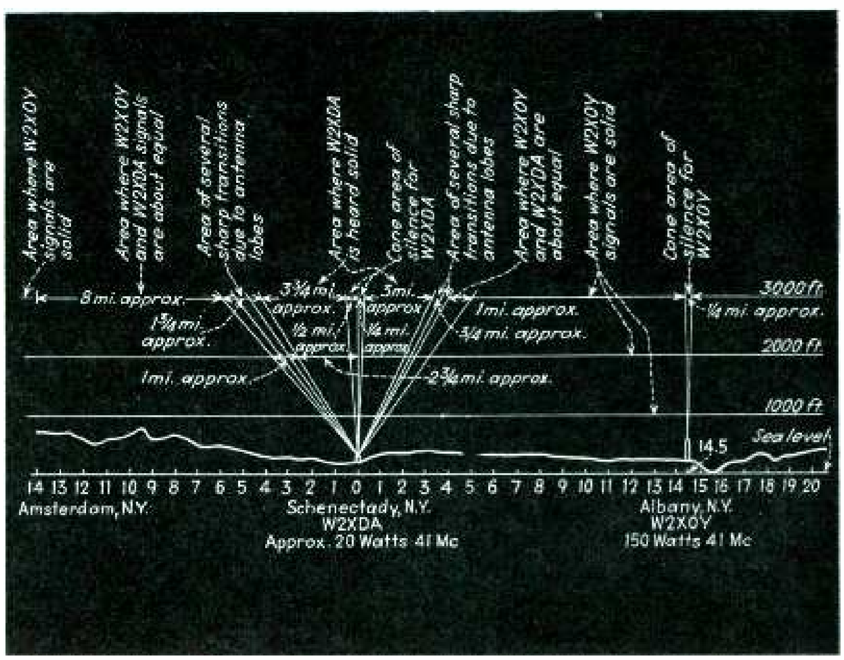
The center of the interference zone was about 37 miles from Albany and 80 miles from Alpine as shown. This equal signal point is nearer Alpine than would be expected from the ratio of the output powers of the two stations, but it can be explained by the presence of a range of hills just to the north of Alpine which must cause considerable attenuation of the signal.

It was noted that complete changeover from Albany control to Alpine control occurred two or three times while passing over the interfernce zone, the exact pattern depending on the course flown. It is presumed that this is due to reflections from high hills or mountains along the path and that the multiple transition would not be present at, say, 5,000 feet. It was noted also that, when banking for a turn, the "shadow" of the wing cut off the stronger signal permitting the other to take control for a short time.

It was observed in the interference area that the Alpine signal caused more interference to the Albany signal when the latter was 100 per cent tone-modulated than for idle carrier or voice. That is, music could be heard superimposed on the Albany tone when it could not be heard with Albany announcing or idling. This can be explained on the basis that the demodulating effect of the Albany carrier is greater when it is at or near constant frequency than when it is subjected to a sustained variation over its maximum swing. A complete explanation of this effect is made by Major Armstrong (May, 1936 issue of the *Proc. I.R.E.*, page 115). This effect would

(*Continued on page 92*)

Fig. 3—Profile of terrain between Albany and Schenectady, showing areas of signal control under line-of-sight conditions



AN IMPROVED C-R OSCILLOSCOPE DESIGN

Cathode-coupled stages and frequency compensation circuits, originally designed for other purposes, have been successfully applied to the cathode-ray oscilloscope, with resulting improvement in frequency response, deflection range, stability and independence of the controls

By WILLIAM A. GEOHAGEN

Formerly, Allen B. DuMont Laboratories

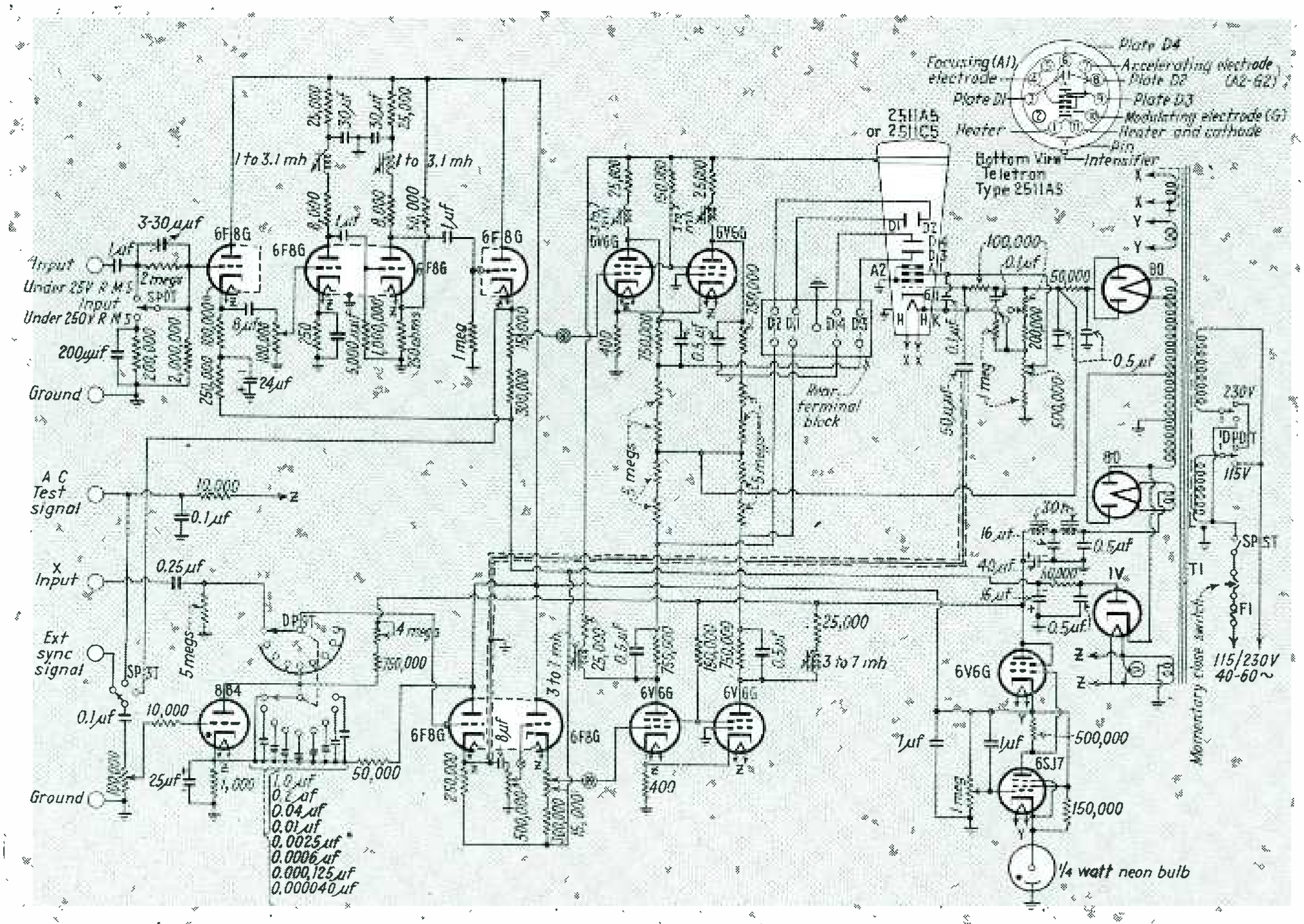
IDEALLY, a cathode-ray oscillograph, to be used as a universal test instrument, should include the following characteristics: The input impedance should be very high, so that its connection to observe the phenomenon occuring in any circuit will in no way affect the characteristics of that circuit. Its voltage response should be uniform to signals of all frequencies so that it will reproduce accurately any waveform applied. It should provide a means for attenuating or amplifying the applied signal in any desired amount without frequency discrimination, and further, the control of attenuation or amplification should be continuous rather than in steps. It should provide for observing an applied signal in its entirety, or for expanding a small portion of the signal to any desired size, and for bringing that portion of the signal into view on the screen. Positioning of the pattern should follow the adjustment of the positioning control instantaneously, and without lag.

This paper describes an instrument in which departures from conventional design have been made in order to approximate more closely these ideal conditions. A complete circuit diagram of this instrument, is shown in Fig. 1.

Attenuator and Gain Control

The simplest form of signal attenuation is shown in Fig. 2, in which C_2 and C_3 represent stray ca-

Fig. 1—Complete circuit diagram of the oscilloscope



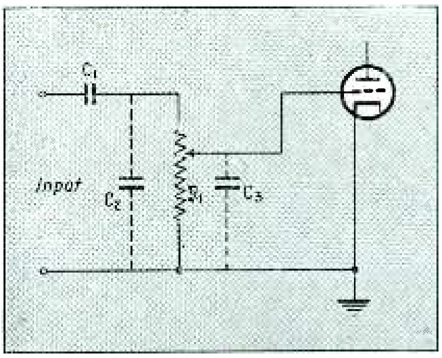


Fig. 2—Basic attenuator circuit which introduces frequency discrimination

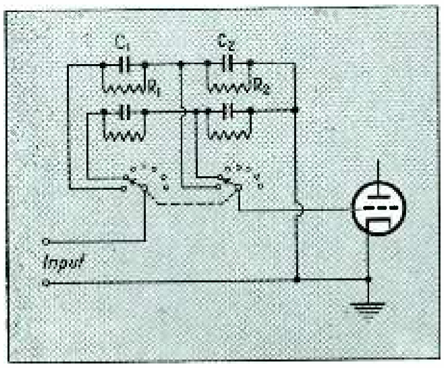


Fig. 3—Balanced circuit employing step attenuators to avoid frequency discrimination. The circuit may lack flexibility if the range to be covered is great

pacitances of circuit wiring and components to ground. Such an arrangement will fulfill the condition for continuous variation from infinite attenuation to maximum gain, but it necessitates a compromise between input impedance and frequency discrimination. For example, if R_1 be made one megohm and if it be set at its midpoint for 50 per cent attenuation at low frequencies, then if C_3 be 25 $\mu\mu$f, a 100 kc signal will be attenuated approximately 90 per cent. If R_1 is decreased to reduce this discrimination, not only will the input impedance be lowered correspondingly, but a larger value will be required for C_1 to avoid undue attenuation at the very low frequencies. This, in turn, will increase the stray capacity C_2, and will further lower the input impedance.

A stepped attenuator such as that shown in Fig. 3, can be adjusted to provide a high, constant input-impedance with uniform attenuation at all frequencies, but it will not provide continuous variation, and where the ratio of maximum to minimum applied signals is large, either the number of steps must be great, or the change between any two steps must be too great for flexible operation.

The arrangement employed in this instrument is shown in Fig. 4. The triode *T* acts as an impedance transformer, and permits an unusually high input impedance in spite of the low value for R_5 and the high value of C_4. Two overlapping ranges are provided for input signals up to 250 volts rms, and the adjustment is continuous throughout each range. Square waves of from 2 to 30,000 cps are passed without noticeable change in shape throughout the entire range of the control.

Deflection Amplifiers

The vertical deflection circuit comprises two stages of triode amplification preceding a push-pull final stage. The use of a twin triode as two stages, instead of a single pentode stage, provides high sensitivity without utilizing the maximum gain of the triodes, leaving considerable additional gain available for low-frequency compensation. Further, the application of such compensation in two stages instead of one, without a corresponding increase in the number of points of low-frequency attenuation, makes it possible to extend the flat response to lower frequencies without introducing over-compensation at any point. The type of low-frequency compensation employed is conventional. Capacitors are used as short circuits across portions of the plate loads at high frequencies, and serving to increase the plate loads, and hence the gain, at very low frequencies. The low-resistance plate loads are favorable for good high-frequency response, which is extended further by the use of series inductances and the small cathode by-pass. The overall response of the instrument, as shown in the accompanying curve (Fig. 10), is flat from 2 to 100,000 cps, with a sensitivity of 10 rms millivolts per inch.

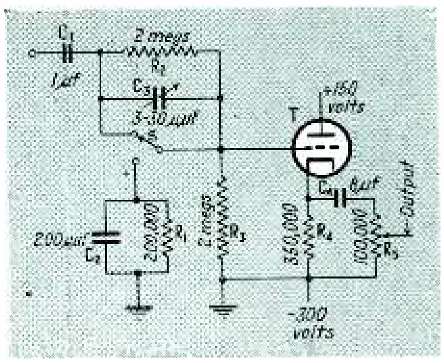


Fig. 4—Cathode-coupled input stage which avoids the difficulties inherent in the circuits shown in Figs. 2 and 3

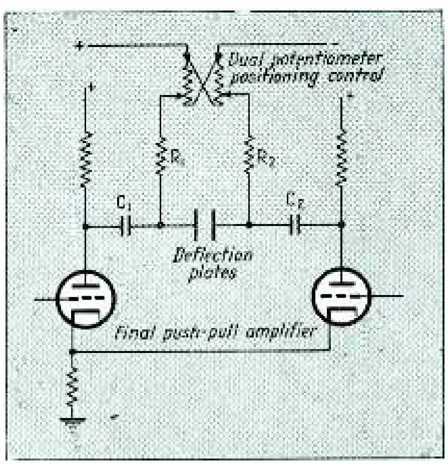


Fig. 5—Typical positive-negative positioning control circuit, which suffers from the sluggishness which may be associated with the CR circuits

Positioning Circuits

The type of positioning circuit most commonly employed in the past has used condenser coupling between the final amplifier and the deflection plates of the cathode-ray tube, with a variable direct voltage applied to the deflection plates for positioning the pattern. A typical arrangement, in which the positive and negative positioning voltages are obtained from the amplifier and cathode-ray-tube power supplies respectively, is shown in Fig. 5. Such an arrangement is entirely satisfactory when response to very low frequencies is not required, but when the range uniform response is carried down to one or two cps, the time constants of C_1R_1 and C_2R_2 must be long, and positioning action becomes sluggish, a matter of seconds being required for the pattern to reach its new position after the control is adjusted. This condition may reach the point of making it virtually impossible to set the pattern at a desired spot on the cathode-ray-tube screen within a reasonable length of time. The circuit becomes more and more sluggish the lower the response is carried, but, paradoxically, if the final amplifier response be carried to dc or zero frequency, the positioning response may be made substantially instantaneous.

The design of the final amplifiers, and of the coupling circuits between them and the deflection plates, is discussed later in this paper. For the sake of the present discussion, let us assume that we have available a direct-coupled amplifier with push-pull output, and a coupling circuit which effectively couples the deflection plates directly to the amplifier, yet which fulfills the desirable condition of maintaining the average deflection plate potential at ground. When an a-c signal is placed upon the grid of the final amplifier, the pattern will appear centered on the screen, but if a small amount of dc be superimposed upon the ac, the entire pattern will be shifted up or down, depending upon the polarity of the direct voltage. A variable source of dc superimposed upon the input to the final amplifier will, therefore, act as a positioning control, and with such an arrangement an immediate advantage over the conventional arrangement is realized. With a power supply in the order of 400 volts, final amplifiers will provide for only slightly more than full-screen deflection without overload. With the conventional positioning arrangement, if the edge of a pattern which is more than slightly in excess of full-screen size be brought into view on the screen, it will be distorted and valueless for observations. With the new method here described, however, the pattern, when on the screen, is always on the linear portion of the final amplifier characteristic and is, therefore, undistorted. It is thus possible to utilize the full undistorted output of the preceding stages, which can easily be made equivalent to several times full-screen deflection. With such an arrangement, a pattern may be expanded to several times full-screen size, and any portion of it brought into view undistorted.

A method devised for the superposition of dc upon the ac signal is shown in Fig. 6A. The signal from the preceding amplifier stage is fed to the grid of a cathode-follower stage, the cathode of which is returned through a high resistance to a source several hundred volts negative with respect to ground. The upper part of this resistance is shunted by a neon lamp, and is

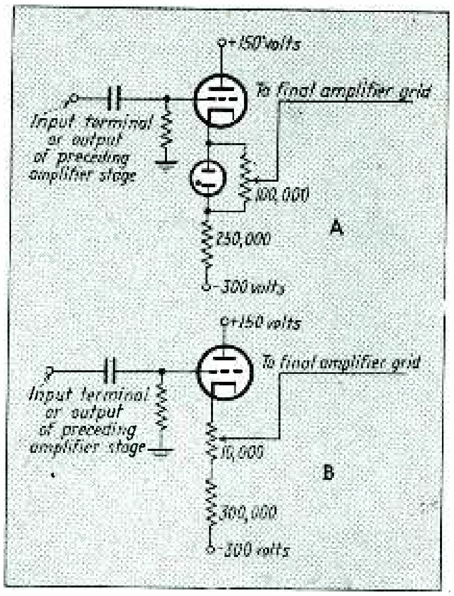


Fig. 6—A method of superimposing dc on ac with direct coupling, which gives instantaneous control of spot position. When the gain is high the neon lamp may be omitted as shown in B

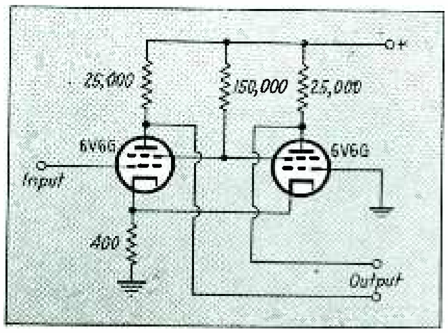


Fig. 7—Push-pull direct-coupled final amplifier, used to obtain optimum focusing of the spot over the entire screen area

utilized as the positioning control. Since the neon lamp maintains almost constant voltage over a wide range of current, the signal which was applied to the grid of the cathode-loaded stage will appear essentially the same at all points on the positioning control, but the "no-signal" direct voltage applied to the final amplifier will vary, for all intents and purpose instantaneously as the control is adjusted. Where the gain of the final amplifier is high, and a relatively small range of d-c variation is, therefore, required, the resistance of the positioning control may be made small as compared with the total cathode resistance, and the neon bulb omitted as shown in Fig. 6B. This introduces a slight gain change from one end of the positioning control to the other, but with the values shown this will be about 3 per cent over a twenty inch range of cathode-ray-tube deflection. In practice this is an adequate deflection range.

In this instrument, positioning is instantaneous, and it is possible to expand the pattern in either axis to three times full-screen size, and still bring any part of it onto the screen, undistorted, for observation. It is thus possible to observe on a five inch cathode-ray tube, detail which with conventional arrangements would be possible only on a fifteen inch cathode-ray tube.

Final Amplifiers and Coupling

With such a positioning circuit, it is necessary to provide an appropriate direct-coupled amplifier, and in order to obtain the best focus of the spot over the entire screen area, it is desirable that the amplifier be designed for push-pull output. Such an amplifier was developed for this instrument, and it is shown in Fig. 7. A combination of screen and cathode coupling is used to transfer the signal from the first to the second tube in opposite phase. The outputs of the tubes are very nearly equal, and the combined output is linear over the range required for full-screen deflection. Since at no-signal the conditions on the two tubes are identical, this circuit remains in adjustment over wide ranges of line-voltage variation.

In order to avoid astigmatism of the spot in the cathode-ray tube it is desirable not only that the average potential of each pair of deflection plates remain constant throughout the deflection range, but that the average potential of the two vertical plates equal that of the two horizontal plates. Employment of identical amplifiers of the type described on the horizontal and vertical axes, with the deflection plates connected directly to the amplifier tube plates would fulfil these requirements. It is, however, frequently desirable in practice to connect one pair of deflection plates directly to an external circuit. Since this external circuit is frequently of such nature that its average potential is at ground, it is desirable for the sake of flexibility to design the oscillograph circuits so that each pair of deflection plates has potential at ground. Several methods of accomplishing this, at the same time retaining direct coupling between

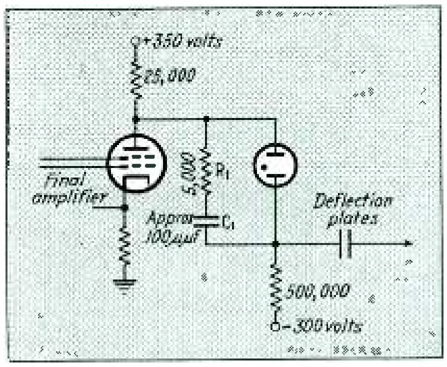


Fig. 8—Method of bringing a set of deflection plates to an average potential at ground, to permit connection to balanced external circuits

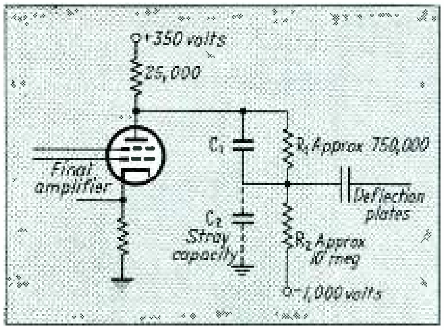


Fig. 9—Simpler method of bringing average deflection potential to ground, which has the disadvantages of variable frequency response and signal pick-up

the amplifiers and deflection plates, are possible. A small neon lamp, whose gap-maintenance voltage equals the amplifier plate voltage at no-signal, may be used as shown in Fig. 8. Because of the neon lamp's current-voltage characteristic, the signal will be transmitted from amplifier plate to deflection plate with little loss. The network C_1R_1 passes the high frequencies at the same slight attenuation which is introduced by the neon bulb. This is necessary because the gap-maintenance voltage of available bulbs increases with frequency.

A simpler arrangement is shown in Fig. 9. R_1 and R_2 are fixed in the ratio of the no-signal plate voltage to the negative power supply voltage (In this case, the negative supply voltage for the cathode-ray tube), and C_1 is balanced against the stray circuit and deflection plate capacity C_2 in the ratio $R_1/R_2 = C_2/C_1$. This arrangement has two disadvantages. Changes in the beam current, when brilliance is changed, affect the deflection-plate impedance and alter the frequency-response characteristics. The deflection plates are left at a high impedance from ground, and are liable to be subject to pick-up from the other pair of deflection plates and from external circuits. A satisfactory modification of this arrangement, and the one employed in this instrument, was found in making C_1 relatively large. Since the d-c signal potential at the deflection plate with no condenser at point C_1 is about 90 per cent of the d-c signal at the amplifier plate, the low-frequency loss in this circuit with even a fairly small condenser at point C_1 will be small as compared with the losses in the usual resistance-capacitance networks of the preceding stages, and this loss is easily made up by slight over-compensation in the earlier amplifier stages. Since the voltage change across the condenser C_1 when the positioning control is adjusted is only about 10 per cent of the total deflection plate potential change, a fairly large condenser can be used without introducing noticeable "overshoot" in the positioning. The value of 0.5 μf chosen is entirely satisfactory from both standpoints, and provides the desired low-impedance path from the deflection plates to ground.

Sweep Circuit

A conventional gas-tube sawtooth oscillator is used to generate the linear time-base. An attenuator and positioning circuit similar to to that used on the vertical axis is used to couple the sweep-oscillator to the horizontal amplifier. The grid of the impedance-transformer triode is connected directly to the plate of the gas tube, and because of the high impedance and low degree of frequency discrimination offered by this circuit, good linearity with respect to time is obtained over a range from two to 50,000 sweeps per second. A synchronization signal selector and control are provided to permit synchronization of the sweep to external signals, power line voltage, or to signals applied to the vertical ampifier. The "frequency-range switch" is arranged in its "off" position to connect the input circuit of the horizontal ampifier and attenuator to a post on the front panel for connection to externally provided horizontal deflection voltages. The negative pulse of the sweep-oscillator during fly-back is applied through a small condenser to the grid of the cathode-ray tube to blank out the return trace.

An electronic regulator supplies plate and bias voltages to all but the final amplifiers, and virtually eliminates any tendency of the pattern to drift, even with heavy line-voltage surges. The remainder of the power supply is conventional, with a half wave rectifier and filter used to supply negative voltage for the positioning and attenuator circuits.

An unusual mechanical arrangement has been employed in this instrument to provide a compact unit with its center of gravity near its physical center for convenience in carrying, and with the power-supply components placed to minimize magnetic disturbances. A shielded transformer is used, and with the additional protection of the tube shield, this transformer virtually eliminates magnetic ripple.

The instrument described represents the application of several new principles to increase the usefulness, flexibility, and ease of operation of the cathode-ray oscillograph. As with any instrument, its design represents a compromise between ideal characteristics, cost, and size, and does not represent the maximum performance which can be obtained in a larger and more complex instrument employing the same basic principles.

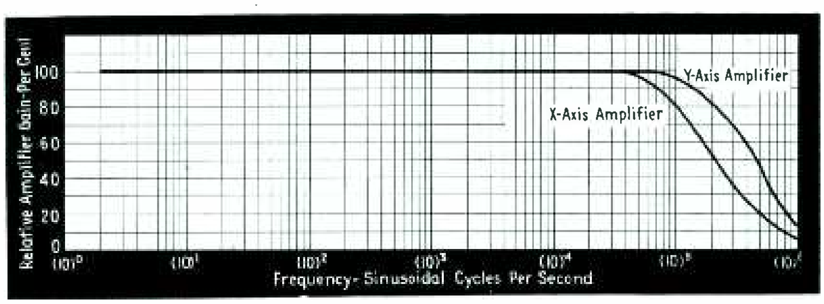


Fig. 10—Frequency response of the deflection amplifiers, showing essentially flat response on the horizontal deflection to 50,000 cps, and up to 100,000 cps on the vertical circuit

TUBES AT WORK

A logarithmic compression vacuum tube voltmeter using cascaded stages and a review of the advantages of autotransformers in modulation circuits

A New Logarithmic Electronic Voltmeter

By Paul J. Selgin

The purpose of the wide-range meter described in this article is that of converting an audio-frequency signal into a direct current of a value proportional to the signal level, expressed in decibels. The current itself may be read on an ordinary d-c instrument, or registered on a recording instrument, or it may be used to operate relays or other devices.

The above conversion is accomplished over a wide range of signal levels, so that it is not necessary to insert a variable loss, by means of an attenuating network controlled by a multiple switch, in order to bring the signal down to measurable levels, as is done in existing instruments. Thus, the following advantages are secured: Signals of widely different amplitudes can be read successively, on the same scale, without changing the range. A fluctuating signal, such as due to sound or noise, can be continuously observed or recorded. Operations involving the measurement of gains or losses varying widely and abruptly with frequency, such as filter losses, are greatly simplified. The instrument requires no periodical re-setting and contains no rotary switches or other mechanical parts. Its "damping" is controlled exclusively by the movement of the d-c instrument, as the electrical circuit introduces no retardation.

The operation of the device is based upon the action of a special non-linear network containing a number of vacuum tubes to which we shall refer as a "converting network" for lack of a better definition. Signals transmitted through the network are subject to a gain which decreases as the signal strength is increased. The rate of decrease is such that, as the signal grows from a small initial value to a value many hundreds of times greater, the output from the network rises, approximately, as the logarithm of the input, or, in other words, stays proportional to the signal level expressed in decibels. The network introduces distortion and is, therefore, not applicable where fidelity is required. However, the original waveform is not so far altered as to introduce appreciable errors in the calibration when non-sinusoidal voltages are measured, except in extreme cases.

The overall gain is not materially affected by variations in tube characteristics. It is essentially controlled by the values of resistances forming part of the circuit. The degree of approximation with which a linear decibel calibration is approached is dependent upon exact choice of these values, as well as by the number of available stages. It is to be noted, however, that no advantage is to be gained by approaching linearity very closely, beyond certain limits.

The "converting network" comprises a number of sections, each of which is made up of two triode stages having different functions. Of the two stages making up each section, one is a low gain, stabilized, resistance-coupled amplifying stage, whose circuit diagram and symbolic representation are shown in Fig. 1.

The operation of the second stage, which might be called a "compressing stage", is as follows (see Fig. 2): If the incoming signal is of sufficient amplitude, during part of each cycle the tube is biased beyond cut-off, and the stage acts as a voltage divider (Fig. 3A). During the remainder of the cycle, the tube conducts, and the operation of the stage is essentially that of the simplified circuit of Fig. 3B. As a result, the output voltage is related to the input voltage, at each instant, in the manner shown graphically on Fig. 4. This Figure shows a plot formed by two straight lines of different slopes, joined by a "knee". All symbols refer to Fig. 2.

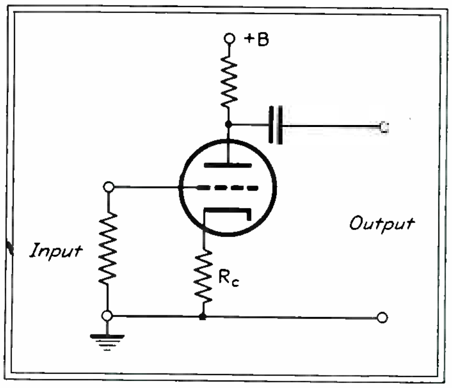
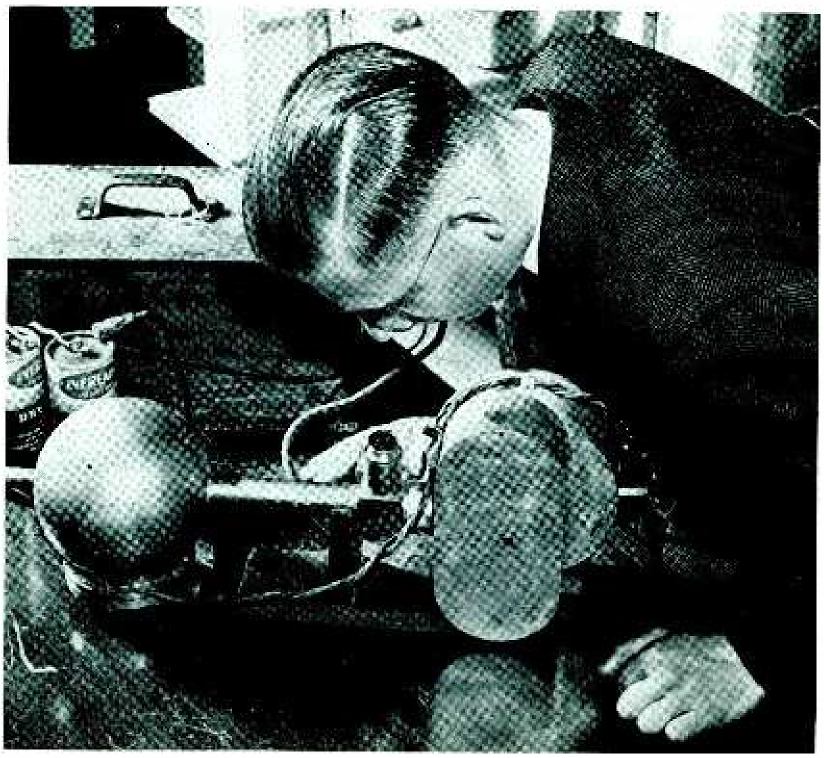


Fig. 1—Basic amplifier section of the voltmeter

MEASURES INTENSITY OF COSMIC RAYS



Paul F. Gast attending the cosmic ray electroscope shown at a recent convention of the American Physical Society at Seattle, Washington

The steeper slope, S_1, depends on the value of the resistance R'_c only. The slope S_2 depends upon the ratio R_1/R_2 (It should be noted that both the above resistances are very much larger than R'_c.) The relative position of the knee is affected by R'_c as well as by the plate voltage B'.

The above dependances can be demonstrated very clearly by viewing the plot of Fig. 4 on the screen of a cathode-ray oscilloscope. This is done simply by connecting the "H" terminals of the oscilloscope to the input side, the "V" terminals to the output side of each section.

If the input voltage amplitude is less than a given value, depending upon the cathode resistor and the plate voltage, the tube conducts all the time and the stage transmits the signal without distortion.

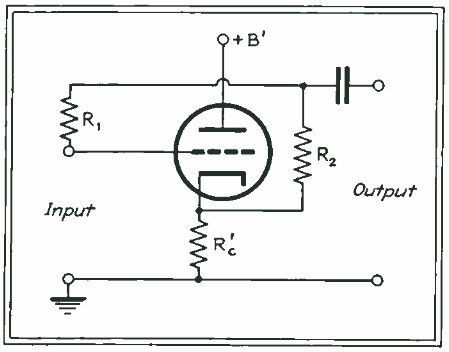


Fig. 2—Basic compressing stage of the voltmeter

It should be noted that the distortion introduced by each "compressing" stage tends to be neutralized by the next, as there is a 180° change of phase, due to the amplifier, in between. The net action upon the waveform produced by a number of sections, as re-

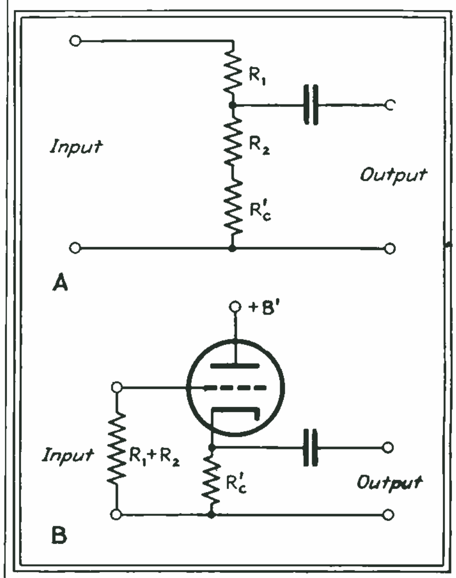


Fig. 3—Equivalent circuits of compressor stage under different input voltage levels

vealed by the oscilloscope with plates connected to the input and output terminals of the whole chain, is a pattern, with several "knees" separated by straight sections of slopes fluctuating about an average value. This average value is indicative of the overall gain. As the signal amplitude applied to the input is increased, the non-linear action extends to more and more sections, with the result that the above-mentioned pattern acquires an increasing number of "knees", and its average slope becomes less and less.

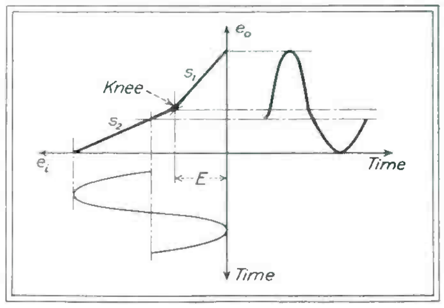


Fig. 4—Graphical analysis of compressor stage action

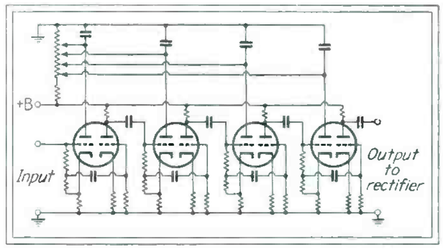
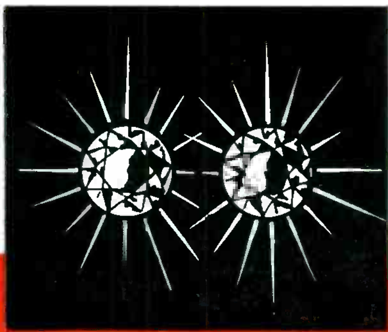


Fig. 5—Complete diagram of four-stage compressor voltmeter

A complete wiring diagram of a 4-section "converting network", as well as its symbolic representation, is shown in Fig. 5. The resistance values depend upon the upper and lower limits assigned to the linear decibel scale. Once these are set, the scale is divided into equal parts, each part corresponding to 2, 5 or 10 db depending upon the degree of linearity which it is desired to achieve. Then the resistances of each section can be adjusted independently of the others, to fit the prearranged calibration. This is possible because changes in the resistance values of each stage do not affect the calibration up to the point at which the stage becomes non-linear. It will be understood that this process is of a nature that, while relatively easy to demonstrate, cannot be explained in writing within a reasonably short space.

When the resistance values have been found, and inserted, with or without small changes to "round off" odd values, in the circuit, the instrument is calibrated in the ordinary manner. Small deviations from linearity will be present in any case, and will be, of course, more noticeable if the resist-



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ance values have not been selected accurately, or if the preliminary scale subdivisions were very far apart. It should be noted that each stage will take care of *two* such subdivisions, as it contains two variables, namely, the ratio: R_1/R_2 and the cathode resistance R'_c.

Hence, if the subdivisions are spaced 5 db from one another, 5 sections (5 tubes) will cover a range of 50 db. However, for practical purposes such close spacing is unnecessary, and 4 tubes can be made to cover a 60 db range when selection of resistances is possible.

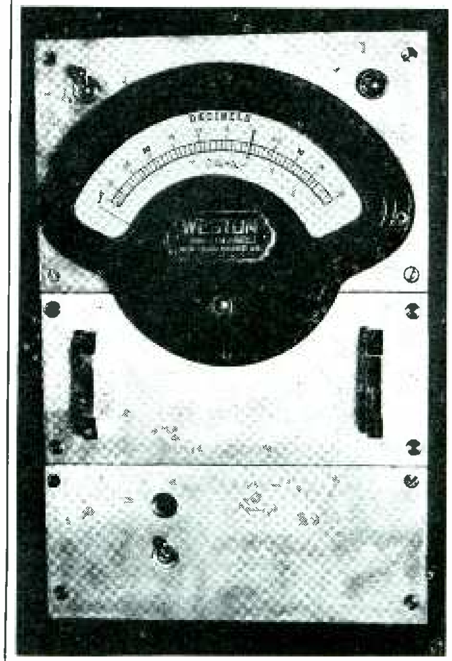


Fig. 6—External appearance of experimental four-stage voltmeter

In accordance to the above, an experimental model shown in Fig. 6, was constructed. It contains, in addition to the "converting network", a rectifying circuit and a source of regulated d-c voltage. The rectifying circuit is shown in Fig. 7. This particular circuit was found most satisfactory from the point of view of stability, and it has the advantage that it makes use of a tube of the same type as those in the "converting network" (type 6F8-G).

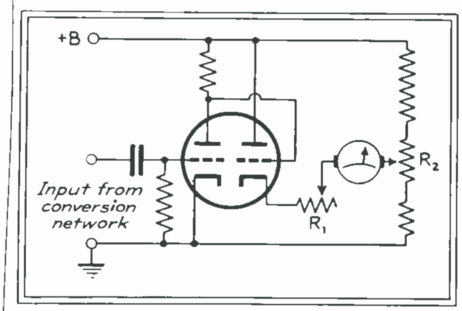
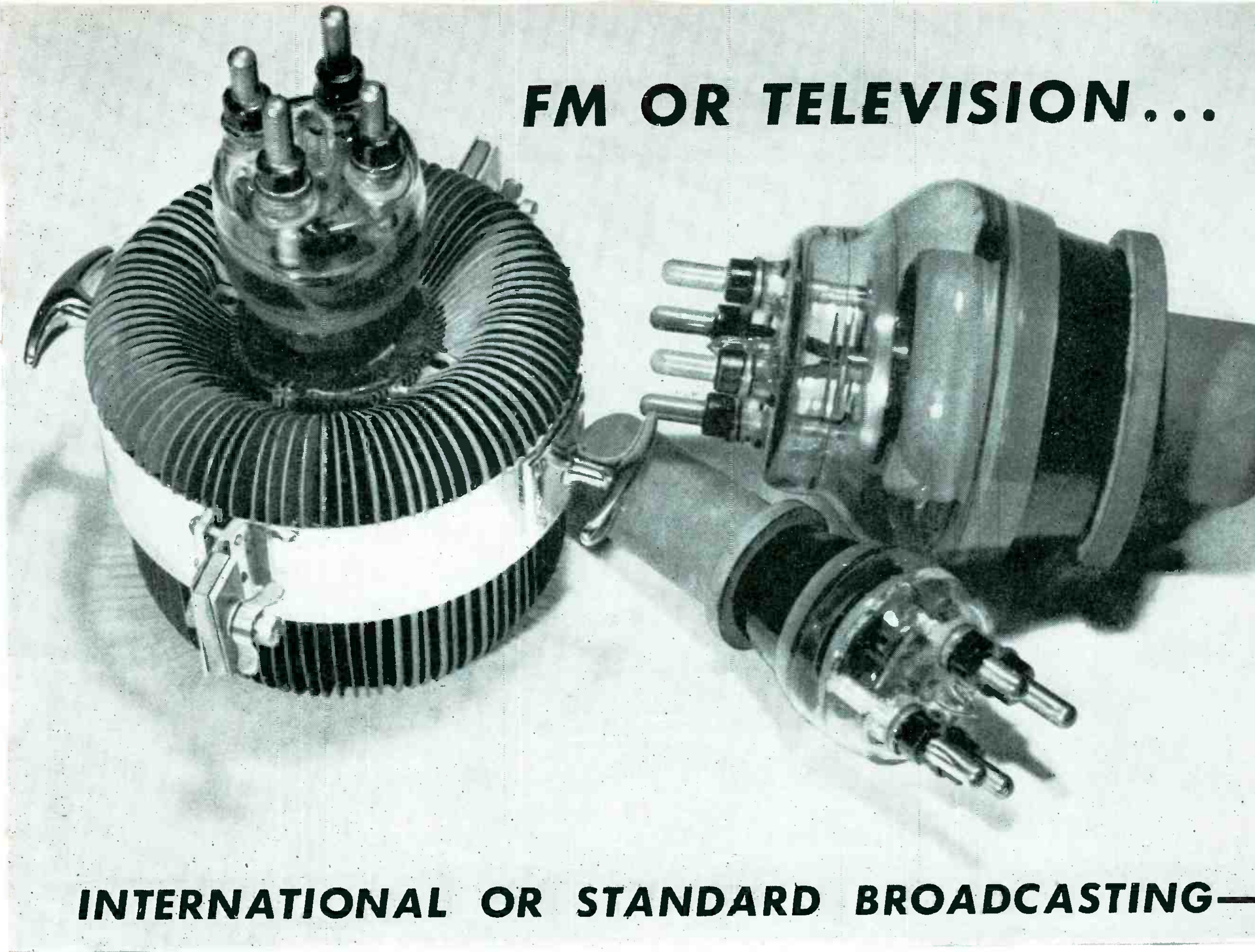


Fig. 7—Rectifying circuit for converting signal to d-c meter reading



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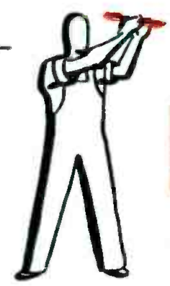

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Tube replacements, of course, affect this circuit (while they do not appreciably affect the "converting network"). To correct for this two variable resistors are provided. Of these, R_1 is used to correct the meter deflection, and R_2 to correct the zero.

In the above discussion, no mention has been made of the behavior of the meter at increasing frequencies. No full data on this are available at this time, as the oscillator used only reached a frequency of 15,000 cps. Up to this frequency there was no change in the calibration, except a very slight one (of the order of .5 db) at the top of the scale, i.e., for signals approaching 10 volts r-m-s. It seems apparent, however, that the behavior of the instrument from this point of view is satisfactory for most practical purposes.

• • •

Auto-Transformers in Modulation Circuits

By Thomas A. Gross

The high efficiency and low cost of auto-transformers account for their extensive use in power service. However, in radio practice lack of co-ordinated effort between designing engineers and transformer manufacturers has prevented its widespread adoption in modulation circuits. The principles discussed here apply to all r-f, a-f, and power transformers. Because the benefits are particularly marked in their application to modulators, special emphasis is placed on this service.

Transformer Efficiency

The insertion loss of modulation transformers is important in view of the high power levels encountered and the expense of generating the a-f power. Multiple circuit transformers (two windings or more) which are usually employed in broadcast station modulators frequently have losses twice as great as equivalent auto-transformer designs.

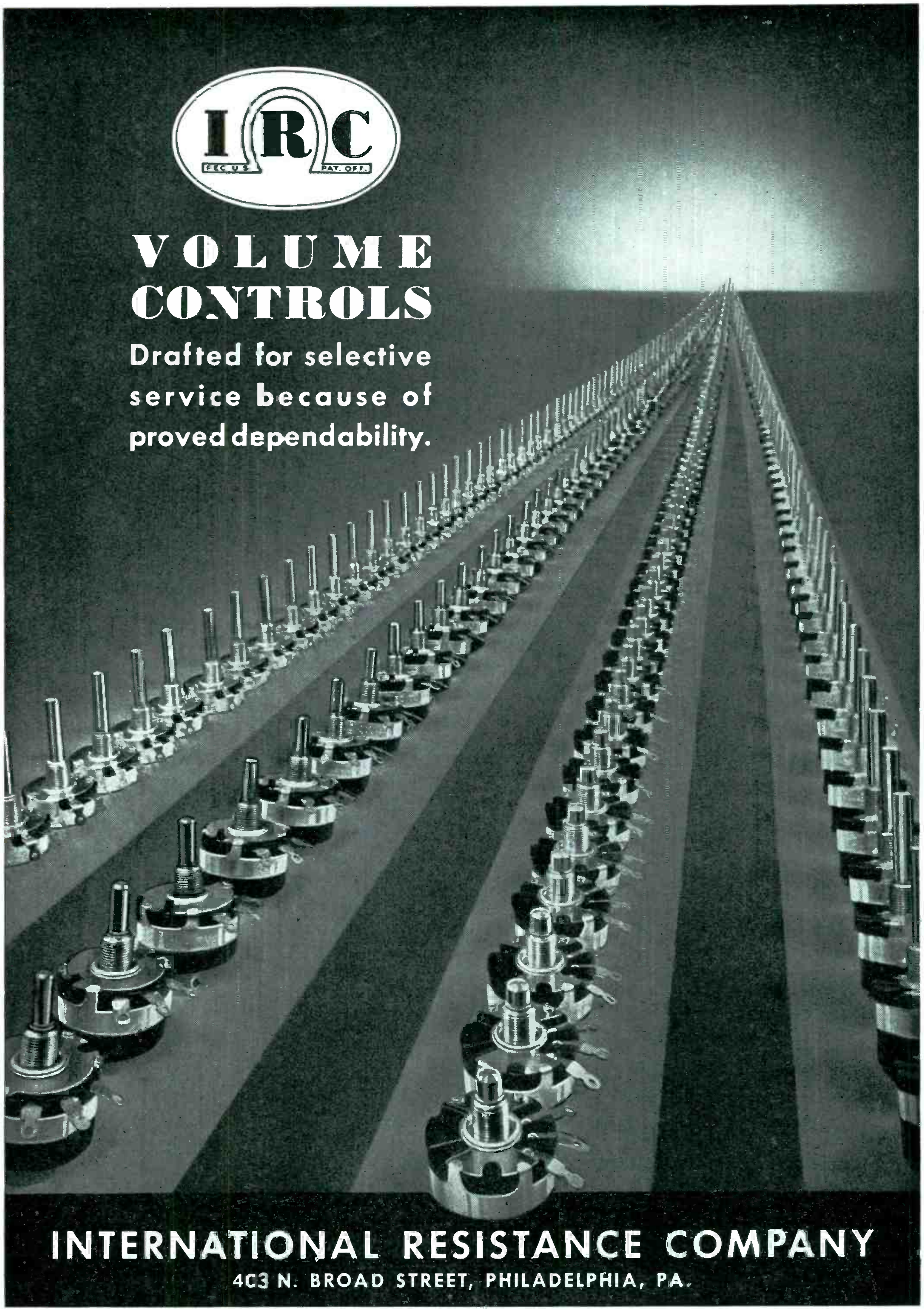
The decreased resistance of auto-transformer coil windings account for important gains in transfer efficiency. The percentage efficiency of a multiple circuit transformer as governed by copper loss—

$$\text{Efficiency} = \frac{100}{1 + \dfrac{R_p + N^2 R_s}{N^2 R_L}} \text{ per cent} \quad (1)$$

where:

R_p = D-c resistance of primary winding
R_s = D-c resistance of secondary winding
N = Primary turns/secondary turns
R_L = Load resistance

This formula also applies to an auto-transformer where the primary and secondary circuits have part or all of a winding in common (Fig. 1B).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Evidently the heat dissipation due to the a-c current in the common winding is not the scalar sum of the two currents squared times the resistance. It can be shown by Kirchoff's Laws that the a-c power loss is the same for both circuits (Figs. 1A and 1B) when the resistance of the primary windings is the same. This follows to the conclusion that Eq. (1) describes the power loss for either circuit.

The practical advantage lies in the elimination of a large portion of the transformer windings with no decrease in efficiency when the auto-transformer principle is employed. This lowers the manufacturing cost and, as we shall see later, improves the high frequency response. Similarly, the auto-transformer will have a higher efficiency compared to multiple winding transformers constructed with the same amount of core and copper.

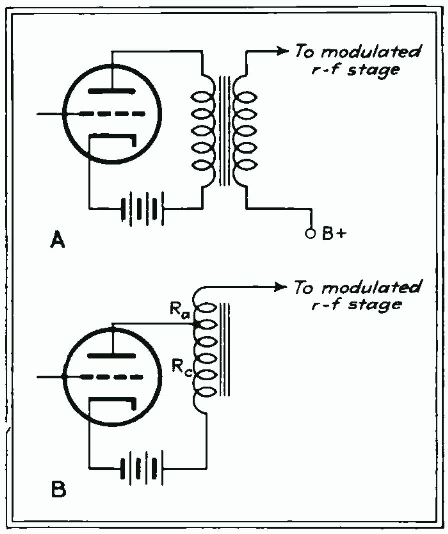


Fig. 1—Multiple circuit (A) and auto-transformer (B) modulators

The d-c losses, however, are generally higher in the auto-transformer. In the circuit of Fig. 1A the d-c power dissipation is

$$(I_p)^2R_p + (I_s)^2R_s$$

where:

I_p = Pri. d-c current
I_s = Sec. d-c current
R_p = Pri. d-c resistance
R_s = Sec. d-c resistance

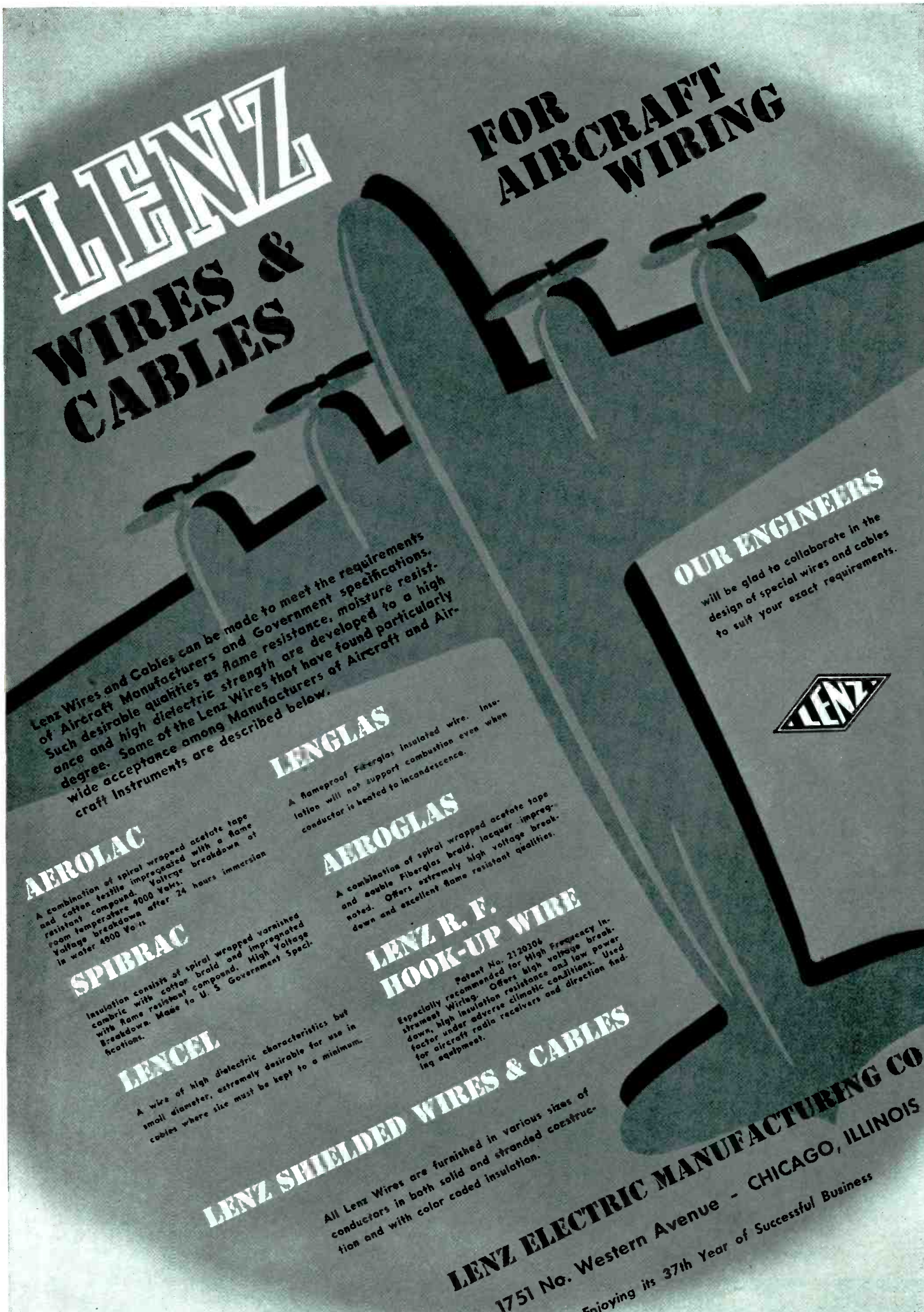
The d-c power loss in the transformer of Fig. 1B is

$$(I_p + I_s)^2R_c + (I_s)^2R_a$$

where:

R_c = Resistance of the common winding
R_a = Resistance of the auxiliary winding

In the customary push-pull modulator stage it is not possible to employ the entire primary winding common to the secondary circuit because the high voltage plate supplies are at ground potential so far as ac is concerned. Thus the direct-voltages are



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fed into points of zero a-c voltage, as shown in Fig. 2.

The modulated amplifier circuit is connected to an appropriate impedance tap. Note that no auxiliary winding is required if the impedance of the modulated amplifier is equal to one-quarter of the modulator plate-to-plate load. In this case the modulated amplifier is connected to one of the modulator plates. In the event that the modulated amplifier has a lower impedance, the appropriate tap is located nearer to the center of winding "*c*" in order to reflect a proper load to the modulator plates.

Frequency Response

The auto-transformer does not offer intrinsic advantages in the transfer of low frequencies excepting an improved space utilization factor making more

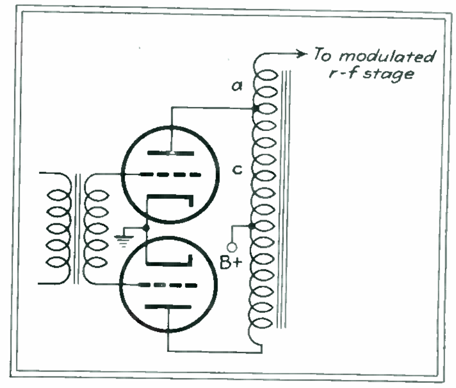

Fig. 2—System for maintaining B+ at zero a-c potential

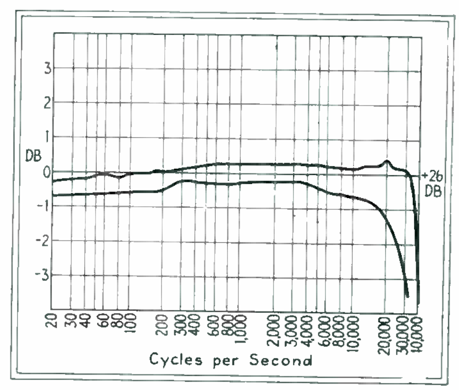

Fig. 3—Comparison of auto-transformer (top) and multiple circuit frequency response

turns possible in a given window area. The high frequencies, however, depend upon a low leakage inductance if they are to be effectively transmitted by the transformer. This leakage inductance varies inversely as the coupling coefficient between the primary and secondary windings. Close coupling can be obtained by segregating portions of each winding into pancake shaped coils and placing them close together. Unfortunately this procedure is limited by increasing capacities and manufacturing expense. When the respective circuits have common wind-

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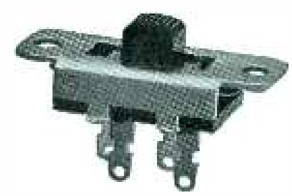

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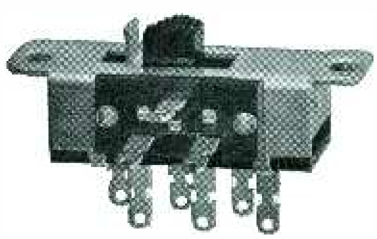

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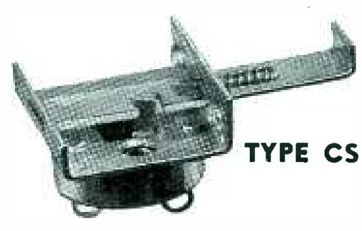

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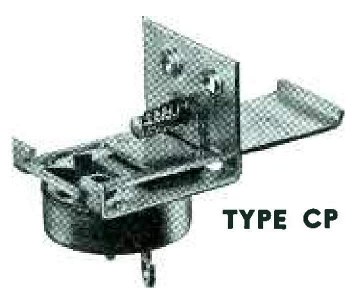

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These products are sold only to manufacturers of original equipment.

VOLUME CONTROLS • TONE CONTROLS

ings, however, the coupling coefficient is unity. If auxiliary windings are necessary in the case where a push-pull modulator is used or when the circuit impedances differ, the coupling between these windings and the common winding is close to unity because of their spatial proximity. The extended response characteristic of the auto-transformer is probably its most important attribute. In addition, auto-transformers frequently cost 40 per cent less than their multiple-wound counterpart.

Multiple wound transformers have an advantage in flexibility over auto-

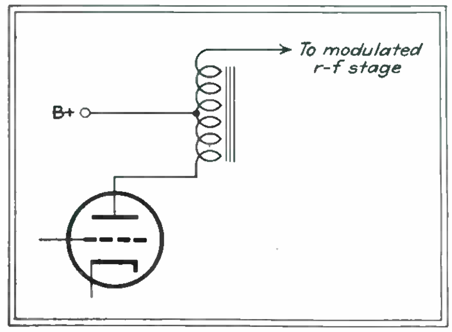


Fig. 4—D-c bucking arrangement to reduce core saturation point

transformers because the coupled circuits need not have a common d-c potential. At the present time, however, shunt fed systems are used in order that the unbalanced direct current will not decrease the permeability of the core materials. The indirect effect of the dc flowing through the modulation transformer is to increase its size and hence affecting the leakage inductance. Empirical observation indicates that auto-transformers with a series-fed modulated amplifier out-perform shunt fed-multiple circuit transformers. Shunt feed can of course be used with auto-transformers but future trends will probably show more popular use of the series-fed connections.

A variation on the common winding principle is the d-c bucking arrangement of Fig. 4. The windings are arranged so that the d-c mmf's cancel thus making a core of low reluctance possible. The mmf's cancel when:

$$(R_m/R_L)^2 = i_L/i_m$$

where:

R_m = Reflected impedance facing modulator
R_L = Impedance of modulated stage
i_L and i_m = modulated amplifier and modulator currents, respectively.

For reasons already explained the circuit in Fig. 4 does not compare favorably in respect to efficiency and frequency response with the d-c "adding" circuit of Fig. 1B. Experiments however suggest its use for low power audio circuits. The example is given to show the extent of the many possible variations in common winding auto-transformer circuits.

The Chronoscope

(Continued from page 30)

pearance of the Chronoscope. The input terminals are at the extreme left with their switches to change from a make to a break type of input circuit. The switch marked "Milliseconds" selects the five time ranges, 10, 20, 50, 100 and 200 milliseconds and also provides means of reading the battery voltage and checking the ballistic constant of the galvanometer. The key in the center is normally in the middle position but when thrown up the galvanometer is out of the circuit and the current can be set on the milliammeter. This key is pressed down to take readings of time on the galvanometer. The knob at the right is the fine adjustment on the current. The time indicating galvanometer is in the top of the cabinet on the left and the milliammeter for indicating the current is at the right.

Figure 7 shows the internal arrangement of parts. One set of binding posts on the chassis affords provision for the use of batteries for energizing the tube filaments in case it is desirable to use the chronoscope where an a-c power line is not available. The additional set of binding posts on the chassis is for the insertion of a meter to check the calibration of the milliammeter.

Accuracy, Convenience, and Reliability

To be fully assured that the theory of operation was correct, calibrations at both ends of the scale on each of the five ranges have been made. This has been done by means of oscillograph records using a frequency standard as the time reference. The table shows the current used on each range resulting in a maximum error of 0.65 per cent.

Range in Milliseconds	Current in Milliamperes
10	20.0
20	10.0
50	4.0
100	2.01
200	1.01

These data apply to a galvanometer which requires 200 microcoulombs for full scale deflection as determined by the condenser discharge

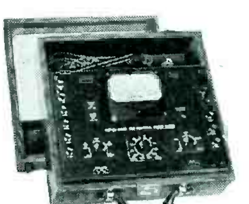
THE EASY WAY ... to Sustain EXACTING PRODUCTION SCHEDULES!

The WESTON multi-range AC Clamp-Ammeter

Available in three models . . . each having six individual full scale ranges . . . to suit all maintenance applications. Has convenient 6 position range changing switch. Well insulated for protection. Can be used with insulated or non-insulated conductors up to 2″ diameter.

WESTON portable and panel type instruments

Available in the types, sizes and ranges necessary for production and assembly testing. Also in multi-range, multi-purpose instruments such as volt-ohmmeters, volt-ohm-milliameters, etc., etc.



WESTON Model 785 Industrial Circuit Tester

A compact, self-contained unit which provides all the ranges (27 in all) necessary for voltage, current and resistance measurements wherever high sensitivity is a factor . . . including signal systems, telephone circuits, sensitive relay circuits, photo-cell circuits, PA systems and amplifiers, etc., etc.

No longer is it necessary to interrupt a circuit and stop production while motors and machines are being tested. With the WESTON AC Clamp-Ammeter you do your testing with all machinery "on the line". The jaws of this compact maintenance tool are just hooked around the conductor or switch-blade, and you get your current reading. So simple, each test takes but a fraction of the time ordinarily required. Thus you save testing time and save working time, while safeguarding against equipment break-downs and costly power losses. *It's an essential tool for any shop faced with an exacting production schedule.*

And for the assembly line, the inspection department, or for other test requirements, there are WESTON instruments specifically designed to do the job quicker, simpler, and with true WESTON dependability. Make sure you are getting all the benefits of modern WESTON instrumentation. Call on your local WESTON representative for information or assistance; or write direct to Weston Electrical Instrument Corp., 618 Frelinghuysen Avenue, Newark, N. J.

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Specialized Test Equipment . . . Light Measurement and Control Devices . . . Exposure Meters . . . Aircraft Instruments . . . Electric Tachometers . . . Dial Thermometers.

FOR OVER 52 YEARS LEADERS IN ELECTRICAL MEASURING INSTRUMENTS

calibration. The increase in current over the theoretical value which was required on the 100 and 200 millisecond scales is due to the fact that for these scales the length of the time interval becomes comparable with the period. It agrees with the calculated increase from galvanometer theory.[5]

In making a series of measurements, the condition of the main batteries can be checked by the internal means provided. The ballistic constant of the meter can then be checked by the condenser discharge method also provided. After the tube filaments are energized and the range is selected, the galvanometer current can be adjusted to the correct value in steady-state. When these three points have been checked, full assurance can be had of the accuracy of the results obtained.

The principle used in the device in combination with the operation of the circuit results in high speed in making measurements. Furthermore, for the same two reasons, both tube life and battery life are extremely long. During the two years of use of the developmental model of the Chronoscope it has proved to be an accurate, reliable and convenient instrument.

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(3.) Barry, T. M., A Photo Electric Time —Interval Meter, *General Electric Review*, March 1940. Vol. 43 #3.

(4.) Starling, S. G., "Electricity and Magnetism," page 253.

(5.) Wenner, F., The Effect of the time of passage of *Q* on the Throw of a Ballistic Galvanometer," *Physical Review*, Aug. 1907, Vol. 25, 139.

• • •

FM IN PRODUCTION

A group of quantity production f-m transmitters and receivers. They are portable-mobile, crystal controlled, and of the phase-shift type. 200 of these units are being manufactured for the Chicago police

But that was in 1917—

Today's Electronic-Equipped Air Forces Are On 24 Hour Duty

● Total war accepts no compromise with time and weather. Total preparedness must be created on the same basis. With the air forces of the Army and Navy this means men and equipment prepared for continent and hemisphere defense at any hour of the day or night, and in every possible weather condition.

Our air forces are getting that training and receiving that equipment. No air force in the world, aggressor or defender, is being as well equipped with trained personnel or with as efficient air and ground material.

We believe that no other single industry has contributed more to this efficiency than the developments of the electronic industry. Given strong, fast aircraft our air defense would still be a daytime, good-weather force without the electronic devices in use on airplanes and by their land or sea-going bases.

Radio, the invisible lifeline of communication, makes the air services always flexible striking or defending units of the services, working in contact and harmony with the land and sea forces. Many other uses of radio and electronic devices are government secrets—but direction finding, homing devices, sound detectors, electronic gun and bomb mechanisms, electrical instruments of every type, traffic control, field and carrier lighting equipment, these are some of the electronic industry's contributions to the effective defense of our Nation.

During the current program for adequate National Preparedness the electronic industry, in cooperation with the aircraft manufacturers, the Army Air Corps, and with the Navy's Bureau of Aeronautics, will continue to provide the world's finest electronic devices for our air defense, and will continue the research that will keep future materials equally superior.

Fortunately, the electronic industry is already equipped to meet any demands of the Preparedness Program.

An Institutional Message from ELECTRONICS, the Authoritative Voice of the Electronic and Allied Industries.

THE ELECTRONIC INDUSTRY IS A VITAL ELEMENT IN NATIONAL DEFENSE

TUBES

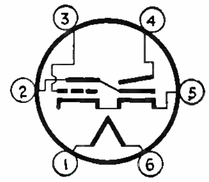
Tubes registered with the R.M.A. Data Bureau during the month of August, 1940 and during 1934, 1935 and 1936

Type 2E5

Prototype 6E5

TUNING indicator, heater type, ST-12 glass envelope, seated height 3 9/16 inches, 6-pin base.

E_h = 2.5v
I_h = 0.8 amp
E_b = 250 v (max) through 1 megohm
I_b = 0.24 ma
I_{target} = 4 ma (approx)
E_c(shadow angle = 90°) = 0 v
Basing 6R



Tube Registry

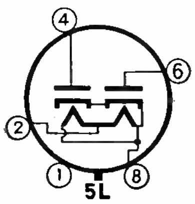
Tube Types Registered by R.M.A. Data Bureau During September, 1940

Type 5Z4GT (G)

Prototype 5Z4

FULL wave rectifier; heater type; T-9 glass envelope; seated height 2 3/4 inches; 5-pin octal base.

E_f = 5.0 v
I_f = 2.0 amps
Tube Voltage Drop at 125 ma per plate = 20 v
CONDENSER INPUT TO FILTER
E_{ac} (per plate, rms) = 350 v (max)
I_{dc} = 125 ma (max)
CHOKE INPUT TO FILTER
E_{ac} (per plate, rms) = 500 volts (max)
I_{dc} = 125 ma (max)
Basing 5L-O-O

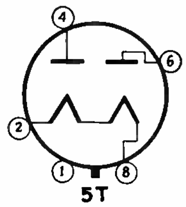


Type 5Y3

Prototype 80

FULL-WAVE high vacuum rectifier, filament type, ST-14 glass envelope, seated height 4 1/16 inches, 5-pin octal base.

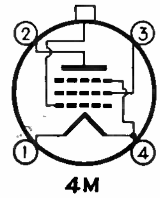
E_f = 5.0 v
I_f = 2.0 amp
CONDENSER INPVT TO FILTER
E_{ac} (per plate, rms) = 350 v (max)
I_{dc} = 125 ma (max)
CONDENSER INPUT TO FILTER
E_{ac} (per plate, rms) = 500 v (max)
I_{dc} = 125 ma (max)
E_{drop} (I_{dc} = 125 ma per plate) = 60 v
Basing 5T



Type 1A4 (P)

SUPER-CONTROL r-f amplifier, medium cutoff, filament type, ST-12 glass envelope, seated height 3 22/32 inches, 4-pin base.

E_f = 2.0 v
I_f = 0.06 amp
E_b = 180 v
E_{c2} = 67.5 v
E_c = 3 v
I_b = 2.3 ma
I_{c2} = 0.8 ma
r_p = 1 megohm
g_m = 725 μmhos
Basing 4M

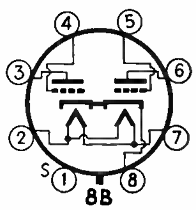


Type 6N7GT (G)

Prototype 6N7

TWIN triode; heater type; T-9 glass envelope; seated height 2 3/4 inches; 8-pin intermediate shell octal base.

E_f = 6.3 v
I_f = 0.8 amp
TRIODES IN PARALLEL
E_b = 294 v
E_c = −6 v
I_b = 7 ma
μ = 35
r_p = 11,000 ohms
g_m = 3200 ohms
Basing 8B-O-O

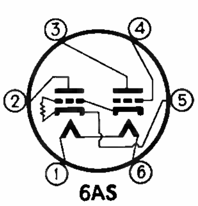


Tube Types Registered By R.M.A. Data Bureau in 1934, 1935 and 1936

Type 6B5

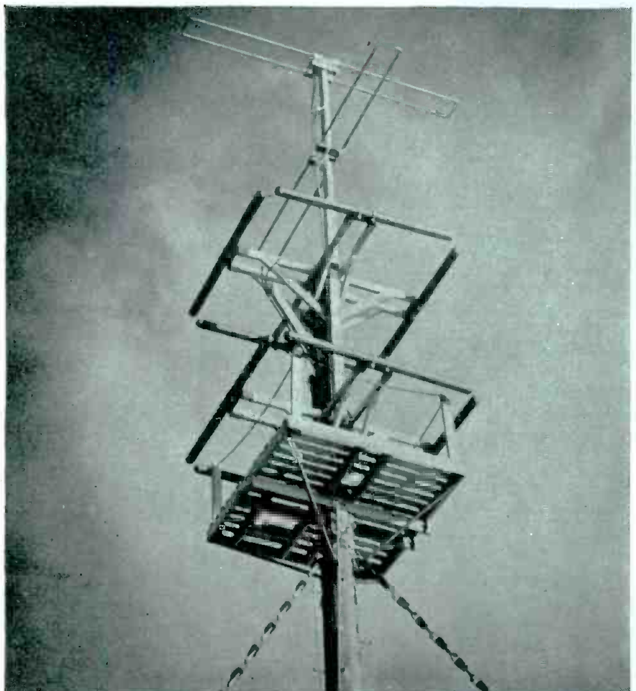
DIRECT-COUPLED power amplifier, heater type, ST-14 glass envelope, seated height 4 1/16 inches, 6-pin base.

E_h = 6.3 v
I_h = 0.8 amp
E_b (output) = 300 v (max)
E_b (input) = 300 v (max)
E_c (input) = 0 v
I_b (output) = 42 ma
I_b (input) = 9 ma
R_l = 7000 ohms
P_o = 4 watts (5%)
Basing 6AS



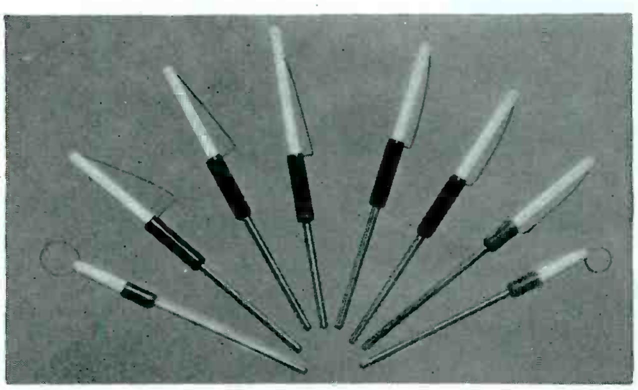
FLYING BOAT TESTED FOR EUROPEAN SERVICE

The radio room of a flying boat intended for European service undergoing tests at Floyd Bennett Airport. T. S. Terrill, first officer (right) hands Ralph Carlson, radio operator, a message to be sent



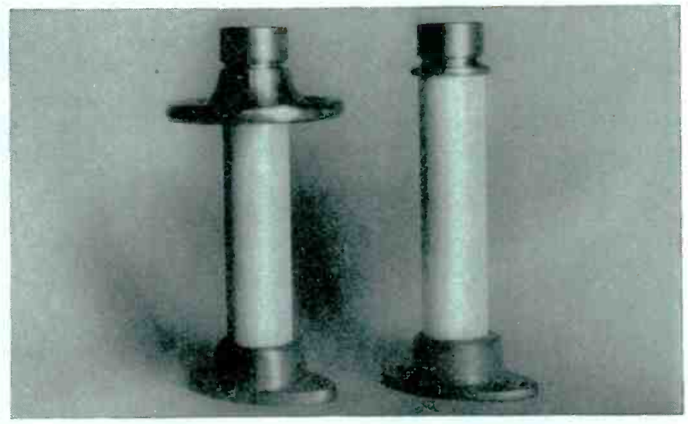
General Electric Co. Photo

▲ THIS NEW G-E DUAL-PURPOSE ANTENNA for television and FM transmission in a single compact unit symbolizes the service of Isolantite to the two newest branches of the radio industry. Isolantite engineering in insulator design has played an important role in anticipating the special requirements of these new developments.



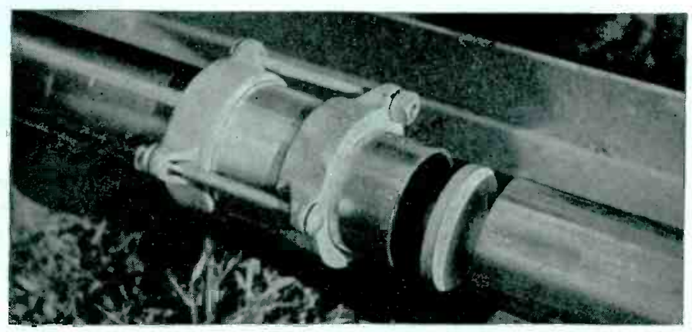
▲ UNUSUAL UTILITY of Isolantite* extends into virtually all fields of electronics. The insulators illustrated here were specially designed for the requirements of these electrotherapeutic instruments.

▼ STRAIN INSULATORS are streamlined for airplane service — another instance of Isolantite's leadership in insulator design. Isolantite's high strength is a double advantage in aircraft service: it gives mechanical protection against shocks and stresses, permits the use of small, weight-saving sections.



▲ NEW CORONA SHIELD on Isolantite stand-off insulators represents a still further improvement over previous designs. Shield is of spun aluminum. Insulators are engineered to relieve electrical stresses at top — point where stress is ordinarily at a maximum.

INSULATION HIGHLIGHTS



▲ SOLDERLESS GAS-TIGHT JOINTS for coaxial transmission lines manufactured by Isolantite, Inc., are accomplished by the patented Raybould coupling. A gas-tight seal is effected simply by tightening nut. End seals, junction boxes and many other special fittings employing this patented device are available for radio purposes exclusively from Isolantite, Inc. (Isolantite coaxial transmission lines are sold nationally through Graybar Electric Co.)

**Registered trade-name for the products of Isolantite, Inc.*

ISOLANTITE

CERAMIC INSULATORS

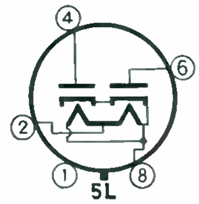
ISOLANTITE, INC. FACTORY: BELLEVILLE, NEW JERSEY

SALES OFFICES: 233 BROADWAY, NEW YORK, N. Y.

Type 5Z4

FULL-WAVE high vacuum rectifier, heater type, metal envelope, seated height $2\frac{11}{16}$ inches, 5-pin octal base.

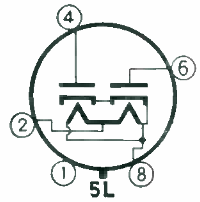
E_h = 5.0 v
I_h = 2.0 amps
CONDENSER INPUT TO FILTER
E_{ac} (per plate, rms) = 350 v (max)
I_{dc} = 125 ma (max)
CHOKE INPUT TO FILTER
E_{ac} (per plate, rms) = 500 v (max)
I_{dc} = 125 ma (max)
E_{drop} (I_{dc} = 125 ma per plate) = 20 v
Basing 5L



5Z4 (G)

FULL-WAVE high-vacuum rectifier, filament type, ST-14 glass envelope, seated height $4\frac{1}{16}$ inches, 5-pin octal base.

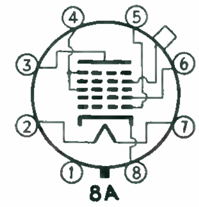
E_f = 5.0 v
I_f = 2.0 amps
CONDENSER INPUT TO FILTER
E_{ac} (per plate, rms) = 350 v (max)
I_{dc} = 125 ma (max)
CHOKE INPUT TO FILTER
E_{ac} (per plate, rms) = 500 v (max)
I_{dc} = 125 ma (max)
E_{drop} (I_{dc} = 125 ma per plate) = 20 v
Basing 5L



Type 6A8

PENTAGRID converter, heater type, metal shell, seated height $2\frac{9}{16}$ inches, 8-pin octal base.

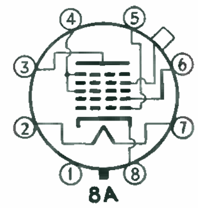
E_h = 6.3 v
I_h = 0.3 amp
E_b = 250 v
$EC_{3,5}$ = 100 v
E_{c2} = 250 v through 20.000 ohms
E_{c4} = − 3 v
I_b = 3.5 ma
$I_{c3,5}$ = 2.7 ma
I_{c2} = 4.0 ma
g_c = 550 μmhos
Basing 8A



Type 6A8 (G)

PENTAGRID converter, heater type, ST-12 glass envelope, seated height $3\frac{29}{32}$ inches, 8-pin octal base.

E_h = 6.3 v
I_h = 0.3 amp
E_b = 250 v
$E_{c3,5}$ = 100 v
E_{c2} = 250 v through 20,000 ohms
E_{c4} = −3 v
I_b = 3.5 ma
$E_{c3,5}$ = 2.7 ma
I_{c2} = 4.0 ma
g_c = 550 μmhos
Basing 8A



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This valuable combination of characteristics explains why Bakelite Low-Loss Phenolic continues to be so widely used, for instance, in the manufacture of capacitor casings of every type and size, such as those illustrated, made by Cornell-Dubilier Electric Corporation.

Low-cost fabrication with this unique molding material contributes not only to improved performance of the capacitors, but also to their attractive appearance. Light weight and compactness, are other advantages—especially important in aircraft and portable equipment.

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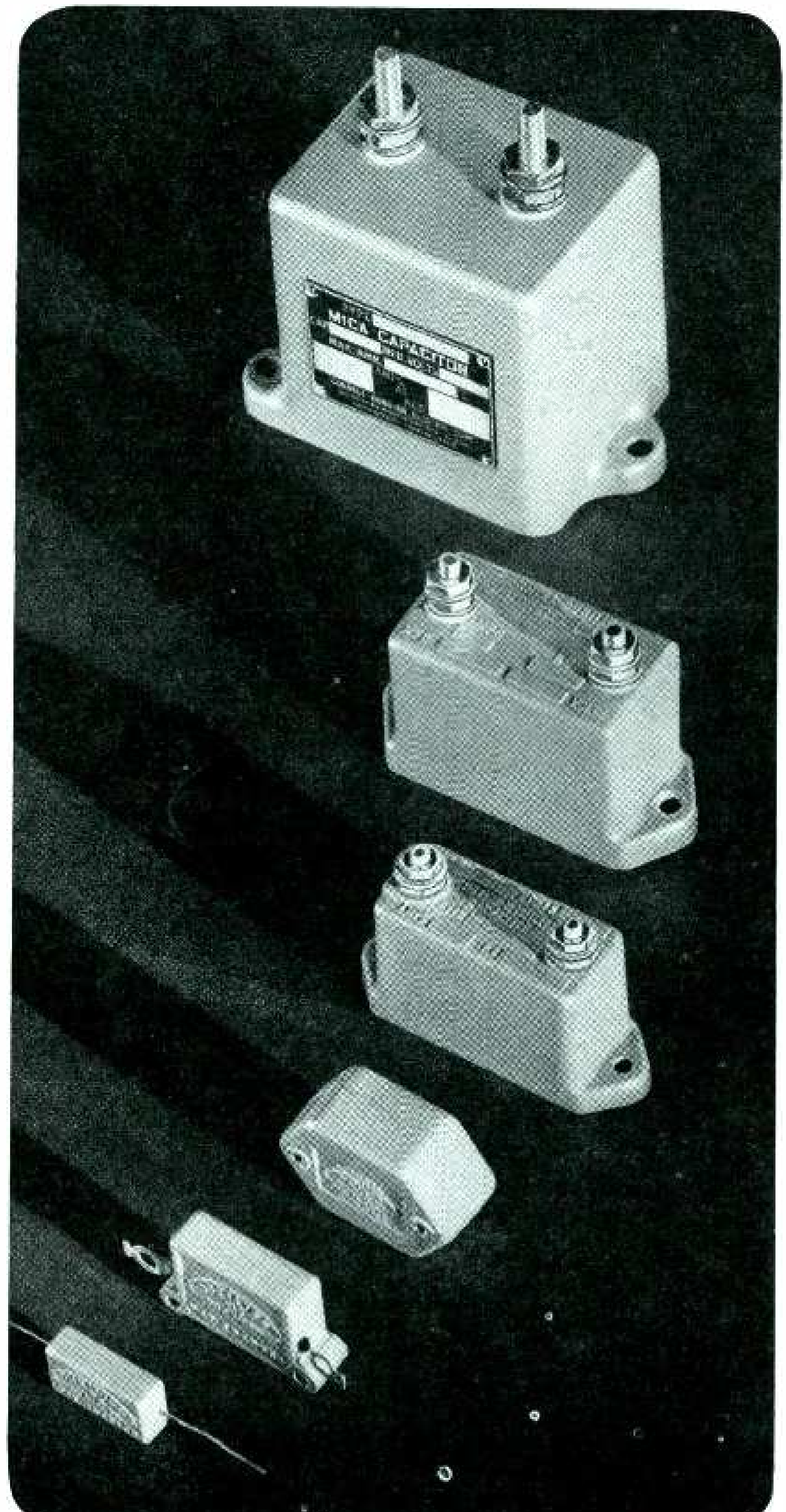
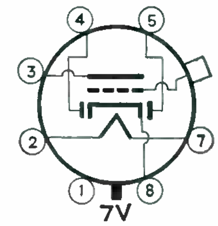
PLASTICS HEADQUARTERS



Type 6R7 (G)

DOUBLE diode, medium mu triode, heater type, ST-12 glass envelope, seated height $3\frac{22}{32}$ inches, 7-pin octal base.

E_h = 6.3 v
I_h = 0.3 amp
E_b = 250 v
E_c = −9 v
I_b = 9.5 ma
r_p = 8500 ohms
μ = 16
Basing 7V

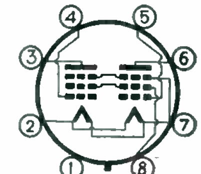


7V

Type 1E7 (G)

TWIN pentode power amplifier, filament type, ST-12 glass envelope, seated height $3\frac{9}{16}$ inches, 8-pin octal base.

EACH PENTODE
E_f = 2.0 v
I_f = 0.24 amp
E_b = 135 v
E_{c2} = 135 v
E_c = −4.5 v
I_b = (zero signal) = 7.5 ma
I_{c2} = (zero signal) = 2.2 ma
R_l = 16,000 ohms
P_o = 0.290 watts (4.5 %)
Basing 8C

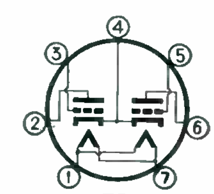


8C

Type 6A6

CLASS B twin triode amplifier, heater type, ST-14 glass envelope, seated height $4\frac{1}{16}$ inches, 7-pin base.

E_h = 6.3 v
I_h = 0.8 amp
TRIODES CONNECTED IN PARALLEL
E_b = 250 v
E_c = − 5 v
I_b = 6 ma
r_p = 11,300 ohms
μ = 35
Basing 7B

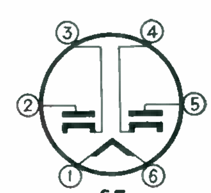


7B

Type 25Y5

HIGH-VACUUM rectifier and voltage doubler, heater type, ST-12 glass envelope, seated height $3\frac{9}{16}$ inches, 6-pin base.

E_h = 25.0 v
I_h = 0.3 amp
HALF-WAVE RECTIFIER
E_{ac} (per plate, rms) = 235 v (max)
I_{dc} (per plate) = 75 ma (max)
Basing 6E

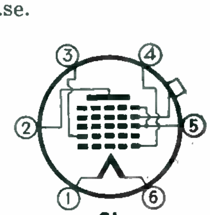


6E

Type 1C6

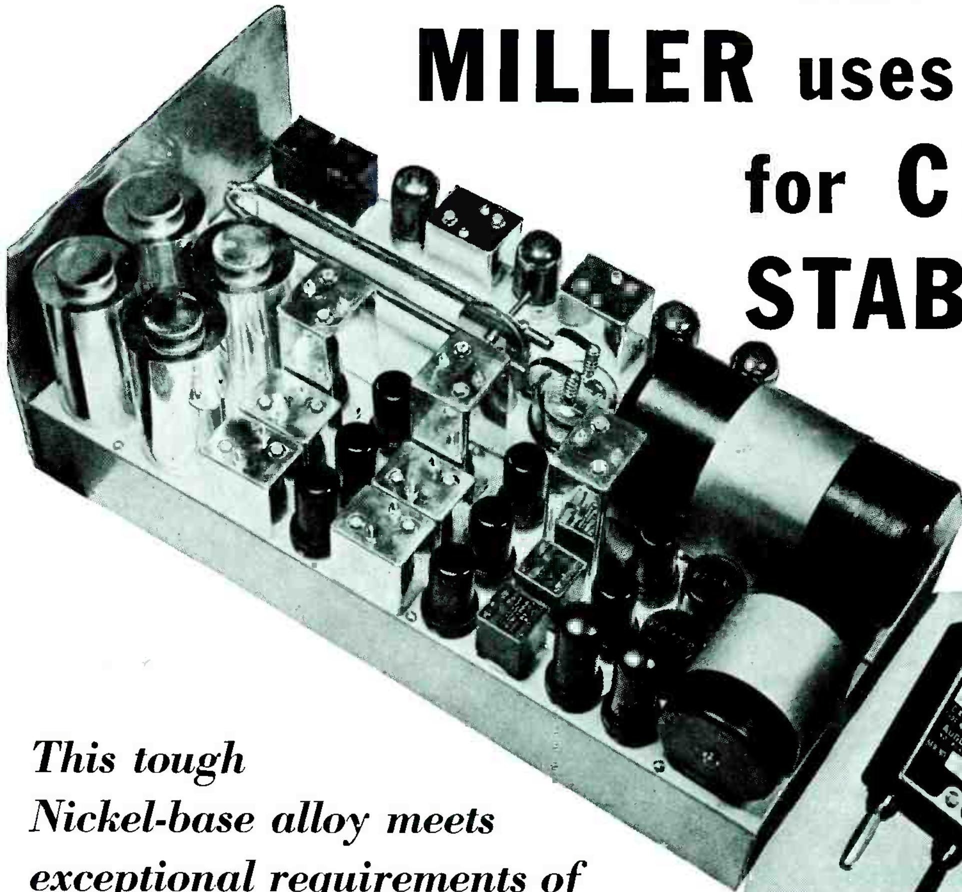
PENTAGRID converter, filament type, ST-12 glass envelope, seated height $3\frac{29}{32}$ inches, 6-pin base.

E_f = 2.0 v
I_f = 0.12 amp
E_b = 180 v
$E_{c3,5}$ = 67.5 v
E_{c2} = 180 through 20,000 ohms
E_{c4} = − 3 v
I_b = 1.5 ma
$I_{c3,5}$ = 2.0 ma
I_{c2} = 4.0 ma
g_c = 325 μmhos
Basing 6L

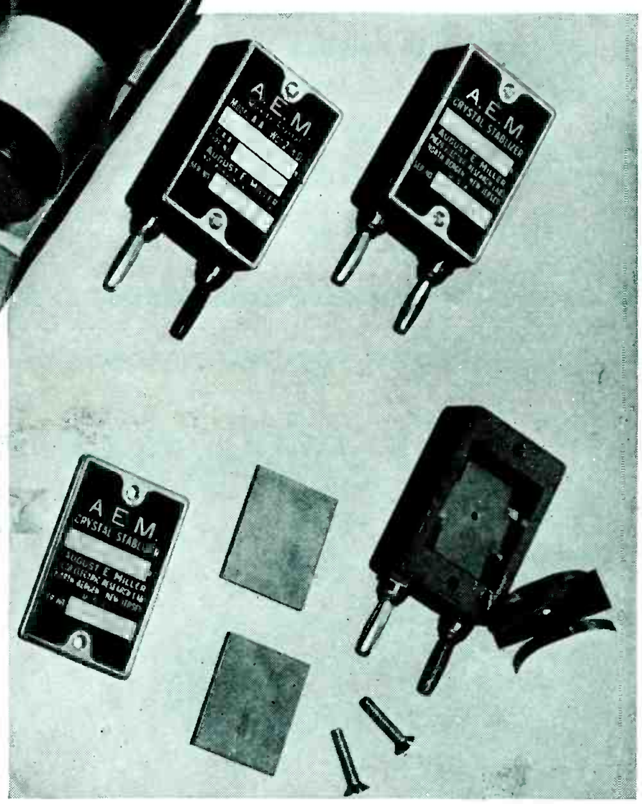


6L

WHY MILLER uses MONEL for CRYSTAL STABILIZERS



(Below) Monel plates, springs and screws as used in crystal stabilizers made by August E. Miller Co., 1922 Bergenwood Rd., North Bergen, N. J. At left is shown transmitter with stabilizers inserted on chassis.



This tough Nickel-base alloy meets exceptional requirements of both fabrication and operation

In big demand for amateur, commercial, police, aircraft and marine transmitters are crystal stabilizers made by August E. Miller Co. of North Bergen, N. J. Contributing to the excellent and reliable performance of these units are springs and electrodes of strong, rustless Monel.

Why do Miller crystal stabilizers give better service than others? According to Mr. Miller there are four reasons:

1. ***Danger of loose contacts*** due to vibration is eliminated ...because use of Monel assures strong solder connections.

2. ***Clips have good spring properties*** and are highly resistant to fatigue...being made from spring temper Monel strip.

3. ***Electrodes ground to close tolerance*** resist corrosion and pitting, because made of Monel. Maintenance of even thickness assures uniform results.

4. ***Location of set is no obstacle***...because even in damp and salt-laden atmospheres Monel parts stand up against corrosion.

Incidentally, Monel has proved so satisfactory in this application that all screws in Miller units are made of Monel.

How leading makers of electronic and electrical equipment are profiting by use of Nickel-base alloys is described in the booklet "Tremendous Trifles." Write for a copy today. Address:

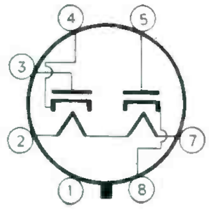
THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York, N. Y.

"Monel" is a registered trade-mark of The International Nickel Company, Inc., which is applied to a nickel alloy containing approximately two-thirds nickel and one-third copper.

Type 6H6

TWIN diode, heater type, metal envelope, seated height 1 3/16 inches, 7-pin octal base.

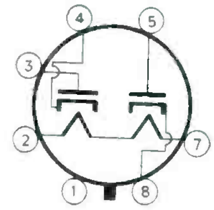
E_h = 6.3 v
I_h = 0.3 amp
E_{ac} (per plate, rms) = 117 v (max)
I_{dc} = 4 ma (max)
Basing 7Q



Type 6H6 (G)

TWIN diode, heater type, ST-12 glass envelope, seated height 3 9/16 inches, 7-pin octal base.

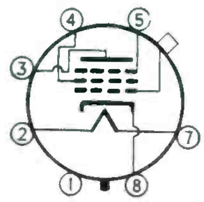
E_h = 6.3 v
I_h = 0.3 amp
E_{ac} (per plate, rms) = 117 v (max)
I_{dc} = 4 ma (max)
Basing 7Q



Type 6J7

TRIPLE-GRID detector amplifier, sharp cutoff, heater type, metal envelope, seated height 2 9/16 inches, 7-pin octal base.

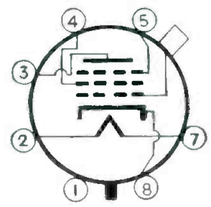
E_h = 6.3 v
I_h = 0.3 amp
E_b = 250 v
E_{c2} = 100 v
E_c = −3 v
I_b = 2.0 ma
I_{c2} = 0.5 ma
r_p = greater than 1 megohm
g_m = 1225 μmhos
Basing 7R



Type 6J7 (G)

TRIPLE-GRID detector amplifier, sharp cutoff, heater type, ST-12 glass envelope, seated height 3 23/32 inches, 7-pin octal base.

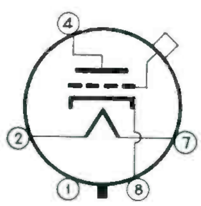
E_h = 6.3 v
I_h = 0.3 amp
E_b = 250 v
E_{c2} = 100 v
E_c = −3 v
I_b = 2.0 ma
I_{c2} = 0.5 ma
r_p = greater than 1 megohm
g_m = 1225 μmhos
Basing 7R

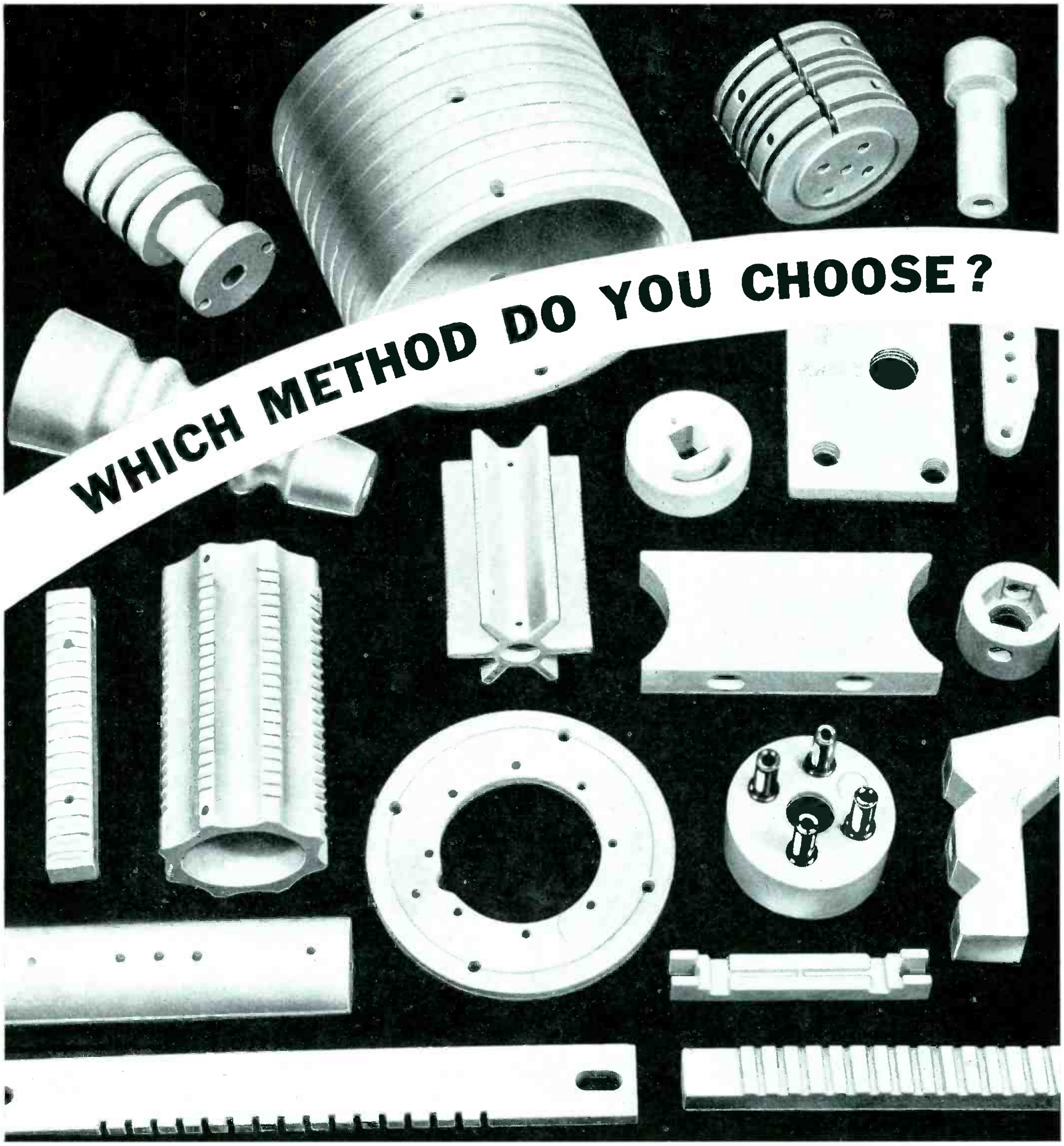


Type 6F5

HIGH-MU triode, heater type, metal envelope, seated height 2 9/16 inches, 5-pin octal base.

E_h = 6.3 v
I_h = 0.3 amp
E_b = 250 v
E_c = −2 v
I_b = 0.9 ma
μ = 100
g_m = 1500 μmhos
Basing 5M





Some engineers try to make their designs fit "standard" insulators. Most engineers have found better results at lower costs in AlSiMag steatite ceramic insulators built to their design. Do you want the facts about AlSiMag Custom-Built insulators for your product? Your letter will have careful attention.

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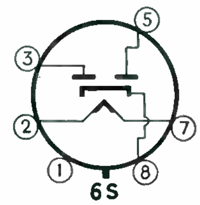
Type 6X5

FULL-WAVE high-vacuum rectifier, heater type, metal shell, seated height $2\frac{11}{16}$ inches, 6-pin octal base.

E_h = 6.3 v
I_h = 0.6 amp
CONDENSER INPUT TO FILTER
E_{ac}(per plate, rms) = 325 v (max)
I_{dc} = 70 ma (max)
CHOKE INPUT TO FILTER
E_{ac}(per plate, rms) = 450 v (max)
I_{dc} = 70 ma (max)

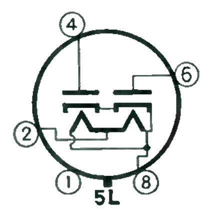
E_{drop}(I_{dc} = 70 ma per plate) = 22 v
Basing 6S



Type 5V4 (G)

FULL-WAVE, high-vacuum rectifier, heater type, ST-14 glass envelope, seated height $4\frac{1}{16}$ inches, 5-pin octal base.

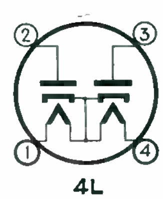
E_h = 5.0 v
I_h = 2.0 amps
CONDENSER INPUT TO FILTER
E_{ac}(per plate, rms) = 375 v (max)
I_{dc} = 175 ma (max)
CHOKE INPUT TO FILTER
E_{ac}(per plate, rms) = 500 v (max)
I_{dc} = 175 (max)
E_{drop}(I_{dc} = 175 ma per plate) = 23 v
Basing 5L



Type 83-V

FULL-WAVE high vacuum rectifier, heater type, ST-14 glass envelope, seated height $4\frac{1}{16}$ inches, 4-pin base.

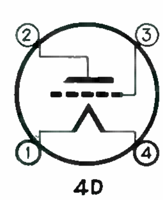
E_h = 5.0 v
I_h = 2.0 amps
CONDENSER INPUT TO FILTER
E_{ac} (per plate, ms) = 375 v (max)
I_{dc} = 175 ma (max)
CHOKE INPUT TO FILTER
E_{ac} (per plate, rms) = 500 v (max)
I_{dc} = 175 ma (max)
E_{drop} (I_{dc} = 175 ma per plate) = 23 v
Basing 4L



Type 6A3

POWER amplifier triode, filament type, ST-16 glass envelope, seated height $4\frac{3}{8}$ inches, 4-pin base.

E_f = 6.3 v
I_f = 1.0 amp
E_b = 250 v (max)
E_c = −45 v
I_b = 60 ma
r_p = 800 ohms
μ = 4.2
R_l = 2500 ohms
Basing 4D

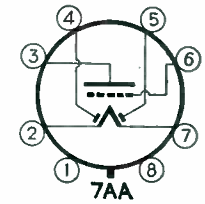


Type 1H6 (G)

Prototype 1B5/25S

DOUBLE diode triode, filament type, ST-12 glass envelope, seated height $3\frac{3}{32}$ inches, 8-pin octal base.

E_f = 2.0 v
I_f = 0.06 amp
E_b = 135 v (max)
E_c = −3 v
I_b = 0.8 ma
μ = 20
g_m = 575 μmhos
Basing 7AA

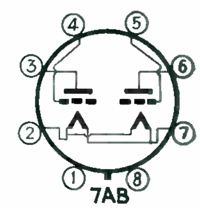


Type 1J6 (G)

Prototype 19

CLASS B twin triode amplifier, filament type, ST-12 glass envelope, seated height $3\frac{3}{32}$ inches, 8-pin octal base.

E_f = 2.0 v
I_f = 0.24 amp
E_b = 135 v
E_c = 0 v
I_b(zero signal, per plate) = 5.0 ma
R_l(plate to plate) = 10,000 ohms
P_o = 2.1 watts
Basing 7AB



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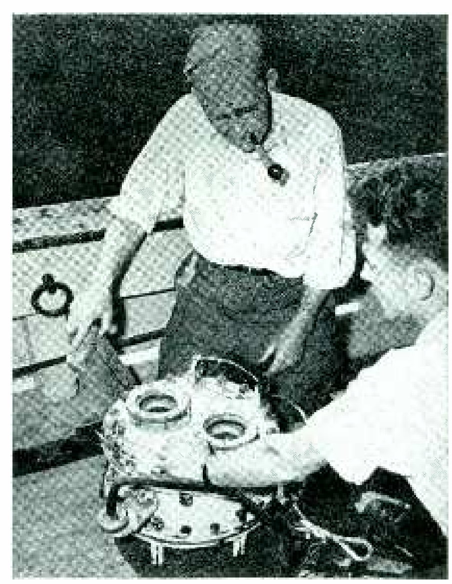
PHOTOTUBES AID IN CAMOUFLAGE



Prof. C. L. Utterbach of the University of Washington has announced a new method of submarine camouflage. The instrument shown, a waterproof chamber containing two phototubes covered by rotating discs which in turn embody multi-colored light filters, was used in perfecting the new camouflage. The device is lowered into the sea and light rays refracted from different colored objects are recorded on a surface craft

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"MINI-MAX"

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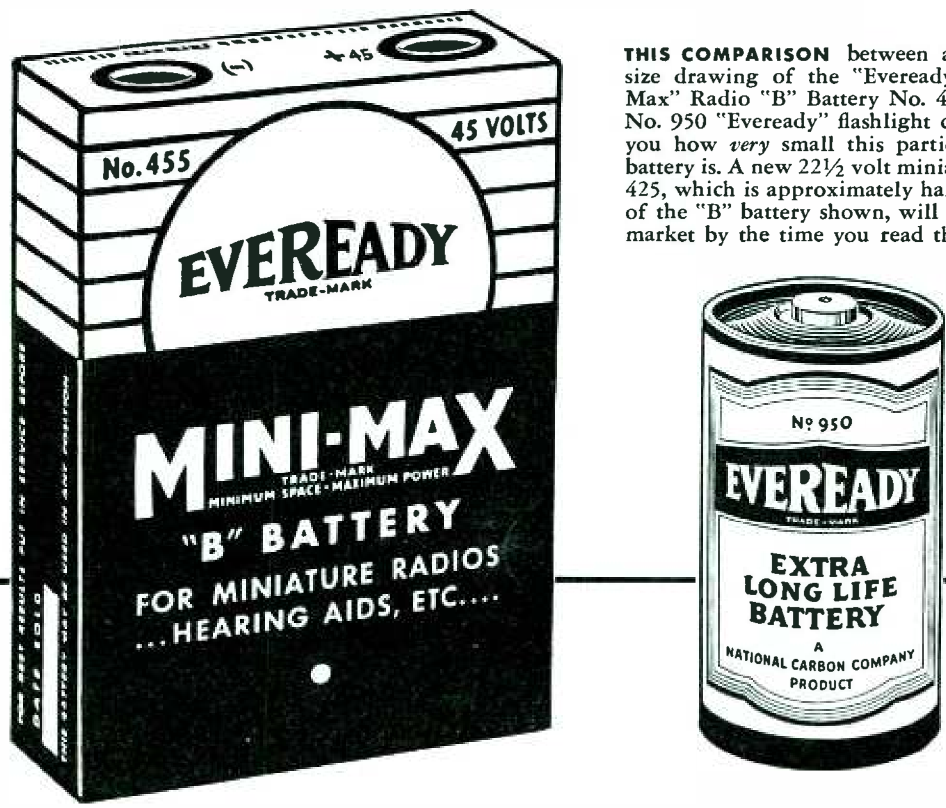
To give you a lot of power in little space!



THIS COMPARISON between an actual-size drawing of the "Eveready" "Mini-Max" Radio "B" Battery No. 455, and a No. 950 "Eveready" flashlight cell shows you how *very* small this particular "B" battery is. A new 22½ volt miniature, No. 425, which is approximately half the size of the "B" battery shown, will be on the market by the time you read this.

When you are designing special equipment for specialized purposes, you will find reason for enthusiasm in these miniature "Eveready" "Mini-Max" Radio "B" Batteries. These batteries permit great reduction in size and weight—as much as 50% in size—as much as 30% in weight—without sacrifice of power.

Designed to operate over a range of drains up to 9 milliamperes, these miniatures will last as long as ordinary batteries twice their size. They are the only batteries that pack so much power in so little space. Try them ... in your research ... and in new design.

CHOOSE FROM THESE MINIATURES

Miniature "Eveready" "Mini-Max" "B" Battery No. 467. 67½ volts. Height, 3⅝"; width, 2 11/16"; thickness, 1 5/16"; weight, 10½ oz.

Miniature "Eveready" "Mini-Max" "B" Battery No. 455. 45 volts. Height, 3⅝"; width, 2⅝"; thickness, 29/32"; weight, 7 oz.

Just Introduced! Miniature "Eveready" "Mini-Max" "B" Battery No. 425. 22½ volts. Height, width and weight approximately ½ that of No. 455 Battery.

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UCC

THE ELECTRON ART

Several papers on television, a square-law vacuum-tube voltmeter, compulsory patent licensing, transformer design, and crystal filters are reviewed this month in the technical literature

Television

FOUR PAPERS DESCRIBING the various aspects of television are included in the September 1940 issue of the *Journal of the Society of Motion Picture Engineers*. They are: "Television Pick-Up of the Pasadena Rose Tournament Parade," by H. R. Lubcke; "Quality in Television Pictures," by P. C. Goldmark and J. N. Dyer; "A New Method of Synchronization for Television Systems," by T. T. Goldsmith, Jr., R. L. Campbell and S. W. Stanton, and "Remote Control Television Lighting," by W. C. Eddy. All four were presented at the 1940 spring meeting of the Society at Atlantic City.

Mr. Lubcke's paper describes the equipment used in the pick-up of a parade in Pasadena and its transmission to the Don Lee Building in downtown Los Angeles. The suitcase type portable television equipment and a 324 Mc beam transmitter were used. The transmission distance was nine miles and the line of sight was interrupted by two hills and buildings. Much effort was therefore directed toward erecting high and efficient antennas at both the transmitter and receiver. It was found that diathermy machines caused interference on frequencies as high as 324 Mc. Even though rain fell during the parade and the morning was darkly overcast, reception as far away as fifteen miles from the main transmitter was considered quite good.

Messrs. Goldmark and Dyer discuss in their paper the various factors which determine the quality of a television picture. They are: Definition, contrast range, gradation, brilliance, flicker, geometric distortion, size, color and noise. An artificial television scanner is described by means of which a photograph can be scanned to obtain a picture which is free from distortion other than that introduced by the scanning. These pictures indicate that television pictures as received today must be considerably improved before the capabilities of the present 441-line standard are fully utilized.

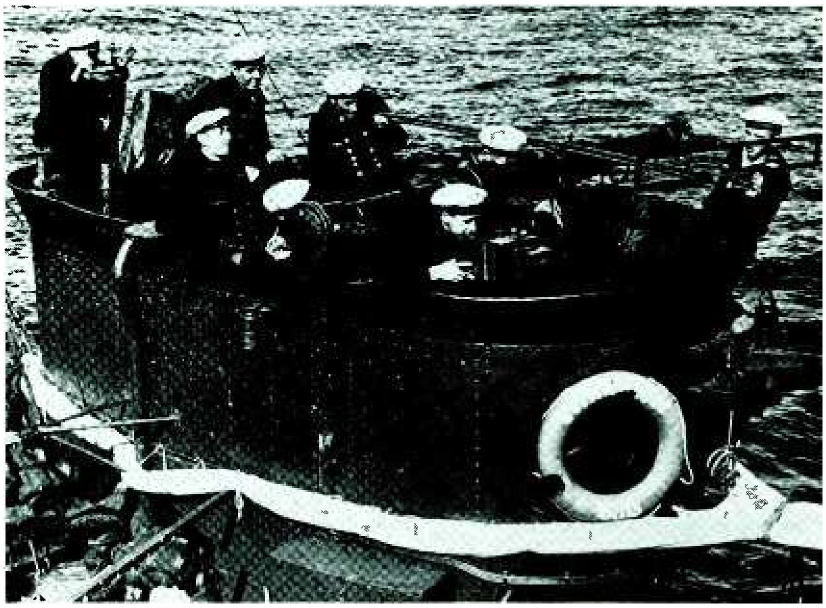
An automatic method of synchronizing television systems is described by Messrs. Goldsmith, Campbell and Stanton. The purpose of such automatic synchronization is to provide a means by which television pictures can be transmitted using various numbers of scanning lines. The advantages of such a system of automatic synchronization are: (1) ease of generation at the transmitter; (2) ease of separation at the receiver and (3) automatically synchronized receivers permitting reception from high definition stations as well as low definition stations without the necessity of servicing, and permitting improvements in vertical definition as the art advances without necessitating replacement or modification of receiving equipment.

Mr. Eddy describes in his paper the remote control lighting system which is now in use in the television studios of N.B.C. in New York. A series of overhead units using inside-silvered incandescent lamps are the basic units of the system. They can be controlled in rotation, tilt and elevation by control cords, from a single point. The flexibility of the system is such that the lighting engineer can rearrange the lighting completely without interrupting the program in progress. The weight of the system runs about the order of 13 lbs. per kw. Illumination levels as high as 2,400 foot-candles can be provided on an average set, but due to improvements in both cameras and circuits it is seldom necessary to exceed 800 foot-candles in foundation light.

Square Law Vacuum-Tube Voltmeter

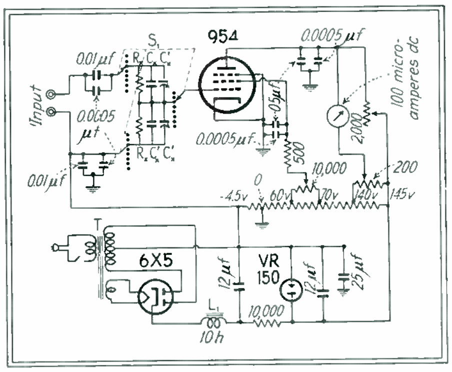
A VACUUM-TUBE VOLTMETER using the type 954 acorn pentode for use in the measurement of the r-m-s value of alternating voltages is described in the October 1940 issue of the *Review of Scientific Instruments* by J. R. Ragazzini and B. R. Boymel. In the design of this instrument the following requirements were satisfied: (1) A square-law response over a wide range; (2) a range of 0.25 to 25 volts; (3) a calibration substantially independent of frequency; (4) no turnover error since fluctuation voltages are usually unsymmetrical; (5) a high input impedance whose value is constant regardless of the range used, and (6) operation to be from power lines and the calibration to be independent of normal line voltage fluctuations. It was found necessary to restrict the plate current swing to a limited region of the characteristic curve to insure a

GERMANS USE RADIO CONTROLLED TORPEDOES



Conning tower of one of the five remote control mother ships which have operated in the English channel and in the North Sea to harass British shipping. The "Fernleitboot" (remote guide boat) has a displacement of about 800 tons and contains a radio transmitter capable of operating on several frequnecies by which it controls the operation of radio controlled torpedoes. Each mother ship has room for forty-nine guided torpedoes square-law response over all ranges of the meter. It was necessary to use an attenuator in the input of the voltmeter because of the wide range of voltages to be measured so as to use the same portion of the tube characteristic for all voltages.

The diagram shows the circuit of the voltmeter together with its power supply. The attenuator has a total



Circuit diagram of the square-law vacuum tube voltmeter including the power supply

input resistance of one megohm and the resistance voltage divider is supplemented by a capacity divider to insure correct values at high frequencies. The condensers used are silver mica padded with air trimmers to insure permanence of setting. A VR-150 tube is used in the power supply to overcome the effects of line voltage variations. A balancing-out circuit is used to remove the steady component of the plate current from the meter and cause it to read only increments resulting from the application of the signal. The response of this instrument is made to fit a pre-marked square-law scale on the microammeter by the simultaneous adjustment of the screen voltage and the microammeter shunt.

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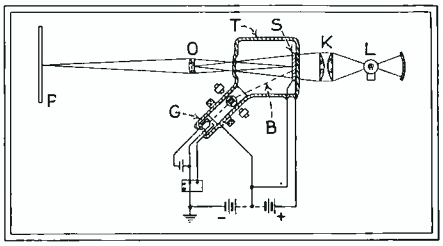
Projection Television Making Use of the Variable Opacity Crystals

A MEANS OF OBTAINING LARGE-SIZE TELEVISION pictures, making use of a property of certain crystals in which the opacity is varied by the passage of electrons through it, is described by A. H. Rosenthal in the May 1940, issue of the *Proceedings of the I.R.E.* If an alkali halide crystal, which is subjected to an electric field, is struck by a beam of electrons, the electrons tend to travel through the crystal lattice, composed of alternate positive alkali ions and negative halogen ions, toward the anode of the electric field. During its passage through the alternate layers of positive and negative ions, an electron may be captured by a positive alkali ion. This seems to happen at points in a crystal with some defect. The positive ion, plus the electron, forms a loosely-bound alkali atom which absorbs part of the visible spectrum and becomes less transparent.

Then, due to the thermal oscillations of the lattice, the loosely-bound atom splits up again into an alkali ion and an electron and the electron proceeds through the lattice toward the anode until it is captured again by another alkali ion somewhat nearer to the anode and goes through the process once more. When the electron reaches the anode it passes into it and disappears. The velocity of migration of the electron is proportional to the field strength and increases with the temperature of the crystals.

Use is made of this phenomenon in television in the following manner. The crystal is cut into a thin sheet of suit-



Television projection unit making use of a crystal of variable density and a conventional optical system

able dimensions and mounted inside a picture tube which is similar in construction to the iconoscope. The name Skiatron has been applied to the new tube. The crystal is mounted in the same position as the mosaic in the iconoscope and the electron gun is located in a side arm as shown in the diagram. The electron stream scans the crystal in the conventional manner. The necessary electric field is maintained across the crystal by means of very thin deposits of metal on each side of it. If desired, the crystal can be heated and maintained at any desired temperature. As the electrons impinge upon a surface element of the crystal, electrons are injected into it to form an opaque color deposit whose density depends upon the instantaneous intensity of the electron beam. As the beam leaves this area the opacity persists, moving slowly through the crystal to the anode where it disappears. The image persists long enough for a complete picture to be formed and the tube can be designed so that the time of persistence is such that image will disappear just as the electron beam returns to the same surface element. This permits a complete picture to be formed similar to a lantern slide and which can be projected by means of a conventional optical system as shown in the diagram.

Up to this time only crude experiments have been performed using this type of apparatus. However, the method gives sufficient promise so that the author suggests that a television projector making use of this type of tube can be placed in the projection room of a motion picture theater and pictures of a size comparable to present day motion pictures can be projected.

Compulsory Patent Licensing

"What Would Compulsory Patent Licensing Mean to You?" by H. V. Nye and H. S. Silver, is a discussion of the relative advantages and disadvantages of a compulsory patent licensing system appearing in the September 1940 issue of the *Allis-Chalmers Electrical Review*. As a basis for discussion, it is assumed that any compulsory license law would include the following provisions: (1) A non-exclusive license to be granted under any patent, independently of the desire of the patent owner to an applicant meeting the requirements laid down by law; (2) a provision for determination of a reasonable royalty rate to be paid the patent owner for the use of the invention; (3) a provision insuring adequate financial responsibility on the part of the proposed licensee.

Among the advantages of compulsory licensing are: 1. The right to make use of any valuable patented invention would be insured to the public independently of the whim of a patent owner. Inventions of great benefit to the public could not be withheld from use for reasons other than those of public welfare. 2. An adequate supply of a patented article would be assured. 3. The situation will be avoided in which it is impossible to make use of a patent because of prior patents owned by someone else. Many cases have arisen in which the merits of an invention have been lost to the

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POLICE USE PORTABLE RADIOS

All policemen in Atlantic City are carrying portable receivers so that they may be instantly called from headquarters. The motorcycle man shown here carries the receiver on his belt, a headphone on one ear and the antenna over his shoulder. The unit consumes 11 cents worth of battery power each day

public because an invention both practical and useful could not be used because of a prior patent which of itself could not meet the needs of the trade. 4. A financial return shall be assured the inventor commensurate with the value of the patent. 5. A manufacturer would be prevented from withholding an improvement in his product from the public merely because of the commercial advantage to him of continuing his present product.

Some of the disadvantages of the system are: 1. The inventor would lose a part of his exclusive right and in the case of a particularly valuable invention he would be prevented from retaining a financial return greater than what the law had set up as a reasonable return. 2. Because of compulsory licensing a licensee might manufacture a product of such an inferior nature that it would injure the reputation of the product as manufactured by the inventor. 3. It will be impossible to build up a particular line through monopoly due to basic patents and improvements. While this may be a disadvantage to a particular inventor, it will be an advantage to the public generally. 4. The inventor would lose control of the processes used to manufacture and sell his invention.

If it is accepted that the purpose of a patent is to insure that an invention is made available to the public, the authors conclude that the advantages of a compulsory patent licensing system overwhelm the disadvantages.

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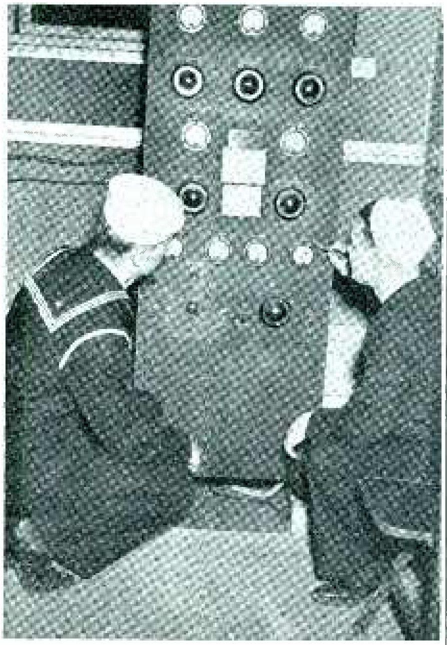
RADIO IN THE NAVAL RESERVE



A volunteer in the naval reserve receiving instruction in the operation of radio equipment from a Radioman First Class

The Nature of Electric Waves in Transformers

An article of interest to transformer designers is "Electric Oscillations and Surges in Subdivided Windings," by Reinhold Rudenberg, appearing in the October, 1940, issue of the *Journal of Applied Physics*. Two general problems are submitted, first, the effects of a finite number of elements belonging to one group of windings as for example, six coils forming a whole winding or 20 layers forming a complete coil, or 12 turns forming one layer; second, the extension of the analysis to the consideration of waves passing from one group to another one with different elements, such as from turns to layers, or from layers to coils. The author draws several conclusions from a mathematical treatment of the subject. They are as follows:

Lumped subdivision of windings into distinct elements as coils, layers or turns causes a critical frequency of its own, lower than that due to internal capacitance. Within the intermediate range of both critical frequencies attenuated standing waves appear within the winding.

Propagation of steep waves through successive turns, layers and coils effects a flattening of the front in several steps. Simultaneously, local oscillations within the layers or turns may be excited by reflections at the transition points of the group of elements.

The head length of the propagating wave and the internal stress of the insulation are favorably influenced by subdivision into elements, particularly in the case of small internal capacitance. The change in time of the internal voltage is derived for both interior and terminal elements. Formulas are given for the computation of the internal stresses between turns, layers and coils as well as between extra-insulated terminal elements.

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Crystal Filters

The use of quartz crystals in wave filters is described in an article by Russell E. Knox, in the October, 1940 issue of *Long Lines*, a publication of the Long Lines Department of the American Telephone & Telegraph Co. In an electrical circuit the crystal presents an impedance to current flow and can be represented by circuits such as the one shown in the accompanying diagram. The mass reaction of the crystal in vibrating motion is represented by inductance L; the resistance R represents the energy dissipating action in the crystal as it vibrates. C_d represents the elasticity determining the storage of mechanical energy in the crystal and C_s represents the natural capacitance of the crystal when at rest. The nature of this circuit is such that it will have not only a resonant frequency, but an anti-resonant frequency as well. The ratio of C_a to C_d is a constant for any given crystal material and for quartz it is 125 to 1. It is this fixed ratio that determines the relation of the resonant frequency to the anti-resonant frequency.

At frequencies other than the resonant and anti-resonant points the crystal is essentially a reactance varying in value as the frequency is changed. This is illustrated in Fig. 1.

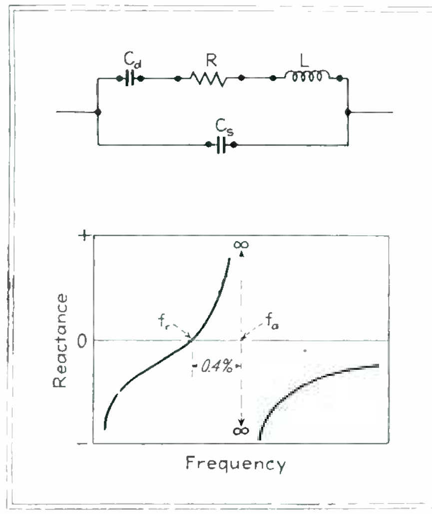


Fig. 1—Equivalent electrical circuit of a quartz crystal and its reactance characteristic

The resonant frequency f_r and the anti-resonant frequency f_a are separated by four-tenths of one per cent of the resonant frequency. This is due to the ratio of C_s and C_d and remains for all quartz crystals irrespective of the particular frequencies involved. When the reactance curve is raised by the added inductance to the point the portion on the right crosses the zero line and provides another resonance in frequency.

The distance between the new resonant point and the anti-resonant point in cps can be controlled by the size of the added series inductance. If the added inductance is selected so that the new resonant points are equal in distance from the anti-resonant they will occur at points which are 4.5 per cent on either side of the anti-resonant point.

In the band-pass filter the crystals and inductances may be arranged in a lattice network such as that shown in Fig. 2. Each arm is designed for two resonant points an equal distance from the anti-resonant point as outlined above. The series arms A and A' are identical and the shunt arms B and B' are identical, but the anti-resonant frequency point in arms A and A' coincides with the first (lower frequency) resonant frequency point of arms B and B'. Therefore, the anti-resonant frequency point of arms B and B' coincides with the second resonant frequency of arms A and A'. The second resonant frequency of arms B and B' will be 4.5 per cent above this point.

Any alternating voltage applied at ter-

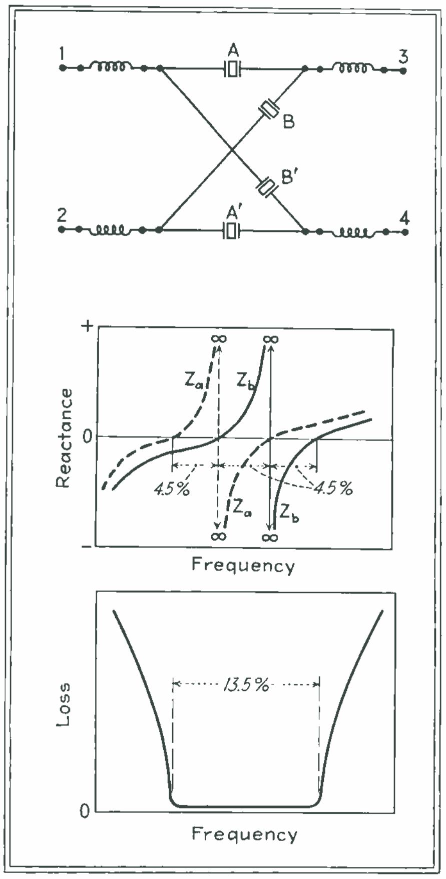


Fig. 2—Quartz crystals and inductances arranged as a band-pass filter together with the reactance and attenuation curves

minals 1-2 at a resonant or anti-resonant frequency will also appear at terminals 3-4 at the same magnitude. The voltage at any frequency outside of the frequency band from the first to the last resonant point will upset the bridge balance and will be subjected to a large loss and effectively suppressed. When such a filter is designed for frequencies in the order of 100,000 cps it will pass a band 13,500 cps wide. This pass band can be reduced, however, to any desired value by adding condensers in parallel with the crystals thus bringing their resonant and anti-resonant frequencies closer together.

Erratum

There appeared on page 42 of the October issue of ELECTRONICS an incorrectly captioned picture. The title should read "U. S. Nabs Illegal Broadcaster". The caption should read, "Sam Klaus, special U. S. prosecuter in a recent gambling case, examines the 'phono-oscillator' by which bookies, to whom phone service was denied, allegedly received race reports. The reports are said to have been phoned to a beauty parlor, where this set was secreted, and then sent by radio to the bookies in a nearby building. It was claimed that the bookies operated a radio transmitter without a license."

THE INDUSTRY IN REVIEW

News

✦ On October 14th Thad H. Brown resigned as a member of F.C.C. Mr. Brown is entering the private practice of law . . . The 1940 national conference of the Associated Police Communication Officers Inc., will be held in Orlando, Fla., on December 2nd to the 5th. Subjects for discussion will include inter-city police communications, radio telegraph, teletype and two-way frequency modulation communication. . . . The Society of the Plastics Industry, Inc., recently held its Fall Meeting in Pennsylvania. The purpose of the Society is to speak authoritatively for the industry as a whole and to disseminate reliable information regarding its activities and developments. As a result of the rapid growth of the plastics industry, SPI has opened permanent offices at 295 Madison Avenue, New York City, which will serve as a clearing house for information on sales of raw material, finished products, sources of supply, employment opportunities, etc. . . . A total of forty-five applications for f-m station construction permits are awaiting official approval in Washington. Most of the applications are from owners of standard broadcast stations. If the licenses are granted in accordance with the coverage areas requested, these new f-m stations will supply service to over 75,000,000 potential listeners . . . Adequate frequencies for radio telephone service to Madrid have been set aside by the F.C.C. With the suspension of direct service to Holland, Belgium and occupied France, the demand for the Madrid circuit has increased. It gives an outlet from Lisbon, the only remaining point of contact with Continental Europe. Arrangements are being concluded for a resumption of direct telephone service with Paris . . . Federal Sales Company of Chicago is now known as Federal Screw Products Company . . . Ralph P. Glover, chief engineer for Shure Brothers for many years, has announced his resignation from that company and has joined the staff of Jensen Radio Manufacturing Company. Mr. Glover will be active in an expanded Jensen sales promotion campaign designed to place in service to the trade the facilities of the laboratory and engineering department . . . W. Richison Schofield, formerly chief engineer of Leeds & Northrup Company, Philadelphia, has recently been appointed director of engineering. John W. Harsch, assistant chief engineer, has been advanced to chief engineer. Mr. John F. Quereau is the new assistant chief engineer . . . Of the 16 radio stations now licensed to broadcast facsimile news programs, seven are completely or partially owned by newspapers, according to figures recently released by the F.C.C. The stations with newspaper affiliation using Finch Facsimile equipment are WGN, the *Chicago Tribune*; WHK, the *Cleveland Plain Dealer*, and WOKO, the Albany (N.Y.) *Knickerbocker News*. Other newspapers in facsimile broadcasting are the *Cincinnati Times-Star*, the *Louisville* (Ky.) *Courier-Journal*, the Pulitzer Publishing Company, St. Louis, Mo., and the St. Louis (Mo.) *Star-Times*. The non-newspaper experimenters with facsimile are WLW, Cincinnati; WOR, Newark, N. J.; WSM, Nashville, Tenn.; W2XBF, New York, and W8XUF, Jackson, Mich. (all using Finch equipment); the A. H. Belo Corp., Dallas, Texas; WQXR, New York; the Symons Broadcasting Co., Spokane, Washington, and WBEN, Buffalo, N. Y. . . . A Fellowship for the investigation of biological problems with the electron microscope recently developed in the RCA research laboratories has been established in the National Research Council through funds provided by the RCA Manufacturing Company . . . Dr. C. Guy Suits, has been appointed assistant to the director of the General Electric Research Laboratory . . . A subcommittee, under the chairmanship of John K. Hilliard of M-G-M Studio has been appointed by the Academy of Motion Picture Arts and Sciences to consider the possibilities for standardization of vacuum tubes used in sound recording work . . . Paul H. Tartak, president of Oxford-Tartak Radio Corp., Chicago, has acquired a substantial interest in the United Teletone Corp., manufacturers of Cinaudagraph speakers . . . Station WPTF recently received permission from F.C.C. to increase the power of the station from 5,000 watts to 50,000 watts . . . Application has been made by General Electric Company to the F.C.C. for permission to extend the power of its f-m station, W2XOY, from the present licensed power of 2,500 watts to 50,000 watts . . . General Electric has taken over the complete operation of station WGY, 50 kw broadcasting station in Schenectady. This station has been operated by NBC since 1931 . . . L. O. Myhre has been appointed manager of manufacturing in the Radio Division of the Westinghouse Elec. & Mfg. Co., Baltimore. Mr. Myhre was previously in Long Island City, N. Y., where he was manager of engineering and manufacturing for the Westinghouse X-Ray Co. . . . First of three new buildings at the Westinghouse Radio Division in Baltimore is now completed, aiding the Government's preparedness program by doubling the Company's production facilities for special Army and Navy radio equipment. Two additional buildings are scheduled for completion before November 15th . . . General Electric Co. has announced that contracts have been awarded for the construction of a new building in its Schenectady works to be used in the manufacture of radio transmitters. Construction will start

End plates molded of Lumarith by Chicago Molded Products Company for Sangamo Electric Company, Springfield, Ill. Used for insertion in coil housings

immediately . . . Arthur A. Brandt, who for three years has been associated with the advertising and promotional activities in connection with General Electric radio, has been appointed sales manager for the G-E radio and television receiver line . . . Niles Trammell, president of the National Broadcasting Company, announced the following appointments. John F. Royal, formerly vice-president in charge of programs, takes over new duties as vice-president in charge of the newly created post of New Activities and Developments in Broadcasting. Mr. Royal's new duties will deal with development work in programming and general public service in the fields of international and short wave broadcasting, television, frequency modulation and facsimile. Frank E. Mason will relinquish his supervision of the International Short Wave Dept. to concentrate on his duties as vice-president in charge of the Information Dept. L. P. Yandell, who formerly handled commercial short wave international broadcasting, has been appointed manager of the International Short Wave Dept. Clayland Morgan, formerly assistant to the president in charge of public relations, becomes director of Institutional Promotion. Sidney N. Strotz is the new vice-president in charge of the program department. Harry C. Kopf, sales manager in Chicago, succeeds Mr. Strotz as manager of the Central Division . . . Collins Radio Company announces the construction of a new plant. The building will have 52,000 sq ft floor space, and will be used in conjunction with the 40,000 sq ft which Collins now has. All research, engineering and precision manufacturing will be transferred to the new building which was scheduled to be available for occupancy about November 1st.

Literature

Lumarith Protectoid. "Lumarith Protectoid" is a trade name for a high quality cellulose acetate film which can be obtained in gauges from .0007 to .002 inch. A booklet on the subject has been published by Celluloid Corp., 180 Madison Ave., New York City, which gives its characteristics and applications for the electrical industry. These data and specifications have been especially prepared for engineers.

Test Equipment Catalog. Radio City Products Co., 88 Park Place, New York City, announce a Supplementary Catalog (No. 123) covering a number of new pieces of test equipment which have been added to their line for the 1940–41 season since the issuance of the RCP Master Catalog.

Radio Service Equipment. Catalog No. 120 is a new issue devoted to instruments available from Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio, for f-m, television and a-m servicing.

Industrial Catalog and Engineering Manual. This new 96-page Catalog No. 40, contains helpful facts and information on the selection and application of resistors, rheostats, tap switches, chokes and attenuators. Among other things dimension drawings, illustrations, and special guide pages are included. Ohmite Mfg. Co., 4835 Flournoy St., Chicago.

Molded Plastics. A 12-page bulletin of interest to users of molded plastics has been published by the Plastics Division of Erie Resistors Corp., (640 West 12th St.) Erie, Pa. In addition to giving useful information on injection molded plastics this catalog describes the designing, engineering and production facilities of this company.

Catalog Sheets. The Hollywood Transformer Co., has just released several catalog sheets describing tapped equalizer inductors, input transformers and similar items supplied to customer specifications. These sheets are available from Norman B. Neely, 5334 Hollywood Blvd., Hollywood, Cal.

Vacuum-tube Apparatus. A new 20 page booklet entitled *Electronic Devices for Industry* (GES-2411), just published by General Electric Co., Schenectady, N. Y., briefly lists some of the more important vacuum-tube apparatus and describes its application and method of operation.

Transmitter Guide. Bulletin No. 344-E contains a wide variety of transmitters for the use of beginners and of advanced amateurs. Simplified construction methods are employed throughout the guide. The guide may be had for fifteen cents from Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago.

Miniature Panel Instruments. A new twelve page illustrated catalog covering the "37" line of miniature panel instruments is announced by the Westinghous E. and M. Co., E. Pittsburgh, Pa. These small instruments, approximately 4½ in. in diameter, and available in three mounting styles, have a broad field of application; from industrial and radio test apparatus down to the gadget of the amateur experimenter.

Selenium Rectifiers. Bulletin Fl-3 entitled *Fansteel I. T. & T. Selenium Rectifiers* explains the principle of the selenium dry plate rectifier and enumerates its characteristics and advantages. Recommended circuit arrangements are detailed and illustrated with wiring diagrams. Fansteel Metallurgical Corp., North Chicago, Ill.

Oscillographic Measurement. "Oscillographic Method of Measuring Positive-Grid Characteristics" is the subject discussed in a recent issue of *Oscillographer* published by Allen B. DuMont Laboratories, Passaic, N. J.

Time Switches. Type TSA-14 time switches for control of a-c circuits are illustrated and described in bulletin GEA-2963B available from General Electric Co., Schenectady, N. Y.

Generators. Three bulletins are available from Carter Motor Co., 1608 Milwaukee Ave., Chicago. Bulletin 150 gives data on heavy duty rotary converters for changing dc and ac for use, with pa amplifiers, radio receivers, phonographs, musical instruments, etc. Bulletin 50 is devoted to a new super genemotor for aircraft, marine, police, sound systems, and amateur use. Data on improved heavy duty genemotors for hi-gain amplifiers, two-way police radios, aircraft radios, etc., are contained in bulletin 510.

Radio Service Encyclopedia. Supplement No. 11 to the third edition of Mallory-Yaxley Radio Service Encyclopedia is devoted to the subject of "Superheterodyne First Detectors and Oscillators." P. R. Mallory & Co., Inc., Indianapolis, Ind.

New Catalog. A new catalog, No. 153, covers the complete line of Shure Brothers (225 W. Huron St., Chicago) products and includes new items for 1941 such as the "Stratoliner" microphones, magnetic recording heads, etc.

Flexible Varnished Tubing. A bulletin available from Wm. Brand & Co., 276 Fourth Ave., New York City, describes their process of varnishing flexible tubing.

Cathode-ray Stopwatch. A conventional cathode-ray oscillograph is employed as an indicator for determining the transit time of electrical switching equipment, such as relays and contactors, together with a graphical solution of the pattern obtained from the cathode-ray oscillograph, examples of the method and its extension to other problems, is the subject of the latest issue of the Du Mont *Oscillographer*. This paper is the first of the entries in the Du Mont Cathode-Ray Symposium and Prize Contest recently announced, and is representative of the cathode-ray application ideas being reported by contestants. A copy may be had by writing Allen B. Du Mont Labs., Inc., Passaic, N. J.

Frequency Modulation. A bulletin available from Fred M. Link, 125 West 17th St., New York City, describes two types of frequency modulated main station equipment, two types of frequency modulated mobile equipment, a frequency monitor fixed station coaxial antennas and mobile antennas and mounts.

New Bulletin. A loose-leaf binder just issued by Chicago Transformer Corp., 3501 Addison St., Chicago, contains informations about the company's history, personnel, manufacturing facilities and products. This bulletin will be published at regularly scheduled intervals and will contain information regarding the progress being made in small transformer design and construction.

House Organ. *Nickel Steel Topics* is published in the interest of producers and users of nickel alloy steels. It is available from the International Nickel Co., Inc., 67 Wall St., New York City.

Fastening Devices. Tinnerman Products, Inc., Cleveland, Ohio, have available a booklet (Form No. 135) which illustrates the use of their "Speed Nuts" for assembly line production. Speed Nuts are one-piece fastening devices that afford a double lock.

New Products

Recording Weight Scale

UNIVERSAL MICROPHONE CO., INGLEWOOD, CAL., is now distributing its new weight scale for servicemen, recorders and others who need quickly to determine weight on cutting head or pickup. The tiny instrument is small and lightweight, but extremely accurate. It reads in ounces and has a hook for speedy connections, and enables the holder to see the weight on the needle or stylus. It will be distributed through the usual dealer-jobber channels.

Ballast Tube

THE NEW SHAPE AND SMALLER SIZE will permit a new ballast tube, product of Amperite Co., 561 Broadway, New York City, to be placed anywhere. Better operation is obtained with the new starting resistor which puts approximately 80 volts on the receiver when it is first turned on and increasing to 110 volts after four seconds. The new Amperite is also equipped with the new fuse which automatically burns out when the ballast is connected to a set having a 110-volt tie connection to the ballast socket. After the fuse burns out the Amperite automatically adjusts itself to the set keeping the tube filaments between 6.0 to 6.6 volts with a line voltage variation of 80 to 140 volts.

Record Playback Machine

A NEW PORTABLE TRANSCRIPTION record playback machine is being featured by Charles Michelson, 67 West 44th St., New York City. The new machine plays all records up to the 16 inch size at both 33⅓ and 78 rpm, and operates on ac-dc. The entire unit weighs only 18 lbs complete, and has provision for storing 3 records inside the case.

Portable Voltmeter

FERRANTI ELECTRIC, INC., 30 ROCKEFELLER PLAZA, New York City, have placed on the market a new triple range a-c portable voltmeter designated as Model 956. This is a precision testing instrument for industrial and central station use, and for all service and field testing. While it has been designed for a-c circuits, it may be used on d-c circuits with a small sacrifice in accuracy. It conforms to A.I.E.E. and N.E.M.A. Specifications, and meets Army and Navy Specifications.

Radio Transmitters

NEW RADIO TRANSMITTERS designed expressly for use in stations where limited technical personnel requires the conservation of man-power, as in local broadcasting plants, police work and the emergency communication services, have been announced by the Western Electric Company, 195 Broadway, New York City. Code 450A-1 designates the 100 watt transmitter, while Code 451A-1 designates the 250 watt transmitter. Output power is 100-250 watts except for those stations operating on 250 watts daytime who may desire optional gear for shifting to 100 watts at night. Frequency range is 550-2750 kc depending upon coils and condensers installed. Audio frequency response is flat within ± 1.5 db from 30 to 10,000 cps. Other specifications are as follows: Manual voltage regulation to accommodate primary voltages from 200 to 240 volts; r-m-s audio harmonics show less than 3% distortion below 5,000 cps at all modulation levels to and including 100% and less than 5% from 30 to 7,500 cps; stabilized feedback and other developments enable the modulated amplifier to carry over-modulation without damage to equipment and without sharp increase in distortion; r-m-s noise level 60 db or better unweighted, 70 db or better weighted, below signal level at 100% single frequency modulation; harmonic radiation is not greater than .03%; grid bias last radio frequency stage method of modulation; quartz plate controlled carrier stability within 10 cycles; power supply for input voltage is 200-240, frequency 60 cps (50 cps can be supplied on order. Power consumption for the 450A-1 model is 1250 watts and for model 451A-1, 1750 watts.

Magnifying Glass

PERMO PRODUCTS CORP. (6415 Ravenswood Ave., Chicago), have available a ten-power magnifying glass, mounted in a protecting rubber holder, which is useful for inspecting playback needle points, recording needles and record grooves. The magnifier is also handy for draftsmen, tool makers, etc. Permo Products Corp. will send this magnifier free to engineers, manufacturers and jobbers, who will write to them on their professional letter-head.

Recording Motor

ALLIANCE MANUFACTURING COMPANY, ALLIANCE, OHIO, announces its new Model 90 recording motor and turntable assembly designed for use with individual feed and cutter designs. It makes available an inexpensive turntable and motor assembly suitable for incorporation in any individual complete recording mechanism. The motor is available with 9 inch turntable only, being designed to record up to 8 inch blanks with good speed regulation. The assembly is of the friction drive type which, in conjunction with a dynamically balanced rotor, provides smooth, quiet operation.

Handi-Mikes

Universal Microphone Co., Inglewood, Cal., is now manufacturing and distributing its new handi-mikes for use in the portable sound equipment field, especially for sound trucks, sports events, small transmitters, call systems and other places where a close talking and a clear crisp reproduction unit is required. It is made of polished chrome plate with balanced grip, snap switch, an overall length of eight inches, a packed weight of slightly over a pound and six feet of flexible cord are included in the assembly. "A" circuit is standard on all models, with switch in series on carbon types, shunt on all others. "C" circuit is special for relay operation, shield of cable common ground. "T" switch is heavy duty press-to-talk, vertical toggle types, nonlocking and "P" switch is push button type, also nonlocking. Other circuits are also available from the manufacturer.

Amateur Frequency Monitor

The Browning Laboratories, Winchester, Mass., have recently announced a new precision amateur frequency monitor, Type M3, covering the six amateur bands from 160 meters to 2½ meters. The monitor is so designed that the amateur bands are completely band-spread over 240 degrees on a 5½-inch laboratory dial. 100 and 1000 k-c oscillators are used as secondary standards and may readily be adjusted to one part in a million against the Bureau of Standards Station, WWV. These secondary standards allow accurate checking of dial calibration in the amateur bands. The dial is direct reading and requires no counting of beats to determine the frequency of exciters, transmitters or received frequencies. Zero beat is indicated visually by the cathode ray tuning indicator and aurally in phones. This apparatus may also be used as a visual deviation meter.

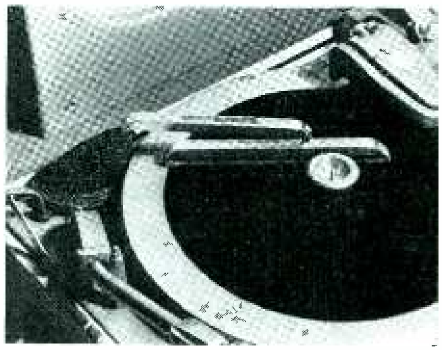
Marine Radiophone

To meet more precisely the communications requirements of small boats, and of larger boats with moderate off-shore cruising range, Hallicrafters (Chicago), announce the Model HT-11 compact marine radiophone which combines modest initial cost with the low battery drain. The HT-11 includes a transmitter and receiver in one metal cabinet. The standard power supply is a separate unit connected to the other by cable. This power supply operates from either 6 volt or 12 volt battery sources, or a special 110 volt, 60 cps supply is available which may be driven from a 110-volt a-c source or from a 32 volt or 110 volt d-c converter.

The transmitter section provides 12 watts into the antenna and a choice of three gang-switched and crystal-controlled operating frequencies.

Recording Thread Controller

CHIP CHASER IS THE NAME of a new device developed by Audio Devices, Inc., 1600 Broadway, New York City, to solve the problem of controlling the thread when cutting an instantaneous recording.



Receiver Components

A WIDE VARIETY OF PRODUCTS of interest to servicemen, experimenters and amateurs has been announced by Consolidated Wire & Assoc. Corp., 520 S. Peoria St., Chicago. Two items of particular interest are miniature dry electric condensers in etched foil tubular, etched foil waxed carton and midget plain foil waxed carton types, and a new series of midget double tuned i-f transformers. Other products available are radio cements and solvents, a variety of phono and record accessories (including plain steel or brass plated high fidelity needles), a line of paints, varnishes and lacquers, and two new broadcast and short wave receivers.

Combination Tester

RADIO CITY PRODUCTS CO., INC., 88 Park Place, New York City, announces a new addition to its line—the Model 803 "Portable Service Shop" which combines in one instrument the functions of set tester and tube tester. Dimensions are 12¾ x 13 x 6. Space is provided for test leads and small tools. Set tester functions include measurement ranges of 0-10/50/500/1000 for d-c voltages (at 1000 ohms-per-volt) and for ac and output voltages. D-c current ranges are: 0-1/10/100/1000 milliamperes and 0-10 amps. Ohmmeter ranges include 0-500/5000/1 meg/10 megs and decibel ranges—8 to 15, 15 to 29, 29 to 49 and 32 to 55. A self-contained battery serves for the medium ohms range and a built-in power supply for the others. Provision is made for testing all old and new tubes including the miniature, bantam junior and ballast types. The usual Dynoptimum circuit is utilized and filament voltages are available up to the full line voltage. All tests are at standard RMA plate voltages and loads and include hot interelement short and leakage tests for individual elements, individual section tests for multi-purpose tubes, etc.

Wide Band Signal Generator

Model 188-X is a new wide band Universal crystal-controlled signal generator specifically designed for f-m and a-m servicing. It is a product of Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio.

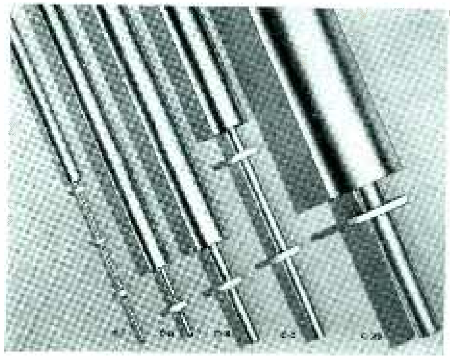
With frequency coverage on fundamentals from 100 kc to 133 Mc the 12 output selections include: Electronic-controlled wide band frequency modulation output with 750 kc sweep for alignment of f-m and television receivers. F-m output, modulated internally, at 400 cps with F.C.C. standard frequency modulation sweep (150 kc) for servicing and checking f-m receivers. Amplitude modulation output as well as narrow band frequency modulation (30 kc sweep) for servicing amplitude modulation receivers. Audio frequency outputs of 400 cps fixed and 50 to 10,000 cps variable are available. Crystal-controlled outputs, modulated and unmodulated, with accuracy better than 0.01% are included with frequency coverage from 100 kc to 10 Mc in 100 kc steps and from 1000 kc to 150 Mc in 1 Mc steps. It also furnishes synchronized sweep voltage for oscillograph use. The oscillator includes a complete built-in power supply consisting of transformer, rectifier and filter. It is standard for any 110 volt a-c line, 40 to 65 cps. All necessary cables and instruction book are furnished.

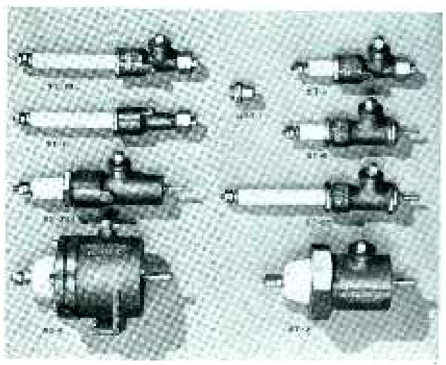
Bakelite Audio Units

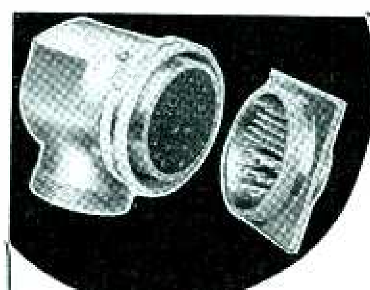
United Transformer Corp., 150 Varick St., New York City, announces a complete line of bakelite cased plug-in audio units. These units have identical characteristics to the UTC Ouncer transformers, and weigh only two ounces. Units not carrying dc have high fidelity characteristics, uniform from 40 to 15,000 cps. The transformers have standard octal sockets with overall dimension of 1-⅓ inch diameter x 1½ inch high. All items are of submersion proof design. Fifteen units are available in this series for every type of low level input, output, and matching sets.

Aircraft Dynamotors

The Carter Motor Co., 1608 Milwaukee Ave., Chicago, announce a new line of small, light weight, aircraft type dynamotors for aircraft, police and marine radio. They are made in two frame sizes, 35 and 100 watts output. The 35-watt frame weighs 4½ lbs with aluminum bearing brackets, and measures 5⅞ inches long, 3½ inches wide, 3 13/16 inches high. The 100-watt frame weighs 7½ lbs with similar type brackets, and measures 7 inches long, 3½ inches wide, 3 13/16 inches high. Some of the features of this new line include a one-piece field ring, double enamel and silk wire, mica extension, dynamic balancing of armature, ball bearings, removable end covers, simplicity of construction and neat design.







A-B Plug-In Unit

A NEW A-B BATTERY-SUBSTITUTE UNIT, Model AD, available from Electro Products Laboratories, 549 W. Randolph St., Chicago, will convert portable and home battery radios into all-electric sets. It does away with both "A" and "B" batteries and it permits operation of portable and other 1½ volt battery radios in districts using direct current. It provides 1.4 volts "A" power and 90 volts "B" power at 18 ma.

Quick Heating Tubes

TWO NEW QUICK HEATING TUBES have been announced by Hytron Corp., 76 Lafayette St., Salem, Mass. They are the HY-1231Z and HY-1269. The HY-1231Z is a High-Mu twin-triode for use as a zero bias Class B modulator, r-f amplifier oscillator, or a-f amplifier. The HY-1269 is a beam tetrode for use as an r-f amplifier, oscillator, Class AB_2 a-f amplifier or as a frequency doubler. The filaments of both tubes are of thoriated tungsten to provide for quick heating. These tubes have been designed for use in 12 volt ignition systems such as are found in aircraft and marine installations.

B Battery Eliminator

A "B" battery eliminator for portable receivers has been announced by American Television & Radio Co., 300 E. 4th St., St. Paul, Minn. These eliminators are designed for operation from a storage battery or from flashlight cells. The total weight of the eliminator is approximately 3 lbs. It will deliver 110 volts ac, 60 cps, at 35 watts for the operation of 3-way portable receivers.

Radiotelephones

HALLICRAFTERS, INC., 2611 S. Indiana Ave., Chicago, have available marine radiotelephones which have been built to government specifications. One model (HT-11) has a 12-watt output. The transmitter can be operated on three frequencies in the marine band of 2000 to 3000 kc ship-to-ship, Coast Guard, ship-to-shore. The receiver is manually tuned and covers the standard broadcast band on range No. 1. Range No. 2 covers the marine channels. A separate noiseless vibrapack power supply is supplied for 6 or 12 volt d-c operation. Other voltages can be used with a suitable converter.

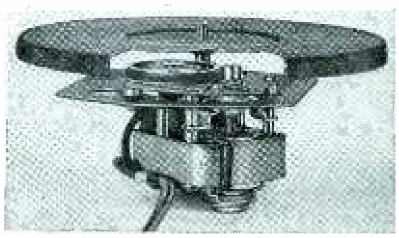
The "Seagoing" model HT-12 has 50 watts output. Ten crystal controlled transmitting and receiving (ship-to-ship, Coast Guard, ship-to-shore) channels provide communication with shore stations. Power supplies for operation on 12, 32, 110 dc and 110 volts ac are available. A booklet available from Hallicrafters contains details on the foregoing radiotelephones, as well as a revised list of frequencies in use for coastal harbor radiotelephone service.

High Speed Electronic Counter

AN ELECTRONIC COUNTER, model 475, announced by Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa., will count at rates up to 2000 per minute. This device multiplies by five the count as indicated on a registering counter, and the registered count increases by one for every five objects counted. If the registering counter is capable of counting 400 per minute, 2000 per minute may be counted with the use of the electronic counter. An outstanding feature of model 475 is that no minimum count per minute is required. The device operates on 110-120 volt, 60 cps supply line.

New Phono-Motor

ALLIANCE MFG. CO., Alliance, Ohio, announce Model K-800 phonomotor which is designed specifically for 25 cps operation. This new motor is adapted to the standard friction drive assembly,



as used on Alliance's model 80, allowing interchangeability in mounting without difference in performance. Model K-800 is available for 110 or 220 volt operation, in eight- or nine-inch turntable sizes.

Solder Pots

THREE NEW SOLDER POTS are available from Electric Soldering Iron Co., Deep River, Conn. These new products are intended for production jobs where fast dipping of parts is required. A special feature is a pilot light which indicates when the pot is heating, if the element or supply circuit fails, the light will go out. Model 12 has a capacity of ¾ lbs and is rated at 200-watts. Model 36 is rated at 250-watts and has a capacity of 2¼ lbs. Model 100 has a capacity of 6¼ lbs and a 450-watt rating. Catalog sheet 511 is available from the manufacturer.

Fuses

LITTELFUSE INCORPORATED are now manufacturing Underwriters approved 3-AG glass enclosed fuses in ratings up to 8 amps for 250 volt a-c or d-c service or less. The new sleeve type 3-AG fuses (four to eight amps inclusive) have a separate glass sleeve over the entire fuse element that takes the pressure shock under short circuits. The 8 amp fuse is powder packed. A bulletin which includes technical data and prices is available from Littelfuse Inc., 4757 Ravenswood Ave., Chicago.

FM vs AM for Aircraft

(Continued from page 35)

not have been noticed if a lower per cent tone modulation had been used. Voice will not maintain a 100 per cent modulation; therefore, this effect will not be noticed to any appreciable degree for voice communication.

Operation of Two Stations Within Line of Sight

The 150-watt Albany transmitter was fully frequency-modulated with 700-cps tone and the 20-watt Schenectady transmitter W2XDA was fully modulated with a 400-cps tone. All tests were conducted with 41 Mc carriers and at 2,000 and 3,000 feet elevation between the two cities.

Flying from Albany to Schenectady, it was first observed that when approximately five miles from the Schenectady station there was a one-mile area where the Schenectady and Albany signals were nearly equal and both could be heard. Beyond this, the plane entered an area of several sharp transitions due to antenna lobes as shown in Fig. 3. Schenectady could be heard approximately the next three miles. When flying directly over the Schenectady antenna, there was a "cone of silence" about one-half mile in diameter. This "cone of silence" was, of course, in the center of the Schenectady service area. In this cone the Albany signal took control and was received very well. When leaving this "cone," going west, the same fields were observed as entering the "cone of silence". The flight was continued west and the Albany signal was again heard about six miles from Schenectady but did not take complete control until the plane was 14 miles west of Schenectady. This slow transition is explainable on the basis that both signals were decreasing with distance and the weaker station was nearer the receiver. Hence, neither signal was twice the other, so as to take complete control, for a considerable distance. When flying over the Schenectady antenna, several high-angle lobes were observed, between which Albany took control for very brief intervals.

Defense Set-up for Communications

(*Continued from page 17*)

effective technical developments. For the most part the army must depend on industrial research organizations, but there are a great many other technical facilities, in schools and colleges, and in the general public, which cannot safely be ignored. To aid in organizing research, design, and engineering developments behind the defense effort, the President appointed the National Defense Research Committee, a part of the Knudsen-Stettinius Defense Commission set-up, to act as compiler and coordinator of all the research facilities in the country, in industry as well as in the academic sphere. The National Defense Research Committee is headed by Dr. Vannevar Bush, President of the Carnegie Institution, and it includes such men as Presidents Conant of Harvard, Compton of M. I. T., Colman of Cal. Tech., F. B. Jewett, of the American Telephone and Telegraph Company, C. P. Coe of the Patent Office, Brig. Gen. Strong of the War Department, and Rear Admiral Bowen of the Navy. The research and development plans of the Army and Navy have been turned over to this committee for coordination with the laboratories best fitted to handle the jobs. Subcommittees have been appointed in each major division of the research field, including communications. When a bottle neck develops in any Army or Navy project, the Research Committee can call in the most competent men and technical facilities to cope with the problem, regardless of other considerations. The organization can thus cut through yards of red tape and get action quickly on vital developmental work.

Another focal point in the question of organizing technical developments for defense is the U. S. Patent Office. The 70,000 patent applications received each year describe many inventions which have military value. This summer Congress authorized the Commissioner of Patents to withhold the issuance of patents on inventions considered to be of significance in national defense, and to issue a secrecy order to the inventor. If the inventor turns over the invention to the government for use, he is entitled to compensation, in addition to patriotic satisfaction in aiding where the need is greatest. To carry out this great responsibility of sifting patent applications, Commissioner Coe of the Patent Office has appointed a Patent Defense Committee, consisting of senior examining officers and others who have special knowledge in various fields. These men, working in close cooperation with the research and development sections of the Army and Navy, must decide whether a proposed invention falls within the defense category, either because it is useful to the armed forces, or because it might be useful to some other nation if divulged.

Finally, another highly important agency in the utilization of technical ideas is the National Inventors Council, set up within recent weeks to bring ideas and inventions from the civilian population to the attention of the military authorities with the least possible confusion and delay. The Council is headed by Charles F. Kettering of the General Motors Company, and includes C. P. Coe, Commissioner of Patents, Dr. W. D. Coolidge of General Electric, and others prominent in the electrical, chemical, and mechanical fields.

The Council is now building up a staff of experts who will sift and evaluate the thousands of suggestions and inventions which are received from the general public relating to national defense. When its work has been widely publicized, it is conceivable that it may be required to go over 100,000 schemes in the course of a year, only a small percentage of which will have any exceptional value. However, if only a dozen suggestions prove fruitful, it will be deemed worth the effort. Essentially the Council acts as a clearing house for suggestions or inventions which are submitted by civilians, provided that these suggestions relate clearly to the national defense. It brings the suggestions it deems useful to the attention of the proper authorities, not only in the Army and Navy but in the Defense Research Committee, so that the suggestion may be reduced to practice by the best qualified men and facilities.

The Inventors Council will also

work in reverse direction, taking the unsolved problems of the Army and Navy and bringing them to the attention of men known to be qualified in particular lines. In this aspect of its work, the Council will act in close collaboration with the National Defense Research Committee.

How Readers of ELECTRONICS *May Participate*

Since communication is a vital arm of the national defense, the readers of ELECTRONICS are in a particularly good position to render service to the government, by contributing practical ideas and suggestions. The best way of bringing such suggestions to the proper authorities is to submit them in writing to the National Inventors Council, Room 7422, Department of Commerce Building, Washington, D.C. An information bulletin is available without charge from the Council and should be consulted before sending in the suggestions. Each suggestion should be made a separate document, preferably typewritten, all sheets fastened together and accompanied by suitable drawings. Models should not be submitted until asked for. Duplicates of all material submitted should be retained by the sender. Submission of a suggestion to the N.I.C. does not secure protection of the idea under the patent laws. If such protection is desired by the inventor, he should submit also a patent application in the usual form, to the U. S. Patent Office. It should be remarked that the Council is of particular value to inventors who have no connection with an established industrial concern in the field covered by the invention. Much lost time in attempts to obtain interviews in the War and Navy Departments can be saved by using the machinery already set up in the Council.

Who's Who in Army and Navy Communications

When all's said and done, the roots of the defense tree are the Army and Navy, the men for whom the other agencies are working. The biggest job right now is procurement of needed equipment and materials, and the men charged with this duty are working overtime getting the orders out. The following roster of men in the Army contains

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Of Electronics, published monthly at Albany, N. Y., for October 1, 1940.

State of New York }ss.
County of New York }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared D. C. McGraw, who, having been duly sworn according to law, deposes and says that he is the Secretary of the McGraw-Hill Publishing Company, Inc., publishers of Electronics, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, McGraw-Hill Publishing Company, Inc., 330 West 42nd St., N. Y. C. Editor, Keith Henney, 330 West 42nd St., N. Y. C. Managing Editor, Donald G. Fink, 330 West 42nd St., N. Y. C. Business Manager, H. W. Mateer, 330 West 42nd St., N. Y. C.

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5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the twelve months preceding the date shown above is. (This information is required from daily publications only.)

D. C. McGRAW, Secretary.

McGRAW-HILL PUBLISHING COMPANY, INC.

Sworn to and subscribed before me this 27th day of September, 1940.

[SEAL] H. E. BEIRNE.

Notary Public, Nassau County. Clk's No. 93. N. Y. Clk's No. 974, Reg. No. 2-B-609.
(My commission expires March 30, 1942)

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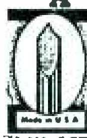

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Date Announced	Concerns Receiving Awards	Item	Amount
Oct. 25	General Electric Co.	Radio Equipment	$8,303,296.50
Oct. 10	RCA Mfg. Co., Camden	Radio Receivers	$7,605,773.06
	Philco Corporation	Radio Receivers	671,000.00
Oct. 7	American Automatic Elec. Sales Co., Chicago	Telephone Equipment	$54,804.72
	Ballantine Laboratories	Microphones	$290,680.00
	Radio Receptor Co.,	Radio Set Equipment	$70,215.75
	Bendix Radio Corp.,	Radio Set Components	$246,641.75
Oct. 5	Bendix Radio Corp	Radio Equipment	$3,565,802.95
	Lear Avia, Inc.	Radio Equipment	$691,500.00
	Western Electric Co.,	Components for Radio Sets	$3,585,954.70
Sept. 28	The Rauland Corp.,	Radio Rec. and Transmitting Equipment	$372,596.00
Sept. 21	Conn. Tel. and Elec.,	Telephones	$540,499.96
	Western Elec. Co.	Telephones	$445,500.00
	American Automatic Elec. Sales	Telephones	$459,140.00
	Stromberg-Carlson Tel. Mfg. Co.	Telephones	$412,500.00
Sept. 13	The Rauland Corp.,	Radio Transmitting Equipment	$454,415.00
	Federal Telegraph Company, Newark, N.J.	Radio Transmitting Equipment	$543,753.50
Sept. 10	Allen D. Cardwell Mfg. Corp., Brooklyn	Telegraph Sets	$90,019.00
Sept. 10	Allen D. Cardwell Mfg. Corp.	Components for Frequency Meter Sets and associated equipment	$247,970.50
Sept. 6	General Electric Co.	Radio Transmitting Equipment	$5,297,775.00
Aug. 20	Federal Telegraph Co.	Radio Components	$121,161.13
	General Electric Co.	Radio Transmitting Equipment	$452,222.50
Aug. 3	Stromberg Carlson	Field Telephones	$148,000.00
	Graybar Electric	Field Telephones	$162,000.00
	Circle Wire and Cable	Wire	$254,966.00
	Phelps Dodge Copper	Wire	$183,413.31
	Graybar Elec. Co.,	Wire	$382,800.00
Aug. 1	The Daven Co.	Components for remote control equipment	$19,970.00
	Holtzer Cabot Elec. Co.	Telephones and Parts	$537,750.00
	Stromberg Carlson	Switchboards and Parts	$399,966.20
July 30	Graybar Elec. Co.	Radio Sets and Related Equipment	$2,004,930.15

NAVY DEPARTMENT

Date Announced	Concerns Receiving Awards	Item	Amount
Oct. 7	Batteryless Telephone Equipment Co. Inc.	Diving Telephones	$34,950.00
Sept. 26	RCA Mfg. Co., Camden	Sound Motion Picture Equipment	$34,467.40
Sept. 19	Bendix Radio Corp.	Radio Equipment	$9,353.42
Aug. 23	J. P. Friez and Sons, Div. Bendix Aviation	Radio Sondes	$67,893.60
Aug. 8	Batteryless Telephone Equipment Co. Inc.	Diving Telephones	$23,300.00

the names of those principally engaged in procurement of communication equipment for tanks, planes, ships, mechanized units and the like:

The Army

Major General Joseph O. Mauborgne, Chief of the Signal Corps: The Signal Corps will place all orders for communications equipment for the Army. General Mauborgne will direct the procurement drive under the defense program.

Major Gilbert L. Thompson, Signal Corps Procurement officer, 78th and First Street, Brooklyn: Major

INDEX TO ADVERTISERS

Thompson's office handles most of the orders placed by the Signal Corps. He is the personal contact man for the Corps in the vital New York and Eastern area.

Other officers of the Signal Corps and their assignments are: War Planning and Training: Major R. B. Moran, Captain F. C. Meade and Captain F. C. Lanahan, Jr. Plant and Traffic: Major Paul G. Gripper. Research and Development: Lieutenant Colonel Hugh Mitchell. Communications Liaison Division: Captain W. T. Guest. Code Section: Colonel S. B. Akin. Fiscal Division: Major J. T. Watson, Jr. Executive Officer: Colonel Clyde L. Eastman.

The Navy

Rear Admiral Leigh Noyes, Director of Naval Communications in the Office of the Chief of Naval Operations: Admiral Noyes' domain is the operation of all communications in ships, submarines and naval planes after their procurement.

Captain Edward Cook Raguet, assistant Director of Naval Communiciations: He is next in line to Admiral Noyes in the operation of Naval communications.

Rear Admiral Samuel M. Robinson, Coordinator of Shipbuilding and Chief of the Bureau of Ships: Admiral Robinson heads up the great bulk of the Navy Communications procurement, as distinguished from communications operation which is presided over by Admiral Noyes.

Commander A. J. Spriggs, head of the radio branch of the design division of the Bureau of Ships: Commander Spriggs is charged with procurement in the Navy expansion program. He has charge of all radio equipment purchasing and procurement of under-water sound and visual signaling equipment, as well as equipment for aircraft. He supervised radio installations on the aircraft carriers Saratoga and Lexington in 1926–27. His experience has been extensive in radio research, design and installation.

Rear Admiral Stanford C. Hooper, head of the inter-departmental communications Liaison Division: Admiral Hooper, dean of Naval communication experts, has attended numerous international conferences on radio and other communications.
—D.G.F.

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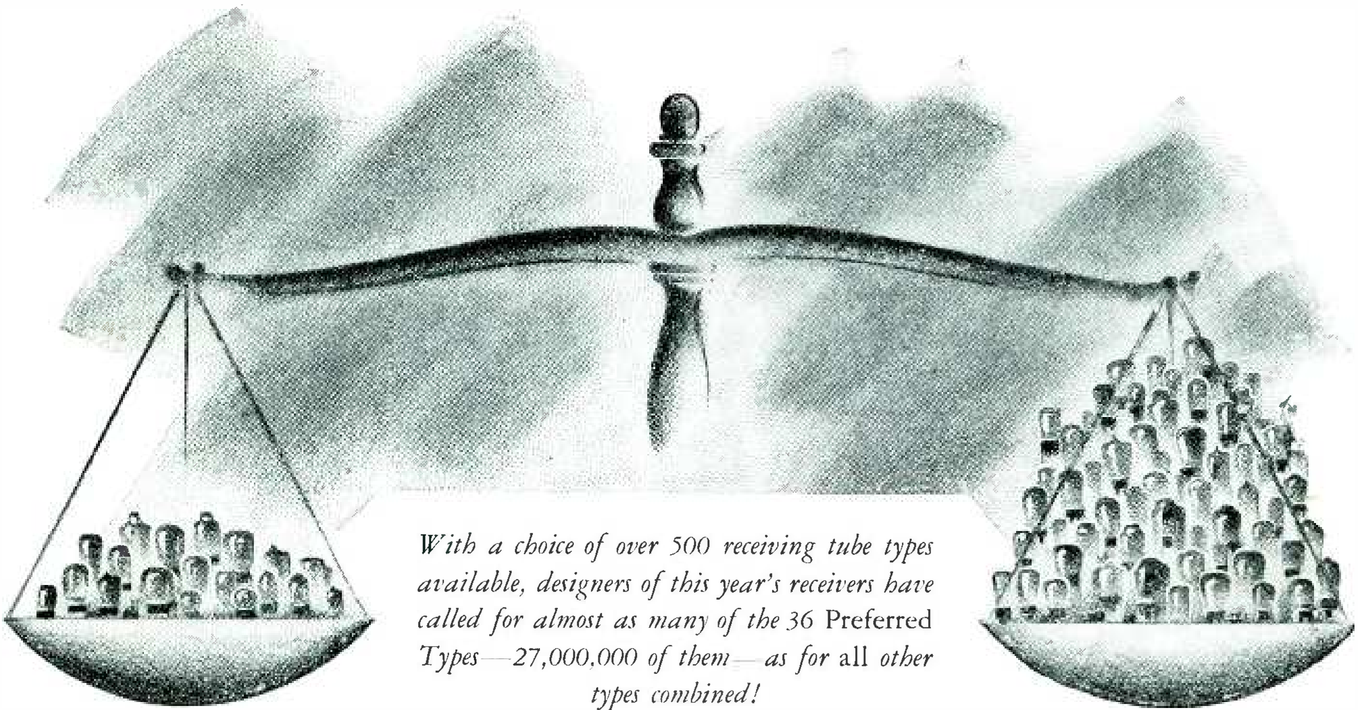

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