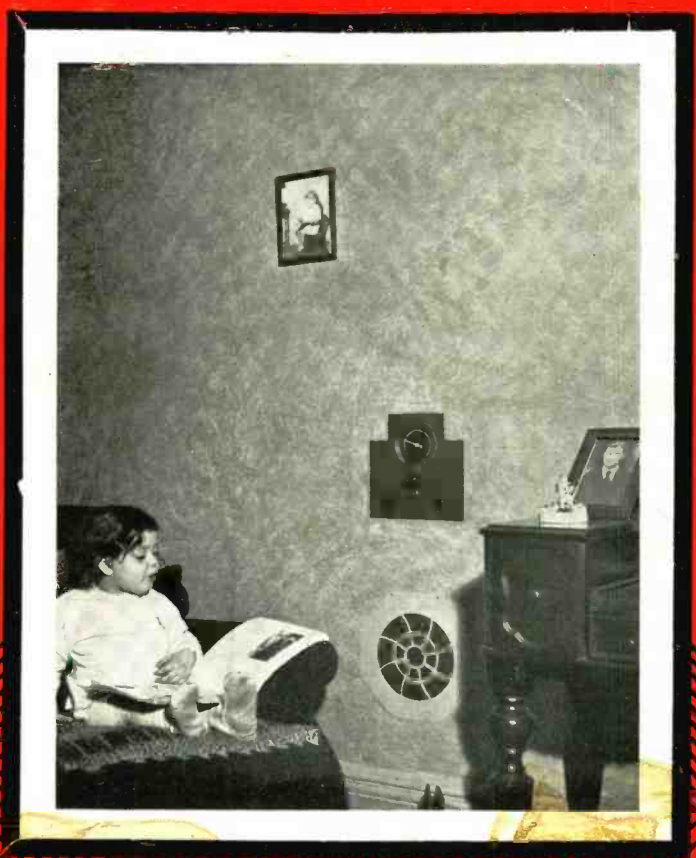
NOVEMBER, 1935

Radio Engineering

VOL. XV NO. 11

DESIGN • PRODUCTION • ENGINEERING

- Broadcast Receivers
- Auto-Radio Receivers
- Electric Phonographs
- Sound Recorders
- Sound Projectors
- Audio Amplifiers
- P-A Equipment
- Electronic Control Devices
- Testing and Measuring Equipment
- Television Appatatus
- Loudspeakers
- Components
- Tubes
- Photocells



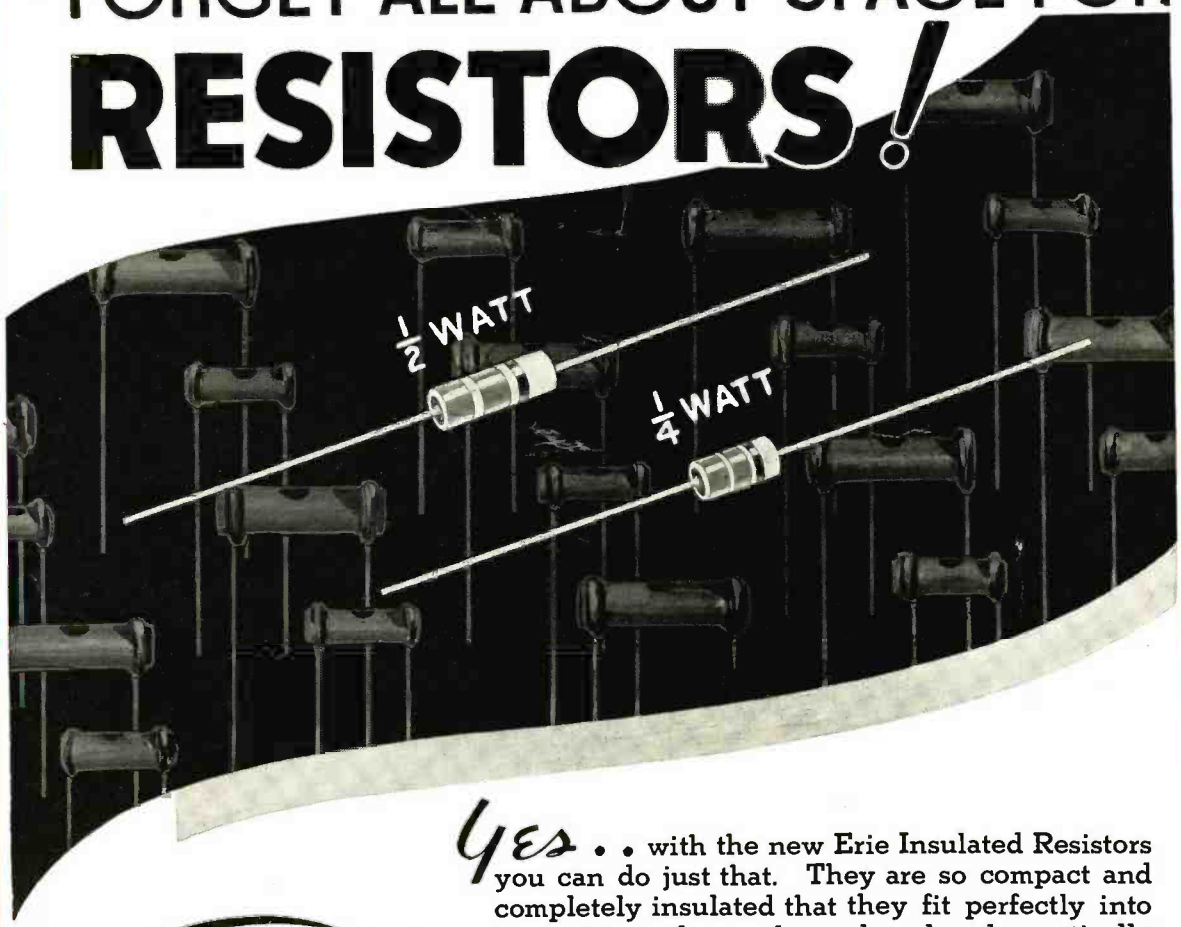
ATTENTION OF:

Pres. _____ V. Pres. _____
Gen. Mgr. _____ Adv. Mgr. _____
Eng. Dept. _____ Prod. Mgr. _____
Sales Mgr. _____ Pur. Agt. _____

The Journal of the Radio and Allied Industries

What . . . ?

FORGET ALL ABOUT SPACE FOR RESISTORS!



DIMENSIONS
ERIE INSULATED
RESISTORS
1/2 watt — 11/16" x 15/64"
1/4 watt — 7/16" x 15/64"
2" leads on both sizes

Yes . . with the new Erie Insulated Resistors you can do just that. They are so compact and completely insulated that they fit perfectly into any wiring plan and can be placed practically anywhere in the chassis.

It is no longer necessary to plan for a central mounting strip on which to fasten the resistors. Point-to-point wiring can be used without danger from the resistors touching other circuit elements.

See for yourself how Erie Insulated Resistors can better chassis design, speed up assembly and improve set operation. A letter to us will bring you a generous supply of samples.

ERIE RESISTOR CORPORATION

ERIE, PA.

***Factories in* ERIE, PA.-TORONTO, CANADA - LONDON, ENG.**

THE HOUSE OF CLAROSTAT

for

INBUILT PROTECTION

ACTUAL SIZE

CLAROSTAT'S facilities for the production of essential components include an experimental laboratory equipped with the latest types of precision testing instruments and staffed with engineers of broad technical experience.

Much of the machinery used on Clarostat's production line is of special design in order to insure the highest degree of accuracy. A constant inspection of parts as they move through production insures the maintenance of Clarostat's exacting standards of precision.

The painstaking care involved in the production of Clarostat Products is your guarantee of uniform high quality. You can therefore depend on the House of Clarostat and the components that leave its shipping department for dependable service.

Clarostat's complete engineering cooperation and manufacturing facilities are available to work with you on standard or special resistor requirements for radio, sound, communication or industrial application.

Write for technical data and samples of Clarostat Products.

NEW—LINE VOLTAGE DROPPING RESISTOR

Designed for use with 0.3 amp. radio tubes with terminal prongs to fit the new metal tube octal sockets for ease of installation. Satisfies requirements of Underwriters.

These units are available in compensated resistance values providing proper voltage drops for heater circuits having one to seventeen 6.3 volt tubes when used on 117.5 volt lines. Pilot light resistor sections for use with 6-8 volt, .250 amp. lamps may be incorporated.

Available in 5 or 8 prong bases. Write for complete list of types.

CLAROSTAT MFG. CO., INC.
285 North 6th Street
BROOKLYN, N. Y.

CLAROSTAT

RADIO ENGINEERING

Reg. U. S. Patent Office

Member
Audit Bureau of Circulations

M. L. MUHLEMAN
Editor

RAY D. RETTENMEYER
Associate Editor

CONTENTS FOR NOVEMBER

COVER ILLUSTRATION

BUILT-IN RADIO IN THE HOME OF E. J. DANNUNZIO, ROCHESTER, N. Y. SUCH INSTALLATIONS ARE NOW ELIGIBLE FOR FHA LOANS

FEATURES

DEPARTMENTS

VOL. XV NO. 11

BRYAN S. DAVIS
President

JAS. A. WALKER
Secretary

Published Monthly by the
Bryan Davis Publishing Co., Inc.
19 East 47th Street
New York City

SANFORD R. COWAN
Advertising Manager

A. B. CARLSEN
Circulation Manager

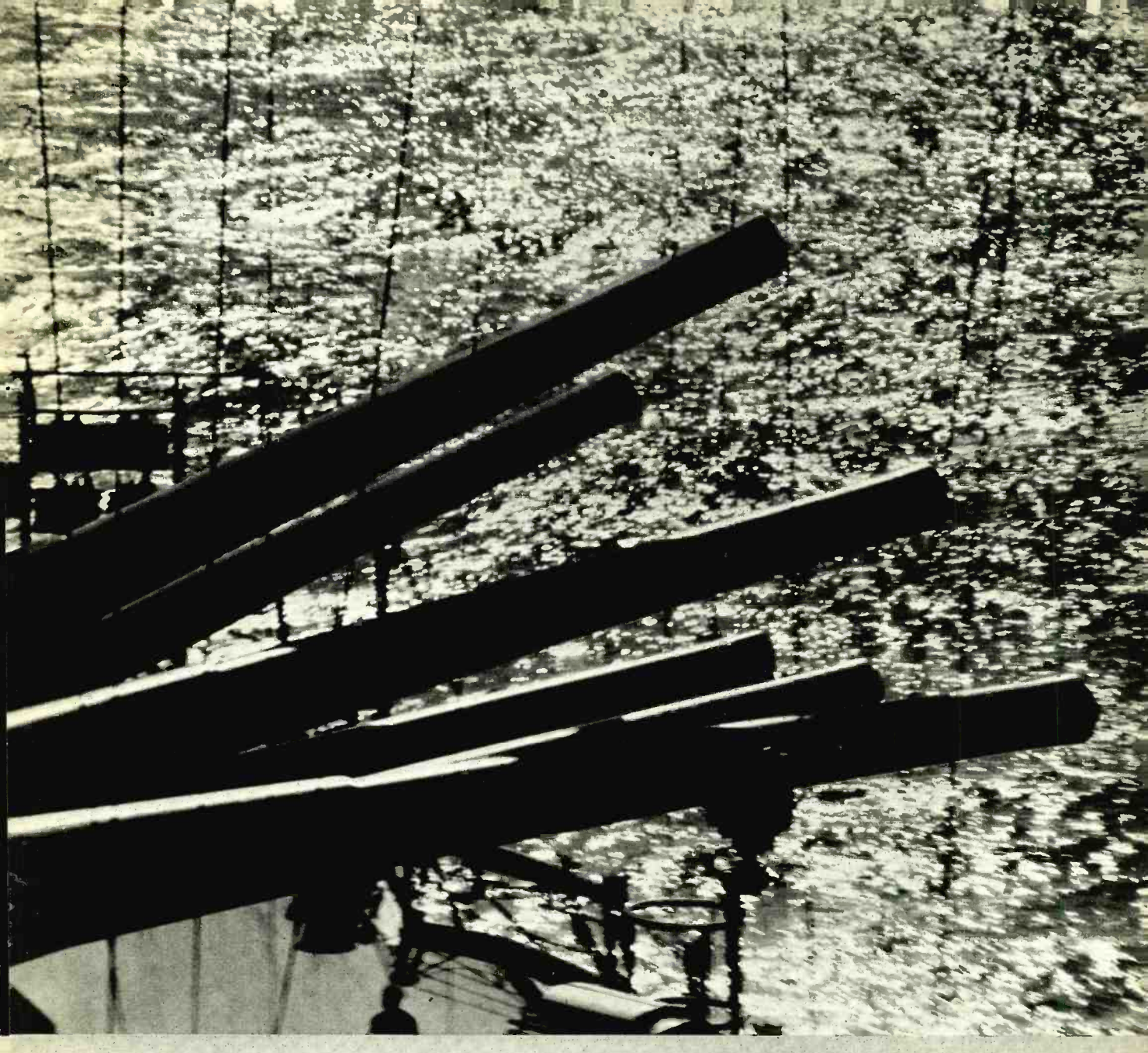
New York Telephone: Plaza 3-0483
Chicago Office—608 S. Dearborn St.—C. O. Stimpson, Mgr.
Telephone: Wabash 1903.
Cleveland Office—10515 Wilbur Ave.—J. C. Munn, Mgr.
Telephone: Republic 0905-J

St. Louis Office—505 Star Bldg.—F. J. Wright, Mgr.

Wellington, New Zealand—Te Aro Book Depot.

Melbourne, Australia—McGill's Agency.

Entered as second class matter August 26, 1931, at the Post Office at New York, N. Y., under Act of March 3, 1879. Yearly subscription rate $2.00 in United States. $3.00 in Canada and foreign countries.



THEY SPEAK FOR US

The reliability of Synthane is responsible for its use in naval gun control apparatus . . . You can assure equal reliability in your products by using the same dependable insulation . . . Synthane laminated bakelite.

SYNTHANE LAMINATED BAKELITE
SHEETS • RODS • TUBES
FABRICATED PARTS
Send for Sample Book

SYNTHANE
CORPORATION OAKS · PENNA

EDITORIAL

CRYSTAL FILTERS

NOW THAT GAIN is no longer a major problem in receiver design, it is possible that some of it could be sacrificed for the purpose of obtaining more satisfactory band-pass characteristics in all-wave and high-fidelity sets.

It is difficult to obtain the character of selectivity required for high-fidelity reception, and reception in the jammed short-wave broadcast bands, through the use of inductance and capacity. The time seems to be ripe, therefore, to turn to the crystal filter for all the losses it introduces.

It would be sweet to throw the burden of selectivity on a crystal filter. It would solve a number of problems which may never be solved if the engineer continues to angle for optimum band-pass characteristics in i-f transformers.

The application of crystal filters to home receivers cannot be expected overnight. There is a lot still to be done before the system will be practical, but now is the time to get going.

A general article on the subject appears in this issue. Other articles, more specific than the present one, will follow.

• • •

BAND SPREAD AND SCALES

EVERYONE STARTED OUT with good intentions with mechanical band-spread and "all-wave" dials. Intentions are still good, but most of the dials are not.

First of all, more spreading is required to take care of the now overcrowded 6- and 9-megacycle international broadcast bands. Secondly, the effectiveness of the "minute-hand" band-spread pointer should be increased by the addition of complete and continuous scale graduations for each band scale. With most present-day dials, it is not possible to log stations because of the absence of these graduations at the very points where they are required most.

• • •

HOUSEHOLD ROBOT

THE LARGE CONSOLE radio receiver—and possibly smaller receivers as well—could be made to serve more purposes than one in the home. We offer no suggestions as to what services might be added, but merely point out that there is enough automatic, electronic equipment in the average set to handle many tricks of a helpful nature.

It's worth study, for sooner or later the radio industry will require a new sales point.

• • •

AUTOMATICS

THE RESULTS OF A recent survey of public reaction to radio programs, indicate that the majority favor the one-hour presentation, even to the exclusion of ace features taking fifteen minutes or a half hour on the air. Why?

Can it be that the one-hour program is favored because it saves steps to the radio? Do people weary of tuning back and forth every fifteen minutes or so?

Remotely-tuned radio sets have been offered to the public many times, but this type has, for some odd reason, never been well accepted. Possibly the story is different today. Possibly a modern automatic job—a real step saver, would go over big.

Which reminds us—controlling a receiver by means of a small, hand flashlight is not as silly as it sounds. It has been tried for the fun of the thing, and it is surprising the comfort it brings. A whole evening in one chair without having to move!

• • •

HEAT AND SOUND

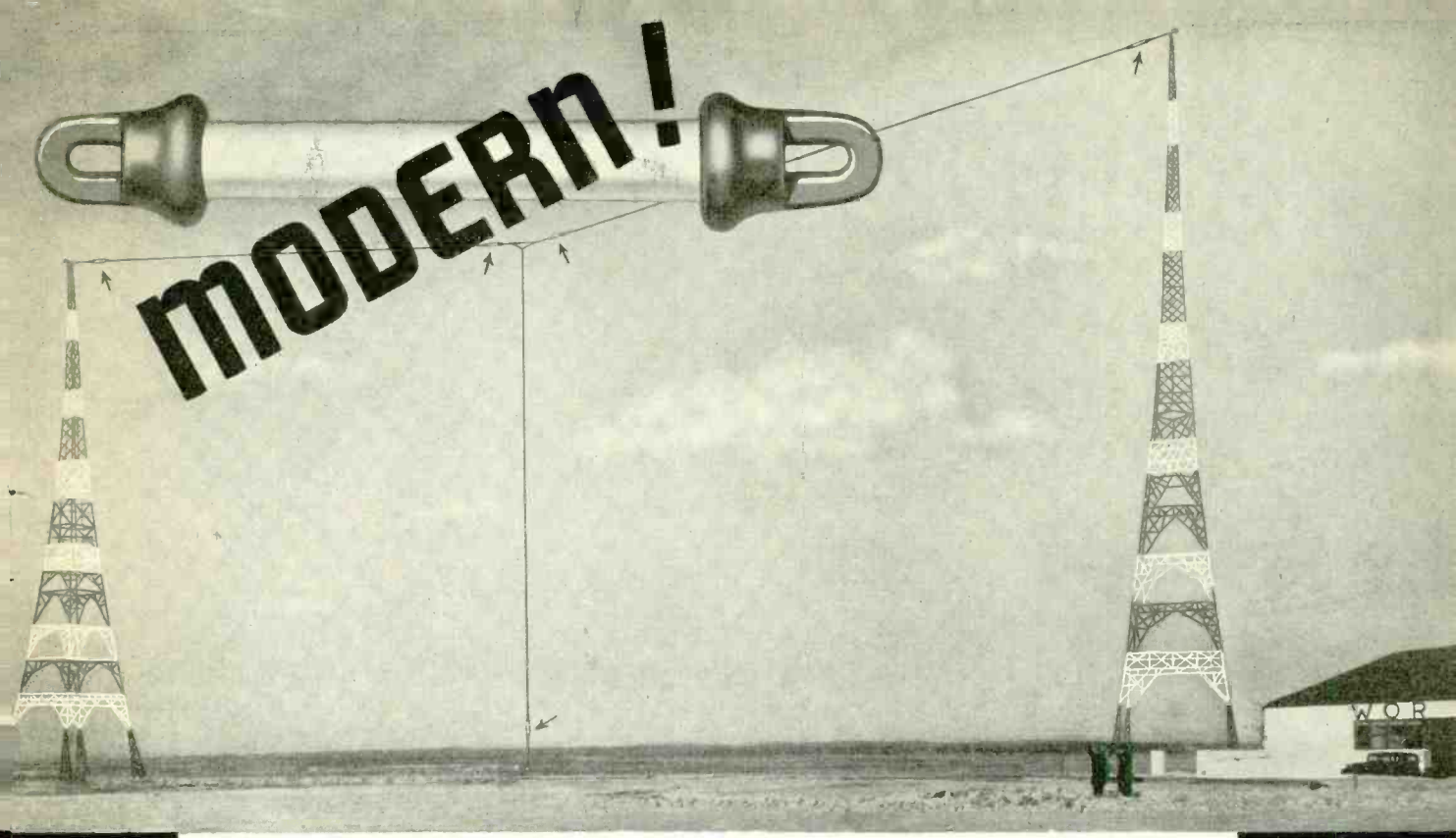
BOTH HEAT AND SOUND should be controlled in the radio receiver. Since precision has become a necessity in both all-wave and high-fidelity sets, more thought should be given to the insulation of condensers and coils from the effects of heat and vibration.

Some of the materials used in the building field could be put to good use in the radio receiver. Housings of insulation material for coils and condensers would prevent a lot of drifting at the higher frequencies. Good air circulation is usually not sufficient to keep things constant.

• • •

PLATED COILS

HAS ANYONE TRIED copper plating a ceramic coil form and "turning out" the coil on a lathe? One ought to be able to get this down to a science, and the coils should be superior for high- and ultra-high frequency work.



Panorama of WOR 50 K.W. Broadcast Station

ISOLANTITE PLAYS AN IMPORTANT ROLE IN THE MODERN BROADCAST TRANSMITTER.

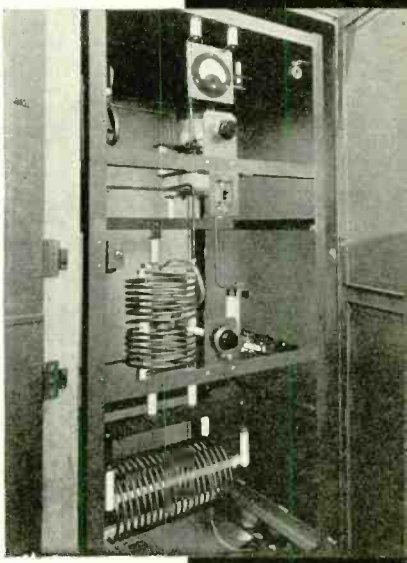
The 50 K.W. Transmitter recently built by Western Electric for Station WOR employs ISOLANTITE liberally.

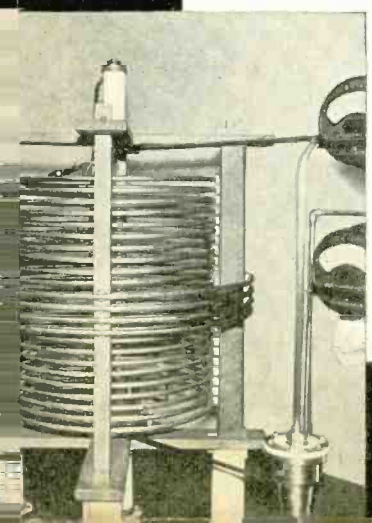
In this up-to-date station are strain insulators, concentric transmission line spacers and end seals, stand-offs, switches, shafts, inductance supports, power and rectifier tube supports, condenser cases, pedestals and many other parts of ISOLANTITE.

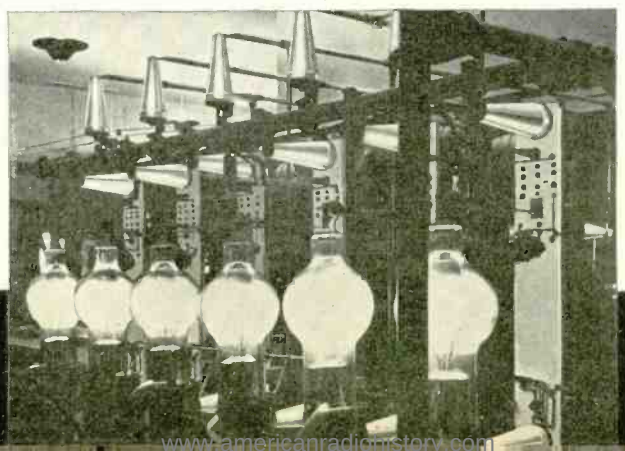
To improve your equipment, specify ISOLANTITE insulation. ***Isolantite, Inc., 233 Broadway, New York, N. Y. Factory at Belleville, N. J.***

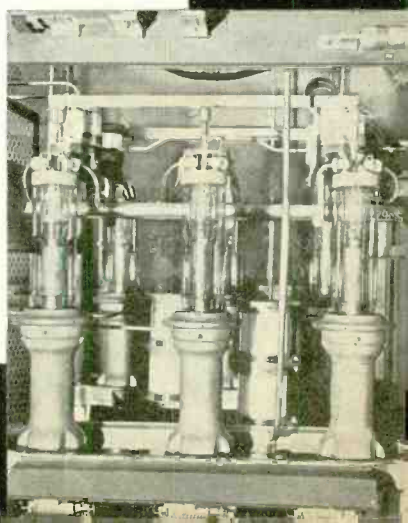
Represented by GRAYBAR ELECTRIC CO.

Isolantite
CERAMIC INSULATORS









UTC

THE MOST COMPLETE
LINE OF TRANSFORMERS ON THE MARKET

Assure yourself of matched and balanced performance by purchasing all of your units from one manufacturer. There is a UTC Transformer for every transmitter, receiver, transceiver, test set, power amplifier or power supply.

UTC Linear Standard Audio Units are the finest quality transformers available regardless of price. Each transformer is housed in a high permeability cast iron shield. The transformer illustrated is a high power output transformer. These transformers are individually calibrated and the response is in accordance with the most rigid requirements of outstanding High Fidelity Broadcast Stations.

Write for the U1100 B bulletin describing the use of Linear Standard Units in amplifier circuits having an output of from ½ watt to 1,000 watts. Also includes Decibel, Reactance and Resistance data charts.

●

UTC Transmitter Components are used by discriminating commercial organizations and experimentors to obtain superior, long lasting results. The unit illustrated is an output transformer designed to match Class B 203's or A Prime 845's to a 6,500, 5,000 or 3,500 ohm load.

●

A typical value in the new CHROMSHIELD FILAMENT Transformers, outer shields chromium plated—bakelite terminal strips—with new type solder or screw terminals. Will handle 4-83's in bridge rectifier circuit, insulated for 5,000 volts.

A typical CHROMSHIELD lower power Plate Transformer—800 volts each side of center at 150 M.A.

CHROMSHIELD Stepdown Transformers 220 - 240 to 110-120 volts, 50-60 cycles. Available in 85, 125, 175, 250, 500 and 1000 watt capacities.

Many other types are described in the new CS-1 Bulletin.

Standard Discounts to Laboratories and Manufacturers of Radio and Electronic Devices.

●

CHROMSHIELD
AMPLIFIER KITS

Radio and PA engineers who have spare time in which to increase their income are building the new UTC Chromshield Amplifier Kits. Why not save $15 to $25 on every amplifier you build yourself. Completely detailed wiring diagrams and point-to-point layouts showing actual placement of all accessory components furnished free with each kit.

CK-7 METAL TUBE PREAMPLIFIER KIT

The CK-7 preamplifier kit uses two metal 6C5 tubes in cascade amplification. A 6C5 is used as a rectifier. Careful placement of parts and shielded components is responsible for the extremely low hum and noise level in the CK-7 preamplifier. The overall gain is 55 DB.

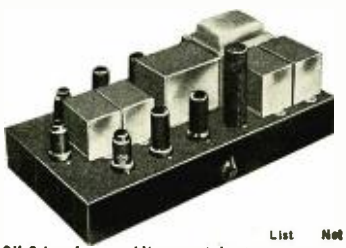
	List	Net
CK-7 transformer kit mounted on chassis	$16.00	$9.60
AK-7 accessories includes all necessary resistors, condensers, sockets, AC cord and plug, hardware, wire...	6.00	3.60

CK-2 AMPLIFIER KIT

The CK-2 amplifier kit is designed for use with crystal microphones. The gain is in excess of 100 DB and the power output is 10 watts. Only four tubes are used, including the rectifier. The plates of the first 6A6 tube are cascaded to permit very high amplification and stable voltage transfer to the second 6A6 driver tube. The final 6A6 is arranged in push pull class B operation.

	List	Net
CK-2 transformer kit with CS-35 output, including chassis	$19.50	$11.70
AK-2 accessory kit includes all necessary resistors, condensers, sockets, terminal strips, hardware, AC cord and plug, ready to wire....	10.50	6.30

CK-8 METAL TUBE SUPER POWER AMPLIFIER



35 watts undistorted output; will handle up to 20 dynamic speakers. 8 tubes used: 3-6C5 triodes, 4-6F6's in Pentode A prime connection. 1-5Z4 rectifier. 95 DB gain. Input of amplifier will match crystal or ribbon mike outputs, also adapted for carbon or dynamic mikes through external transformer input.

	List	Net
CK-8 transformer kit mounted on chassis	$34.00	$20.10
AK-8 accessory kit for above—includes all necessary resistors, condensers, sockets, terminal strips, AC cord and plug, hardware, wire	11.00	6.60

Our Standard Discounts Apply

UNITED TRANSFORMER CORP.
72-78 Spring Street :: New York, N. Y.

EXPORT DIVISION: 15-19 LAIGHT ST., N. Y. C.

RADIO ENGINEERING

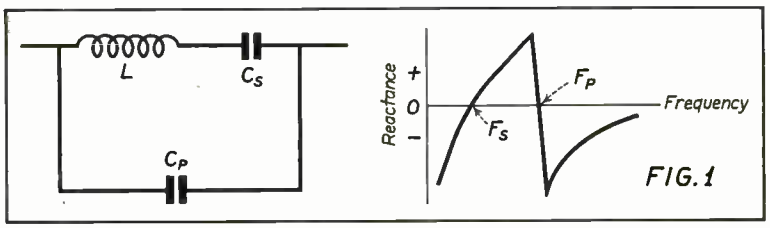
FOR NOVEMBER, 1935

CRYSTAL FILTERS FOR RADIO RECEIVERS

By C. F. NORDICA

The tendency toward higher fidelity and consequent wider band intermediate-frequency filters has been carried to a point that demands a large number of low-Q tuned circuits for adequate selectivity. As the bandwidth is extended, the requirements of slope of i-f characteristics become more exacting. A pass band of 10 kc can usually be made sufficiently selective with a reasonable number of tuned coupled circuits to meet most of the demands placed upon it. However, a bandwidth of 16 kc, which seems to be the accepted standard for high-fidelity receivers, presents a far different problem. While 10-kc beat-note interference can easily be removed by an adequate 10-kc band elimination filter, the interference due to the adjacent sideband of the station in the next channel may result in intolerable interference. The sideband energy in general increases considerably as the carrier is approached. As a result considerable trouble can usually be expected in the night-time reception of almost any station in a wide-band receiver.

To be sure nothing can be done to avoid the interference resulting from this unwanted sideband which falls in the pass band of a receiver. Matters would be considerably simplified, however, if the slope of the i-f curve could be made essentially perpendicular. The physical limitations of tuned coupled circuits are well known and anything approaching the required cut-off with a reasonable number of elements is out of the question.



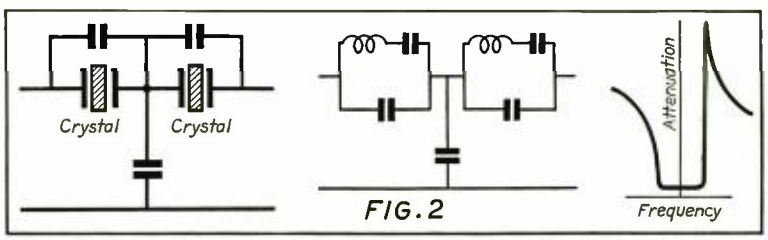
Equivalent electrical circuit of crystal filter, and resonance frequencies.

ENTER THE CRYSTAL

The question of the use of crystal i-f filters as a solution to the problem naturally arises and it appears that we may hear more of this matter before we hear less. Indeed, it is rumored that several manufacturers are working on the problem. Since there have been a number of articles published on the matter during the past few years, it is the purpose of this article to point out some of the possibilities and limitations of crystal filters in the light of present knowledge of the matter. As is well known, crystal filters have extremely sharp cut-off and have in some degree been used already in radio applications outside the field of home receivers.

CRYSTAL RESONANCES

It is well known that quartz crystals which vibrate along their smallest dimension, as is customary for frequency control of oscillators, may have a large number of resonances liberally sprinkled about their frequency of maximum response. This feature must obviously be minimized in crystals used for filters. To reduce the unwanted response it is customary to make the dimension along which the crystal oscillates large with



Band-pass filter employing condensers and crystals, with equivalent electrical circuit and resonance curve.

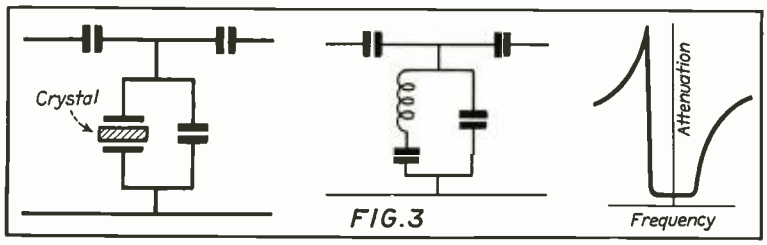


Fig. 3. Crystal filter with high attenuation peak.

complishing this result, but in the light of present knowledge it is probably the most effective.

The equivalent electrical circuit[1] of a crystal is shown in Fig. 1. Resonance frequencies are given by the following formulae:

$$\text{Series resonance } F_s = \frac{1}{2\pi\sqrt{LC_s}}$$

$$\text{Parallel resonance } F_p = \frac{1}{2\pi}\sqrt{\frac{C_s+C_p}{LC_sC_p}}$$

Since the Q of such circuits are of the order of 10,000, it is to be expected that the pass band of the resonant circuit will be extremely sharp. The ratio of C_p to C_s for the usual structure is of the order of 125 and this places a definite limitation on the width of pass band and slope of the resonance curve of crystal filters.

The ratio of the series and shunt resonant frequencies is determined by the ratio of capacities as follows[2]:

$$K = \frac{C_p}{C_s}$$

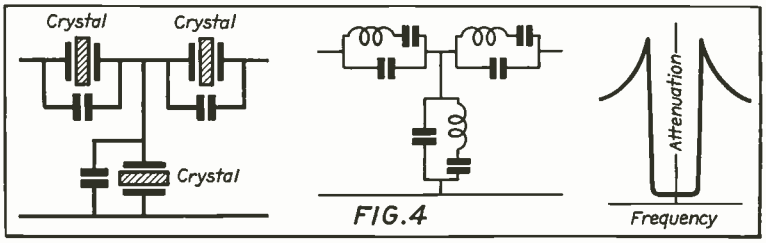
$$\frac{F_p}{F_s} = \sqrt{\frac{K+1}{K}}$$

TYPICAL FILTER CIRCUITS

At first thought it would appear that it would be preferable to associate condensers with crystals to form a suitable bandpass filter, since good condensers have a Q which is comparable with that of a quartz crystal. One type of bandpass filter employing only condensers and crystals is shown in Fig. 2, together with its equivalent circuit. This type of filter circuit will have a point of high attenuation but slightly higher in frequency than the high-frequency cut-off. A similar circuit employing one crystal, but with a high attenuation peak slightly lower in frequency than the low-frequency cut-off, is shown in Fig. 3 with its equivalent circuit. Fig. 4 shows a circuit employing three crystals which have a high attenuation peak adjacent to each cut-off frequency.

The lower cut-off frequency of Fig. 2 will fall at the series resonant point of the crystal and the upper cut-off frequency will fall between the series resonant frequency and parallel resonant frequency. The upper cut-off frequency may be adjusted by the parallel shunt capacity. The parallel resonant frequency will be the point of highest attenuation. For filters of this type the ratio[3] of parallel resonant frequency to series resonant frequency will be less than 1.004. Therefore, the pass band will be less than 0.4 percent of the midband frequency. The same ratio holds for the filter structure of Fig. 3. The addition of condensers in series or parallel with the crystals only serves to narrow the pass band. Thus to obtain a 16-kc pass band would require a midband frequency of more than 4,000 kc, for either of the structures of Fig. 2 or Fig. 3. Almost twice the bandwidth can be obtained with the structure of Fig. 4. But an i-f of 2,000 kc or more is still too high for most purposes, to say nothing of the fact that three crystals per section are required.

Fig. 4. Filter employing three crystals.



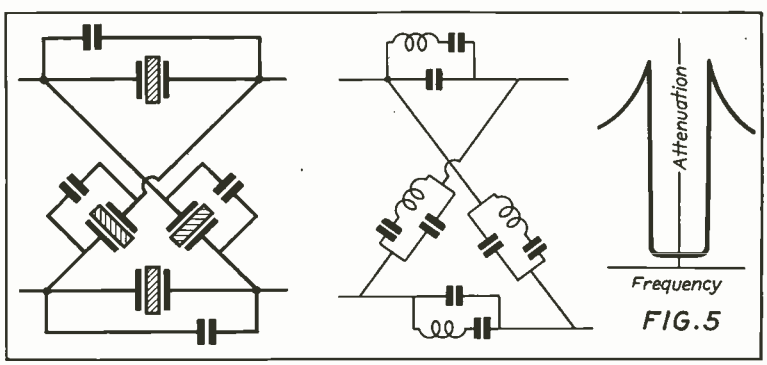


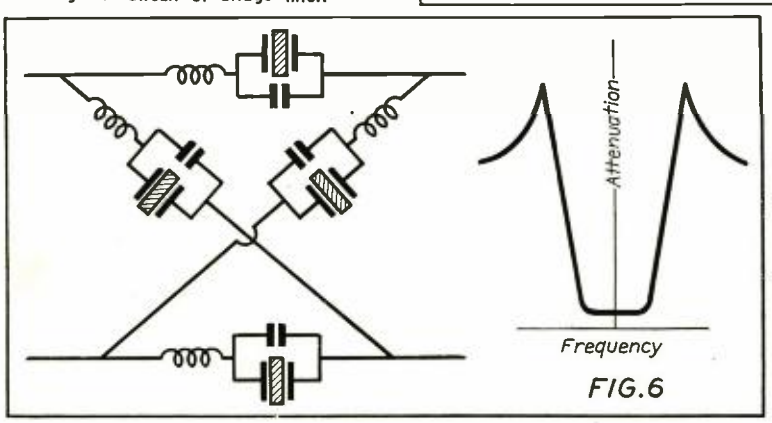
Fig. 5. Circuit of lattice filter.

LATTICE FILTER

Fig. 5 shows a bridge or lattice type of section employing four crystals.

(*Continued on page 25*)

Fig. 6. Circuit of bridge filter.



[1] W. J. Cady, Phy. Rev. XIX 1922.

[2] W. P. Mason, Bell System Tech. Jl. XIII, No. 3, 1934.

LOOKING AHEAD IN RECEIVER DESIGN

I—EXTERIOR

By M. L. MUHLEMAN, Editor

WHAT is a radio? Is it a musical instrument, a mechanical contrivance, a piece of furniture, or a little of each? Or is it, after all, specifically a radio and none of these other things?

If you take the viewpoint of the consumer, a radio is neither fish nor fowl —on the one extreme it may appear to be a cross between an electrical refrigerator and a skyscraper, and on the other extreme a rather poor imitation of an early lowboy. In any case, it is viewed as a hybrid, which is not a very satisfactory condition.

Is it possible to say that a radio is specifically just one thing and no other? If so, then is it a mechanical device, to be treated as such, and stripped of all non-essentials? Or is it essentially a piece of furniture, the mechanics to be completely hidden, or made unobtrusive? Or, is the radio possibly more in the nature of a musical instrument, such as the piano?

FUNCTION AND PURPOSE

The answer will depend upon whether you consider a radio from the angle of its *function,* which is mechanical, or whether you consider its *purpose,* which is cultural. That is, the answer will depend upon these angles if you exclude one altogether, but if you will accept the function and the purpose of a radio as being affinitive, as they are, and as they are in the piano, there is no reason to presume that the fundamental design of a radio receiver should not be distinctive from all other forms.

Suppose we look at it this way: If the function and the purpose of a radio receiver are given equal recognition, neither the expression of one or the other need be subdued in the over-all design. If we give free play to these characteristics, the design should be pleasing—at least, so say the craftsmen.

The difficulty seems to have been that the designer has attempted to suppress one or the other of these two essential factors and in doing so, entirely lost the *character* of the radio.

The mechanics of a radio are nothing compared to the mechanics of a piano, yet the piano has a quiet grace, a distinctiveness, that the radio has never acquired. Presumably this is so because the piano has never been made to be anything but a piano . . . its form follows its function, as the designer would say, and function creates form.

"FUNCTIONAL"

The architect, and the designer, too, refer to modern structures as "functional," meaning that they typify or express the service for which they were made. Frank Lloyd Wright considers an office building a "machine for living," and I suspect that the ultra-modern furniture we had with us some years back was purely a misinterpretation of Mr. Wright's new way of expressing structural design. A bookcase, for instance, has a purpose, but no function, and in consequence should not express a mechanical or dynamic characteristic completely foreign to it.

"RATIONALIZED MODERN"

The rationalized modern furniture designs we have with us today are something else again. This is a far better interpretation of that which Mr. Wright had in mind when he was quoted on functionalism. He is understood today to have meant that any materials or designs not essential to the utility or the support of a structure have no place in the scheme, and only detract from or hide the pleasing lines that create the natural form. This will be observed as a restatement of what has been said with regard to *function* and *purpose,* and in the light of both definitions it turns out that the grand piano, for instance, and colonial furniture, are sufficiently clean of line to be termed rationalized modern.

CONSUMER ACCEPTANCE

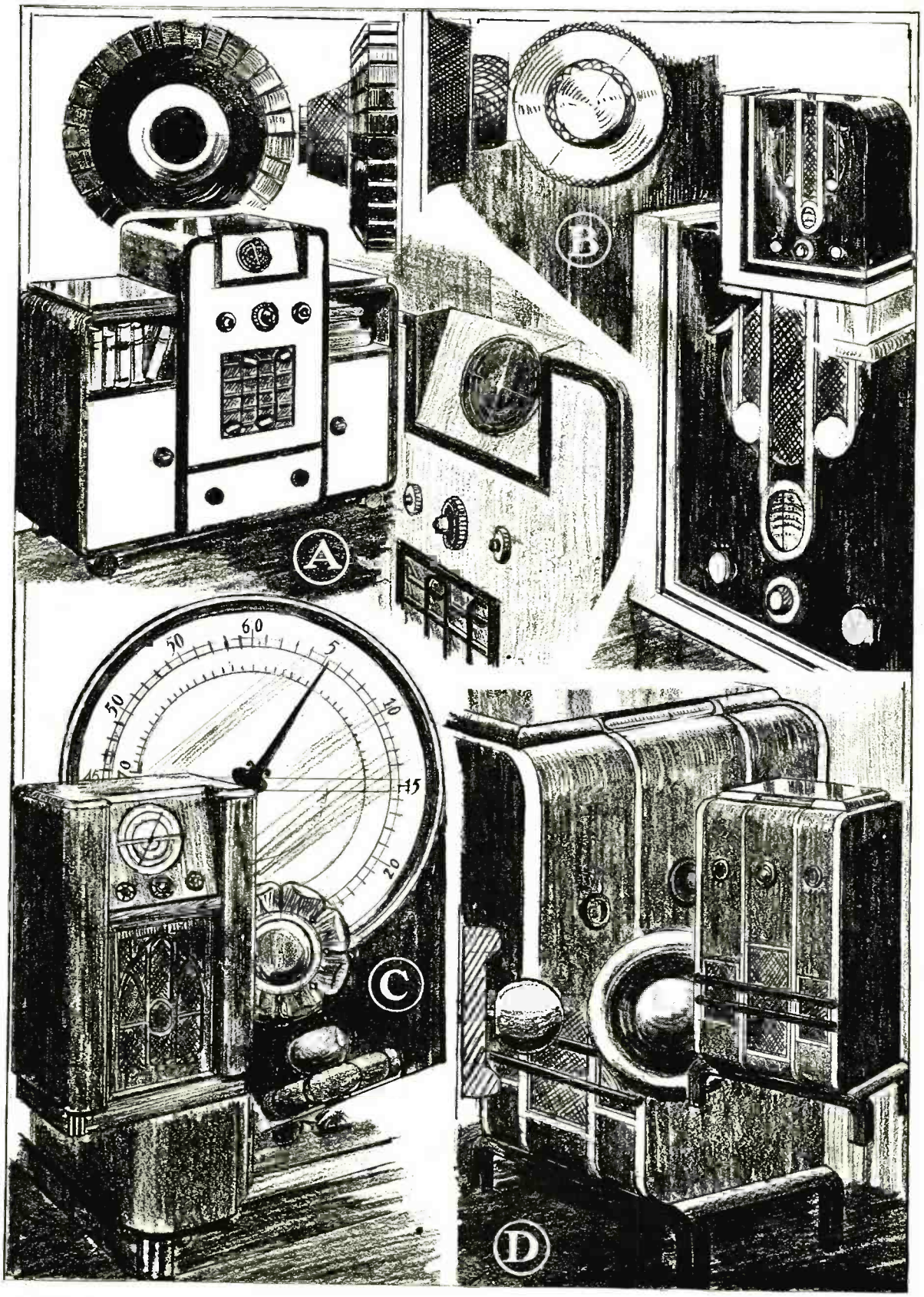
Radio manufacturers have been torn between the "modern" and the "conventional" in cabinet design. No doubt the percentage of each type produced should bear some relation to the trend in consumer acceptance providing, of course, that the manufacturer feels impelled to produce both types of design. A survey made of the furniture field shows there is a strong trend toward the rationalized modern. However, sales are principally to apartment dwellers for the present, which suggests that these designs may not move so readily outside large centers of population for some time to come. Reports on the prevailing tastes of home owners and home builders are conflicting. Results of the survey conducted by the *Architectural Forum* for FHA indicate that the desire for homes of conventional architecture is still predominant, meaning also that furniture of conventional design still holds the tail of the market. *Fortune* (October, 1935) declares a landslide for modern in 1936, but this appears to be wish-thinking, for the percentages quoted do not appear to tally at the source of origin.

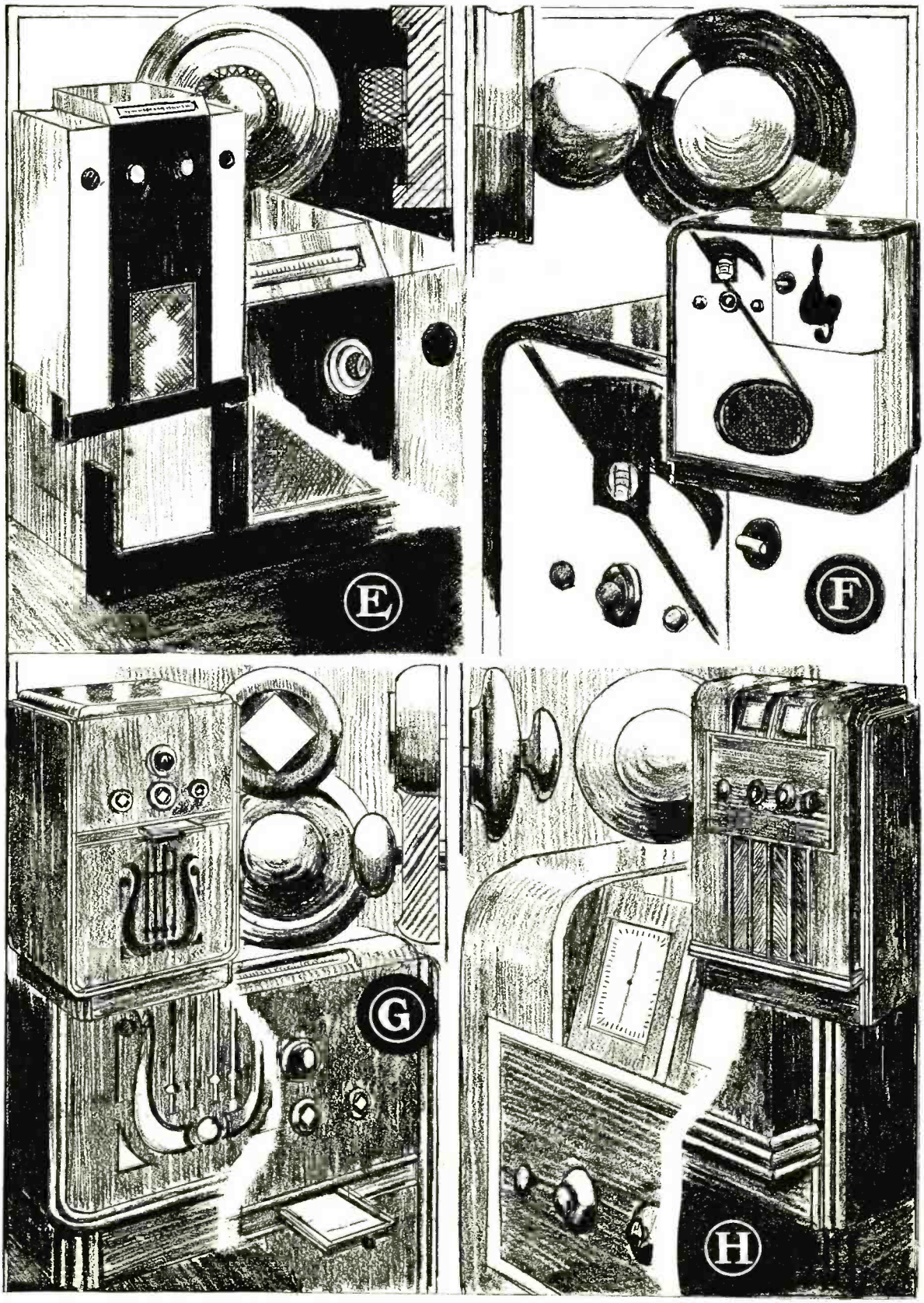
NEW APPROACH

But, *should* the manufacturer worry his head over modern and conventional percentages at the end of the production line when the rationalized modern, which is far from being a compromise, appears to be practically the solution of the radio cabinet problem? It is, in any event, a starting point, and may lead to a design as distinctive and as characteristic as that of the grand piano. It is a design having flexibility, and to its structure may be applied touches from earlier periods without their detracting from the general appearance.

No design, however, is of any value, or is it true to form, if, in its execution the controls and the indicators are handled as an after-thought. If both function and purpose are to follow form the result is bound to be disastrous. Function, purpose and *convenience*

(*Continued on page* 14)





(*Continued from page* 11)
should be considered first—these factors will create the form.

There has been a tendency right along to subdue control knobs and tuning dials, on the assumption, probably, that if they were made with an eye to convenience they would turn out to be ugly. This skimping on controls has been done to gain an effect, yet the effect has not been a good one.

If form is to follow function, the cabinet must bear some relation to chassis design, but it is essential that the relation between the two be natural rather than artificial. Naturalness of form can be attained only through the adaptation of the cabinet to the chassis—*never* through the adaptation of the chassis to some specific cabinet design.

CHASSIS DESIGN

The first essential, however, is that the chassis be mechanically and electrically practical. The tuning dial should be as easy to read as a newspaper headline. If this necessitates the use of a dial the size of a pie plate, let it be so. The dial should be so positioned that it may be read without the listener having to bend over or crouch down. If this means that the dial must be set at an angle with relation to the cabinet front, or placed in the top surface of the cabinet, then arrange it so, and worry about the appearance of the cabinet afterwards.

The tuning indicator should be in approximately the same line of vision as the tuning dial. Markings for the band-selector switch, volume control, selectivity control, etc., should be easily readable. If such readings cannot be made sufficiently clear when placed in direct relation to the controls, relegate them to the surface of the tuning dial scale, or add an indicator window supplementary to the tuning dial.

Manually-operated controls should be easy to handle. Make them as big as door knobs if necessary. This is particularly important with regard to the band-selector switch, but the larger the knobs on all controls, the easier will they be to operate.

"CHARACTER"

Now, if we assume that such a chassis has been designed, the question may arise as to how such large controls and indicators may appear on the cabinet front. And that is the very question which has kept most manufacturers from attempting to produce a radio receiver true to form. Yet the "character" of a radio is expressed not only by its cabinet, but, first, by its function, represented in concrete form by the dial and the controls, and, second, by its purpose, represented by the loudspeaker. It is natural, therefore, to emphasize these factors rather than subdue them, but with the emphasis being the natural product of the utilitarian features. This is exactly the basis upon which all appropriate design rests, and as good an example as any is the grandfather's clock, which, as mechanical as it is, has a quiet grace and distinctiveness intimately related to its function.

REPRESENTATIVE DESIGN

On opposite pages in this issue are shown a group of generalized designs, developed by Mr. J. W. Campbell, a furniture craftsman who has had considerable experience in this type of work. Mr. Campbell has shown what may be done with controls and indicators in relation to cabinet surfaces, without actually pinning down his work to narrow design limits.

Each sketch serves to emphasize but a few features, and a study of the complete set of sketches will show that each design has been given considerable latitude.

Sketch (A) leans toward the modern in design, but serves principally to indicate, first, the possibility of adding to the utility of a radio receiver by placing it in a cabinet having storage space and book shelves and, second, demonstrating the effectiveness of an inclined tuning dial panel and large control knobs. A musical motif is given the speaker grille. The detail drawings of the tuning control show that both knobs have been given "grippings" minus any mechanical appearance.

Sketch (B) also inclines toward the modernistic, but could as well be conventional or rationalized modern. Again there is the musical motif, the dial itself forming the center of two superimposed musical notes. The smaller musical notes which tie in with the tails of the larger notes, and so form the speaker grille decoration, could be carried down the cabinet surface to form centers for the tone- and volume-control knobs. The tuning dial in this case is parallel to the front surface of the cabinet, principally for the reason that table-model receivers are usually set high enough for the dial to be within or near the level of the eye.

LARGE DIALS

In sketch (C) we have a receiver with large tuning dial and large control knobs. A portion of the dial is shown separately for the purpose of demonstrating that, even though large numerals are used, the sting of the mechanical may be removed by following numerical styles having graceful lines—such as Caslon, for instance. The cabinet, though verging on the rationalized modern, has been given touches of modified Gothic—in the speaker grille, for instance, and in the control knobs, where the gripping surfaces are a derivation of the Gothic rosette.

Sketch (D) shows how the dial scale may be made to blend in with the sweep of the cabinet without breaking lines. The dial is of the rotating, cylindrical type, and so positioned in the top edge of the cabinet that it may be easily read irrespective of whether the listener is sitting or standing. Here again the design is rationalized modern, but is derived from Chinese forms. The large control knobs follow example, yet are remarkably simple of line.

STRAIGHT-LINE DIALS

(Sketch (E) is a fling at the ultra-modern form and is amendable to numerous changes because of the absence of period restrictions. The tuning dial is similar to the one shown in sketch (D), but has the slanting panel.

Sketch (F) shows a combination radio-phonograph, the entire design having a musical motif. The compartment behind the door contains the pick-up and turntable, and shelves for records.

Sketch (G) also has the straight-line tuning scale worked into the top edge of the cabinet. There is no escutcheon to break lines. Instead the slit in the cabinet is rounded on the edges. There is a small drawer directly beneath the controls, for station lists or program schedules. The speaker grille is cut into the solid surface of the cabinet front.

MULTIPLE INDICATORS

Sketch (H) is similar in many respects to some of the other designs, but has dual control-reading windows. In one design, the left-hand window contains the dial scales for the short-wave bands only. The right-hand window contains the dial scale for the standard broadcast band, with the call letters of cleared channel stations properly spotted. The pointer of this dial is geared directly to the hour-hand pointer on the short-wave dial. In another design the right-hand window contains the complete tuning scale, while the left-hand window is used for the tuning indicator, wave-band switch indicator and band-width indicator.

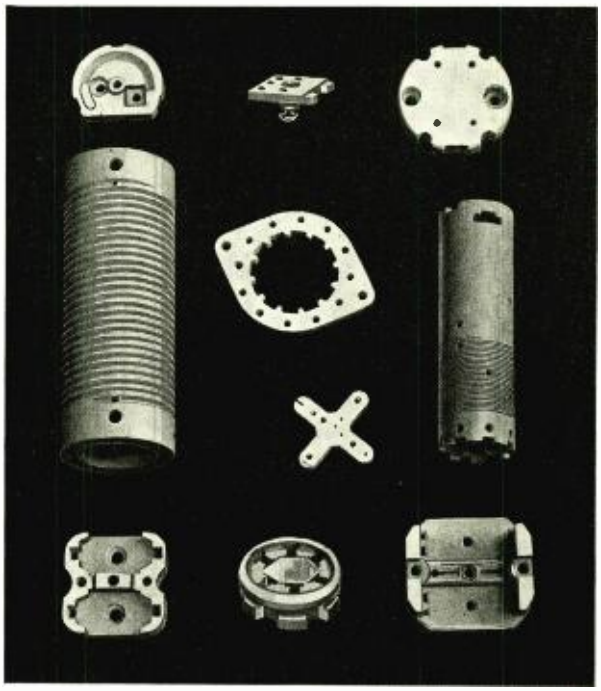
CABINET MATERIALS

Nothing has been said so far with regard to the materials used in the designs shown. Wood, of course, comes into wide usage, but in many of the sketches

(*Continued on page* 17)

Alsimag 196–

A New Ceramic Insulating Material For High - Frequency Purposes



By HANS THURNAUER M. Sc.
Development Engineer
AMERICAN LAVA CORPORATION

Electrical insulation problems are as important to the electrical engineer as electrical science itself and improvements in electrical insulating materials must be kept in step with the progress in electrical engineering. The desire for increased output of generators and transformers necessitated the development of insulators which worked satisfactorily at elevated temperatures. The power output of electrical machines is, even today, limited to the relatively low temperatures at which organic insulating materials can be used. The story of the progress made in electrical transmission is at the same time the story of the development of the high-tension porcelain insulator. Desired properties for the ideal insulator are: good dielectric strength, high mechanical strength, stability, workability, and last but not least, low cost.

For radio, the problem of insulation becomes involved with another important factor—frequency. For 60 cycles many insulating media work satisfactorily because losses at that frequency are inconsequential. As radio frequencies become higher, dielectric losses become more important. Glass and porcelain, hard paper or bakelite, satisfactory for the original long-wave transmitters, are no longer permissible in the short- and ultra-short-wave field.

QUARTZ INSULATORS

For a long time fused quartz has been regarded as the only ideal material for high-frequency purposes because it combines very low dielectric loss with stability and rigidity. The general application in transmitters and receivers is, however, prohibited because of the high cost of manufacture and also because of the limited possibilities of molding this material into desired shapes. Insulators made out of quartz glass have been used to a certain extent in transmitters for ultra-short waves and gave satisfactory service. However they never could be used in radio sets where mass production together with accuracy of dimensions and low cost are deciding factors.

Fortunately enough the radio engineer has now at his hand an insulating material, or, better, a group of insulating materials, which almost ideally combine the above mentioned properties. These are the insulating materials of the steatite group, widely known under the trade name "Alsimag."

STEATITE ALSIMAG

Under steatite is generally understood a ceramic material which is based on the minerals "Lava," Talc or Soapstone. These minerals are identical in chemical composition, but differ in crystalline structure. Talc has a fibrous structure, the crystals are arranged in one direction and similar to mica, a certain cleavage is noticeable. Soapstone and "Lava" are dense. The crystals are small and form a compact mass. All three minerals are hydrated magnesium silicates of the chemical composition: $3MgO\ 4SiO_2\ 1H_2O$.

For the manufacture of steatite bodies the raw materials are finely pulverized and mixed with certain fluxes. A body prepared in this way is plastic enough so that it can be formed by ceramic methods. Such a "body" owing to its smoothness and plasticity has the further advantage over other ceramic mixtures that it can be pressed in steel dies, in a dry condition, and pieces thus produced are distinguished by great density and uniformity. Dry pressed articles are hard enough when leaving the dies, so that they can go direct into the kiln without pre-drying. The formed articles are fired in ceramic kilns at higher than porcelain temperatures by which process a hard and vitrified product is obtained which consists chiefly of magnesium silicate crystals, mineralogically known as Klinoenstatite crystals, which interlock each other and give the strong and tougher-than-porcelain properties to the body for which it is so well known.

Steatite bodies consisting chiefly of crystals are in a physical sense "one phase" bodies. Uniform crystalline structure not only gives mechanical strength, it also accounts according to newer theories, for two very important properties of the group of steatite bodies: High electrical resistance, even

TABLE 1

PHYSICAL PROPERTIES OF SOME MATERIALS USED AS HIGH-FREQUENCY INSULATION

	Tensile Strength Lbs./in²	Compressive Strength Lbs./in²	Modulus of Rupture Lbs./in²	Coefficient of Thermal Expansion 20°-650°C	Porosity (Water Absorption)	Softening Temperature Degrees C	Hardness Moss Scale
Alsimag 196	8000	120,000	19,000-22,000	$6.2\text{-}6.8\times10^{-6}$	nil	1420	8
Alsimag 35	6600	100,000	18,000-22,000	6.37×10	Extruded .02% Pressed .069%	1400	7.5
Commercial Steatite	Above 6000	100,000	17,000-20,000	7×10^{-6} at 20°C	....	....	7.5
Porcelain—Wet Process ..	2000 to 3000	120,000	10,000-14,000	$3.5\text{-}4.5\times10^{-6}$	nil	1150	6
Porcelain—Dry Process ...	1500 to 2000	100,000	6,000-10,000	$3\text{-}4.5\times10^{-6}$	.1%	1150	6
Quartz Glass	Above 10,000	282,000	10,200	0.55×10	nil	1500	4.9
Glass Bound Mica	....	25,000	20,000	....	0.035%	....	3-4

at elevated temperatures and very low dielectric loss. Here lies the great advantage of steatite bodies over porcelain, which is a "2 phase body," consisting of approximately 60% crystalline matter, imbedded in 40% glass.

Early in 1921 the American radio industry realized what great advantages could be gained by using steatite insulators in the construction of short-wave transmitters. In this early stage, however, the possibilities of shaping steatite bodies and producing them in mass production were not so well developed to make use of all the advantages of this insulating material. During recent years the leading firms in the manufacture of steatite bodies, made great progress in the development of pressing processes suited for mass quality production and in astonishingly short time the radio industry took advantage of these new developments and found many new applications for steatite insulators in radio transmitters, receivers and numerous other electrical apparatus.

ALSIMAG 196

Although steatite has a much lower dielectric loss than any other known ceramic material, it was the desire of the radio engineers as well as of the manufacturer of the ceramic insulator, to cut down to a further degree the dielectric losses in order to approach as nearly as possible the ideal insulator: quartz. This desire led to the development of special steatite bodies with low dielectric losses especially at ultra-short waves.

This development of special steatite bodies, characterized by low dielectric losses, originated in Europe and there it was first realized what an advantage could be gained in selectivity and reception quality by replacing insulating materials of high dielectric losses with those having extremely low losses. It is quite natural that European manufacturers used steatite earlier and to a much greater extent in their sets than the Americans did, because selectivity is a necessity over there considering the short distances between the various and powerful stations. Until recently the American steatite factories manufactured steatite bodies which had a power factor of approximately 0.18—0.25%. Only imported steatite products from Europe showed lower power factors of approximately 0.09%. After going through a considerable amount of research work, we have now succeeded in producing a new steatite body with a power factor of only 0.06% as an average over the whole short- and ultra-short-wave spectrum, therefore having about 1/3 of the value of the former steatite body Alsimag 35 and even better than the famous German products. This improvement has been gained by still further developing a uniform crystalline structure throughout the body and by eliminating the last traces of glassy matter usually remaining in ordinary steatite bodies. This was possible by carefully selecting the purest raw materials and minerals, incorporating them in this new insulating material and by special methods of manipulating and kilning at hitherto unused temperatures. The new ceramic material which is called Alsimag 196 has the advantage that it can be formed in the same manner and by the same process as the former Alsimag steatite bodies and therefore all the advantages and experiences gained during the last years for making ordinary steatite bodies can now be taken over directly to produce articles of this new and improved material. In order to realize the advantages which can be gained by using this new material, Alsimag 196, in preference to organic or other ceramic materials, the physical and electrical

(*Continued on page 25*)

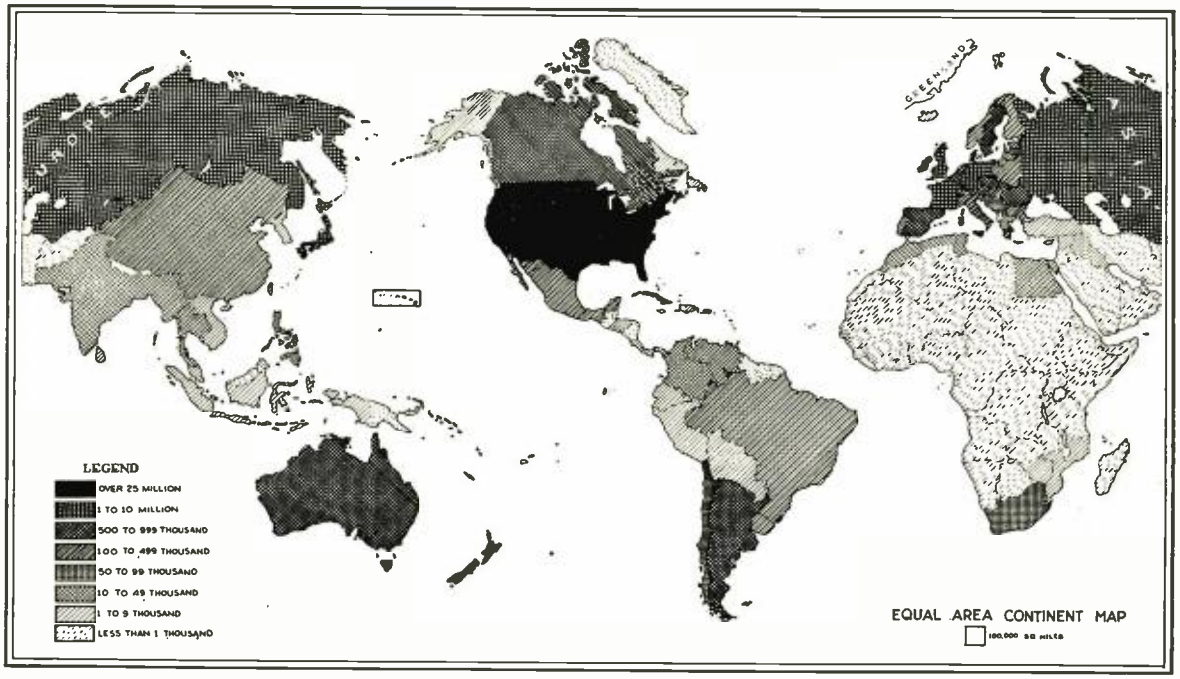
TABLE II

ELECTRICAL PROPERTIES OF SOME MATERIALS USED AS HIGH-FREQUENCY INSULATION

	Dielectric Strength Volts per Mil	Volume Resistivity Ohms/cm.-cube (AC 200 V)	Dielectric Constant	Power Factor Percent	Loss Factor
Alsimag 196	200	68°F : Above 10^{15} 1000°F : 1.1×10^{8} 1200°F : 2.7×10^{7} 1400°F : 8.4×10^{6}	5.6	1000 kc-50 mc : .08-.04	1000 kc-50 mc : .448-.224
Alsimag 35	200	68°F : 3×10^{14} 600°F : 11×10^{6} 800°F : 1.4×10^{6} 1000°F : 3×10^{5} 1200°F : 2.3×10^{5}	5.9	3000 kc: .18-.25	3000 kc : 1.06-1.48
Commercial Steatite	200	77°F equals 2.7×10^{14}	6.1	1000 kc : .185	1000 kc : 1.13
Porcelain—Wet Processed	130-150	....	7	.7 - 15	5.2 - 105
Porcelain—Dry Processed	100-140	....	7	.7 - 15	5.2 - 105
Transparent Fused Quartz	100	77°F : 1×10^{19} 1000°F : 6×10^{8} 1200°F : 8×10^{7} 1400°F : 6×10^{7}	4.2	.026-.028	.11-.118
Glass Bound Mica.....	60	....	8.5	.19	1.62
Electrical Glass	40-100	....	5.7-10	.40	3.0
Synthetic Resins	80-250	....	5.5-11	3-11	16-55

THE EARS OF THE WORLD

Distribution of Radio Receiving Sets By Countries



Figures based on a survey made by U. S. Department of Commerce, in 1935.

RECEIVER DESIGN

(*Continued from page* 14)

presented molded and sheet plastics play an important part. In sketch (A), for example, the cabinet is wood, with sheets of plastic material for the front surfaces. The speaker grille is molded plastic of contrasting color. The control knobs are likewise molded, and the dial escutcheon is a molded plastic ring which forms an inset in the plastic sheet dial panel.

The table model receiver shown in sketch (B) is completely molded, but not all in one piece. Contrasting colors are used.

The cabinet shown in sketch (E) is metal—aluminum or chromium-plated steel sheets—with backings of heat- and sound-absorbing material. The black front is a sheet of bakelite laid over the metal, while the speaker grille is neutral color chair caning. The control knobs are molded bakelite, the two in the center having chromium facings. The "legs" of the cabinet are also bakelite.

The musical motif designs on the surface of the cabinet in sketch (F) are bakelite stampings. The sides of the wooden cabinet are black, the front and right-side surface canary yellow with black designs.

PLASTICS

Remarkable strides have been made in the field of plastics. These materials have become desirable in the design of furniture, for the interiors and exteriors of homes, and other places calling for a product more durable than wood. The designer is no longer restricted to a few of the prime colors, but has a wide choice of neutrals and combinations. Moreover, these materials are now available in sheets almost as thin as paper, which makes them adaptable for surface coverings and intricate designs.

It is interesting to note in this connection that the design of an article or a structure bears a very close relation to the materials that must be used. That is, the character of the design is, to a degree, a reflection of the materials. The character of a desk, a chair or a table, rests to a large degree in the wood used; the character of a building in the steel, the stone and the brick. The materials are selected to meet a requirement, and until other and more suitable materials are developed, the character of the product remains unchanged.

NEW TEMPO

Thus, for the reason that wood has been found the best material for radio cabinets, some of the character of the radio finds its expression through the wood. It may well be, however, that it is time for the manufacturer of radio receivers to survey the wide field of new materials for the purpose of determining if, strictly from the viewpoint of requirements, other materials have not been developed that would more readily serve the engineer in his efforts to improve upon the radio receiver. If such materials are available, they may contribute to the emergence of the radio receiver from its present hybrid existence.

(*To be continued*)

THE DESIGNS SHOWN IN CONJUNCTION WITH THIS ARTICLE ARE THE PROPERTY OF MR. CAMPBELL.—ED.

VIBRATORS—

History • Design • Applications

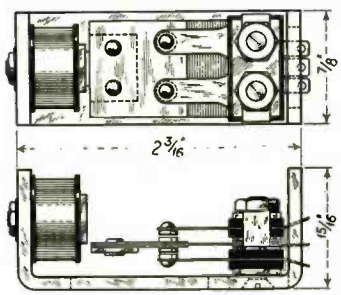
By WILLIAM GARSTANG

ELECTRONIC LABORATORIES, Inc.

On looking back into the annals of the electrical art, we find a great many references made to vibrators of various types.

HISTORY

During the early months of 1930, a demand occurred in the radio industry for a substitute for "B" batteries. Immediately, engineers investigated the possibilities of the motor generator to deliver high-voltage d-c from a low-voltage d-c source, and investigated the possibilities of using what is commonly known as a rotary transformer in conjunction with a synchronous rectifier. Both of these methods of producing high voltage, necessary to be the equivalent of "B" batteries, were expensive to produce and were not altogether stable and



Details of new, compact vibrator

satisfactory in operation. At that time, if the engineers had referred to the telephone art, they would have found many references made to vibrators of various structures which had previously been used in the telegraph and telephone industry as bell ringers and circuit exciters and would have saved themselves several years of research.

Immediately the application presented itself for a vibrator as a "B" battery substitute and this device took the form of a half-wave buzzer which intermittently excited a transformer with direct current. The output of this transformer was rectified by means of a gaseous rectifier. The device was sold as a "B"-battery eliminator and found a large application in the field of automobile radios which was then in its infancy.

At that time, the engineers who were working on this development had no conception as to the field or the extent of the application of vibrators.

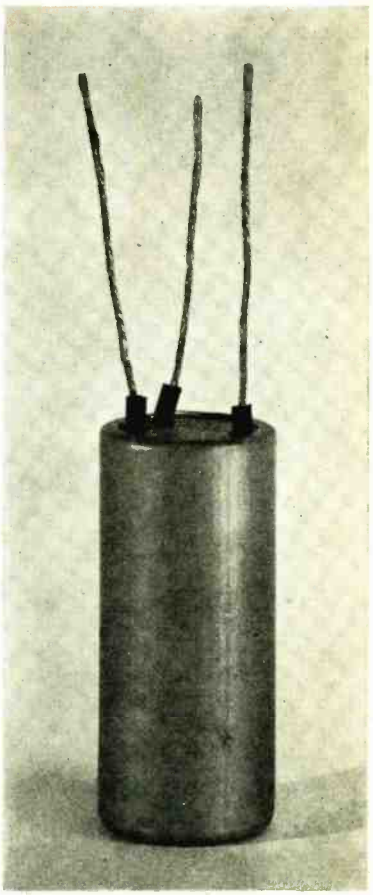
VIBRATOR TYPES

During the next two or three years, various types of vibrators were developed of various structures which met with varying degrees of success. Roughly, we can classify them into two groups: the full-wave, non-synchronous vibrator, and the full-wave, self-rectifying vibrator. Practically all of these units, at that time, were used to convert 6 volts d-c to high-voltage d-c. The maximum wattage obtainable from a device of this nature was in the order of 10 to 15 watts. It was not considered practical to supply more wattage from a converter of this nature.

With vibrators becoming more popular in their use and confidence was obtained by the user, other applications presented themselves. It was a natural consequence that a power supply should be developed using a vibrator for operation on 12 volts. These units were primarily used for radio installation in trucks and in aircraft and their durability was proved under the most extreme conditions.

APPLICATION TO 32 VOLTS

At this same time, farm conditions in the country improved and it was found that there were millions of farmers who had no radio set at all, primarily because of the cost of "B" batteries and the necessary equipment to operate a radio set of the old type. It was natural that a vibrator should be applied to a 32-volt radio set so that the farmer could have good performance and operate a radio set from a 32-volt system without the use of auxiliary batteries.



Vibrator in double case—designed for permanent installation.

For several years this was the maximum voltage applied to vibrators and it was not until several radical developments and improvements had been made that it was found possible to operate vibrators on 110 volts d-c at high wattages in the order of 200 or 300 watts.

CONVERTERS

Converters were introduced about this time using a vibrator to interrupt the high-voltage d-c and produce an a-c of sufficient purity to operate a standard built 110-volt radio set. In the past, it had been necessary to apply the 110 volts d-c directly to the plates of the power tubes in the set. Now it was found possible to supply high-voltage a-c so as to convert a complete line of standard 110-volt a-c radios for opera-

tion in the d-c districts of 85 of the largest cities of the country.

Seemingly, the engineers had entirely overlooked applications for the use of vibrators for anything except radio. In the commercial field, rotary converters had been used extensively to produce 110 volts a-c from a d-c source for the operation of neon signs, ignition on oil burners, regulators on heating equipment, and a hundred and one other uses. In almost every instance, the wattage of the device operated was far lower than the capabilities of a rotary converter. The cost of installation of such equipment was far in excess of its worth, and there were many disadvantages in the rotary type of apparatus.

DESIGN DIFFICULTIES

Difficulties were at first encountered in the application of vibrators to these various functions. These difficulties were mainly due to the fact that the frequency was not always constant and the device was not always stable, and its regulation and efficiency were rather poor. It was found that vibrators that had been used in the past on 6-volt application were not suitable for this high-voltage and high-wattage work. The difficulties encountered in the design of the apparatus were entirely different than the difficulties found in 6-volt application. In the operation of a neon sign, a highly inductive load was encountered which made it necessary to correct the power factor on the d-c side of the vibrator. In the past, a correction of this nature was unheard of, but it was found to be essential before the device would operate. It was necessary to develop a vibrator type converter which would operate efficiently at no load and withstand sudden heavy surges in the application of oil burners and where it was desired to excite the oil burner by high tension.

HEAT AND HIGH CURRENT

Most of the difficulties encountered in the high-wattage converters centered themselves into one or two minor points which it seemed impossible to correct. It was a known fact that a vibrator is susceptible to two factors; one being heat, and the other being high current at the contact points. It was consequently, necessary for the engineers first to eliminate heat and secondly, to balance a circuit with such precision so as to make the current at the contact point zero at the time of make and break. This was readily accomplished by means of various ingenious arrangements where the heat ordinarily generated in the vibrator coil was dissipated externally to the vibrator by means of a series resistor. The current at the contact point was made to be zero at the time of make and break by means of a series resistor which was alternately eliminated from the circuit.

Immediately, when these two developments were made, an entirely new field presented itself for vibrator application. It was no longer difficult to operate neon signs from a d-c source. It was possible to obtain performance of a vibrator type converter which was far superior to that of a rotary converter in efficiency and regulation. A 110-volt converter was developed having an efficiency of 85% and a regulation in excess of 97%. These characteristics could not have been equalled by the finest types of rotary mechanism.

NEW APPLICATIONS

It was found that applications presented themselves which were entirely new, such as the operation of small spot welders in the optical industry to melt rivets when a lens is attached to the frame of a pair of glasses. It was also found that surgical instruments and diathermy machines could be operated from a vibrator-type converter.

A small 110-volt adapter was developed which, when placed in series with apparatus ordinarily operating on a-c, would make it possible to plug that apparatus directly into a d-c line. This has been used extensively in the production of physician's equipment where very small lights are used on the ends of prods.

After the development of the high-voltage equipment, the experience obtained, when applied to low-voltage conversion, made it possible to operate neon signs on trucks and fire apparatus. Previously investigators had been skeptical of apparatus which would deliver 30 to 40 watts high-voltage d-c from a 6-volt battery but it was now found possible to furnish equipment of this type for transmitters and transceivers for use in police apparatus. Apparatus of this nature has made it possible for the Oakland Bridge to be some 200 days ahead of schedule due to the fact that the laying of the cables and the spinning of the wires has been supervised by means of two-way portable transmitters and receivers.

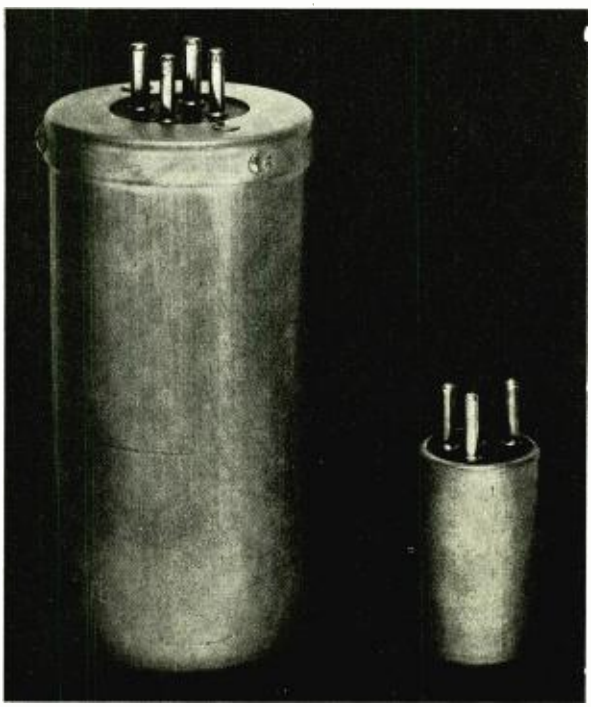
FREQUENCY STABILITY

In the early stage of the development of the vibrator, it was commonly known as a buzzer of rather indefinite frequency. Now it is possible to maintain a frequency having a variation of less than 1%. Apparatus of this type is being used in thyratron converters where the grids are excited by means of constant-frequency vibrators. It is now possible by means of a vibrator-type converter to operate synchronous motors and to maintain the speed of a phonograph turntable constant.

METAL ALLOYS

The experience obtained in the field of high-wattage converters was found to be invaluable in the manufacture of

(*Continued on page 23*)



The old and the new in vibrators. Difference in size is appreciable, yet the smaller of the two provides improved operation.

CABINET VIEW OF THE LAFAYETTE TUNER-AMPLIFIER COMBINATION.

By HUBERT L. SHORTT
Chief Engineer
WHOLESALE RADIO SERVICE, Inc.

Broadcast Monitor · P-A System

In small and medium power broadcast stations having limited audio facilities, some sort of a combination tuner-monitor-amplifier system is highly desirable for the purpose of feeding actual programs, announcements, incidental music, etc., through loudspeakers located in reception rooms, executive offices, sponsors' demonstration rooms and the like. The ideal place for such equipment is the reception room or the main office, these two rooms usually being one and the same in most small stations.

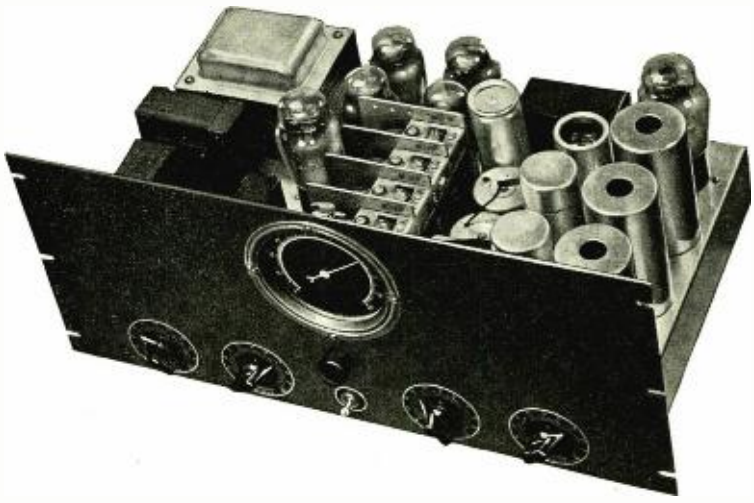
APPLICATION OF EQUIPMENT

This monitor-amplifier unit must be of simple, compact construction, and specifically designed for manipulation by non-technical personnel. The idea is to make it as independent as possible of the regular station equipment, so as to eliminate any danger, however remote, of interference with the normal functioning of the station. A number of medium-size broadcasters are already using such installations to good advantage.

For feeding actual broadcast programs into a reception room or offices, the radio tuner is turned on, signals picked up via a small indoor or outdoor antenna (depending on whether the transmitter's antenna is nearby or distant), and the demodulated signals are fed through the audio amplifier section for distribution through as many loudspeakers as desired. When the station is not on the air, or when rehearsals are in progress, other stations can be tuned in, or electrical transcriptions can be played. Visitors to broadcast studios always expect to hear entertainment, and the locally operated combination unit becomes very useful as a means of "filling in." In small, time-sharing stations, it is virtually a necessity.

As a means of dealing with sponsors or prospective sponsors, a flexible tuner-amplifier may easily pay for itself the first week it is in operation. As station owners know only too well, prospective air-advertisers have a habit of wanting programs similar to, but not quite a direct copy of other programs that are known to be successful. By fading remarks and suggestions of his own into a program tuned in from the outside, a clever announcer or continuity writer can make a good impression on a would-be sponsor and possibly sell him an idea.

The applications described in the two foregoing paragraphs explain why the apparatus should be divorced from the regular control room. The operators may not be on duty, or they may be



INSIDE VIEW OF THE TUNER-AMPLIFIER. R-F AT RIGHT, A-F LEFT AND REAR.

busy with an actual program or rehearsal, just when some important prospect comes in and wants to hear things. If the installation is correctly designed, any receptionist can be taught in a few hours how to use it. A few gain controls certainly present no more difficulty than a mass of telephone cords on an ordinary switchboard.

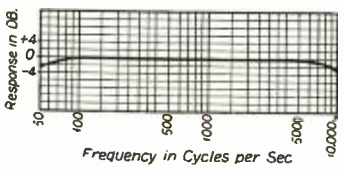
DESIGN OF EQUIPMENT

Since versatility and simplicity, plus thoroughly dependable performance, must be combined in one, the design of such a tuner-amplifier is naturally quite a problem. The first requisite, dictated by station engineers, is that everything be on one chassis, in a single cabinet. The instrument must be a piece of reception-room furniture, rather than a control room accessory. "Studio quality" of reproduction is to be taken for granted; if good reproduction is not obtained in the studio, what can the poor listener expect?

As a result of correspondence with studio and station technicians, growing out of his past articles in RADIO ENGINEERING, the writer undertook the design and construction of a tuner-amplifier combination to meet the aforementioned requirements. He suspected in advance that he was in for a little work, and he wasn't disappointed!

THE R-F END

Since extremely high gain in the radio-frequency portion of the contemplated instrument was not important, and high-fidelity reception was very important, the tuner section resolved itself into a straightforward tuned r-f job, using two type 58's as signal-frequency amplifiers and a 55 as diode rectifier. A band-pass tuner ahead of the first r-f tube, in combination with the two interstage tuning circuits, gives more than enough selectivity for all ordinary needs. No avc is used, as the receiver is intended primarily for local reception.



Audio response curve of Lafayette Tuner-Amplifier.

THE AUDIO SYSTEM

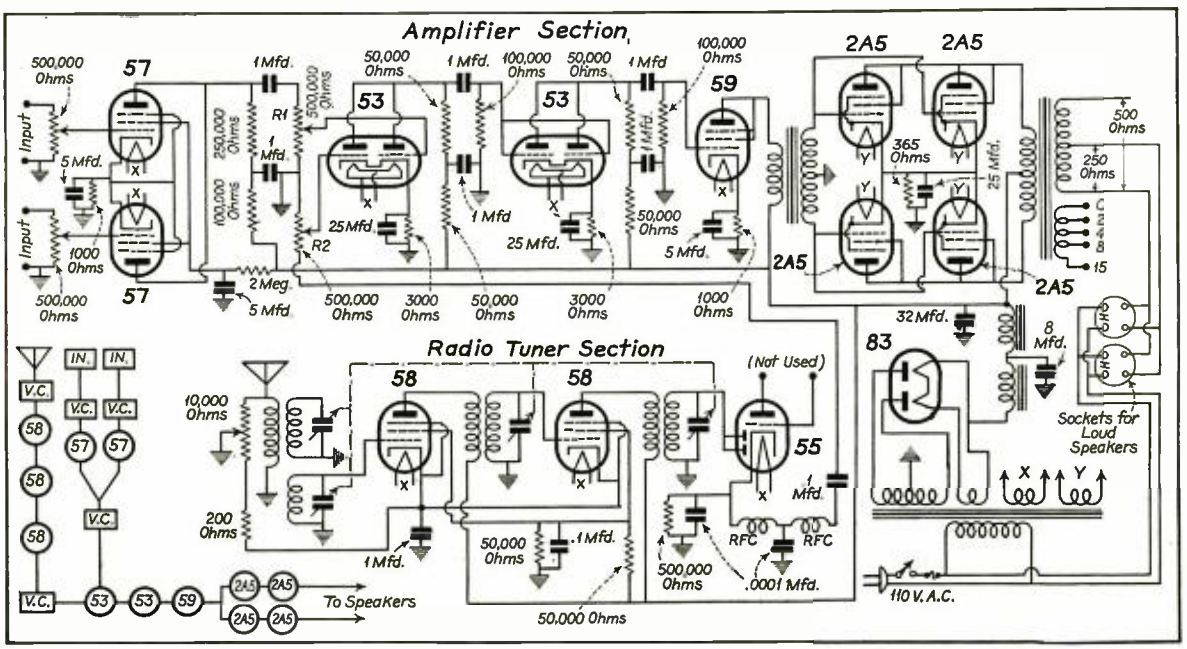
The audio section is more complicated. As may be seen from inspection of the accompanying diagram, two input circuits are provided, each with a pentode-connected 57 as amplifier-mixer. The outputs of the latter work into a 53, with separated grid circuits and common plates, for mixing. Note that volume control R-1 regulates the overall response from the microphone or phono pickup (connected to the inputs on the extreme left), while R-2 controls the level of the radio signals from the tuner below. Simple manipulation of these two controls enables the receptionist or announcer to mix radio programs and his own voice in the manner described in the early part of this article.

The first 53 is followed by another, with the triode sections in parallel. This feeds a triode-connected 59, which in turn swings four 2A5's, also triode connected, in push-pull parallel. The secondary of the output transformer has provisions for 250-500-ohm lines and for voice coils of .7 to 15 ohms.

With an overall gain of 120 db, this amplifier section permits the direct use of crystal or velocity type microphones, as well as all types of phono pickups. In practice, a mike is left connected to one pair of input posts and a pickup to the other.

DESIGN PROBLEMS

In spite of the fact that a total of 13 tubes is used, this whole tuner-amplifier combination is completely self-contained in a steel cabinet measuring only 19 by 8¾ by 12 inches. The r-f and a-f sections were first built separately, put into perfect working order and then combined, and then the fun began. What with both r-f and a-f currents circulating at the same time in one chassis, coupling effects raised the merry devil. They were finally eliminated by the use of a special aluminum chassis, together with careful placement of parts to avoid capacitive as well as magnetic effects, and low-impedance return paths that prevent coupling due to current loops in



Schematic of Tuner-Amplifier. Note amplifier-mixer.

the metal base. Indiscriminate grounding to the chassis was found to be particularly bad.

SEMI-PORTABLE

The unit as it was designed to meet the requirements laid down by station engineers is shown in the accompanying illustrations. Although the whole apparatus weighs about 85 pounds, it *is* complete in itself (except for loudspeakers, of course) and it can be moved readily from one location to another. In fact, one idea is to take the whole works to the office of a prospective program sponsor (or user of public-address service) and to demonstrate it right under his nose. The beautiful quality of reproduction, even at high volume levels, and the flexibility of operation due to the number of mixers, makes a tremendous impression and help to clinch a contract or sale.

FIXED OPERATION

If the tuner-amplifier is to remain in a fixed location, say a reception room or an executive office, it can readily be dressed up in a console cabinet. One type includes an automatic 12-record turntable and therefore comprises a complete radio-public address system. In addition to its broadcast-station applications, it also makes a deluxe p-a system for clubs, restaurants, grilles, ballrooms etc. The console model illustrates the trend in amplifier practice away from cumbersome conglomerations of assorted amplifiers, pre-amplifiers, mixers, turntables, etc., and toward a sensible combination of related units into one cabinet. Of course, although the console includes only two loudspeakers (a regular dynamic and also a crystal "tweeter"), additional speakers within the limit of the amplifier output can be used in concealed positions elsewhere in the room.

The equipment is likewise adaptable to "built-in" jobs, for offices, private residences, etc., and, if permanently installed, is eligible for an FHA loan.

OUTSIDE WORK

The portable feature makes the amplifier suitable for outside public-address work. The station engineers can pick up some nice extra income by installing and operating the apparatus for lodge meetings, banquets, etc., at times when it is not needed in the studio. This business is only a side line, but many "riders of the gain" are finding it profitable. With a pair of dynamic speakers in a split carrying case (the sections of which act as baffles), a couple of mikes and a small turntable, the boys are all set for a night's work. The whole mess of stuff can be carried in the back seat of any small car, and can be set up for operation in ten minutes. It's something to think about.

Raytheon 0Z4 Gaseous Rectifier

A NEW rectifier tube, type 0Z4, developed by Raytheon Engineers at their Newton Laboratory, especially for automobile radio supply systems, has just been announced.

HAS NO FILAMENT

This new tube has no filament, but operates through the ionization of a gas contained in the glass inner bulb. In basic principles the 0Z4 is closely related to the gas rectifier which Raytheon pioneered in 1922 and continued developing to date. Raytheon holds several exclusive patents on this gas type of rectifier. The cathode of the new rectifier operates at an emitting temperature, thus permitting values of rectifier efficiency and voltage drop comparable to those found in a mercury-vapor tube, equipped with a filament.

R-F NOISE

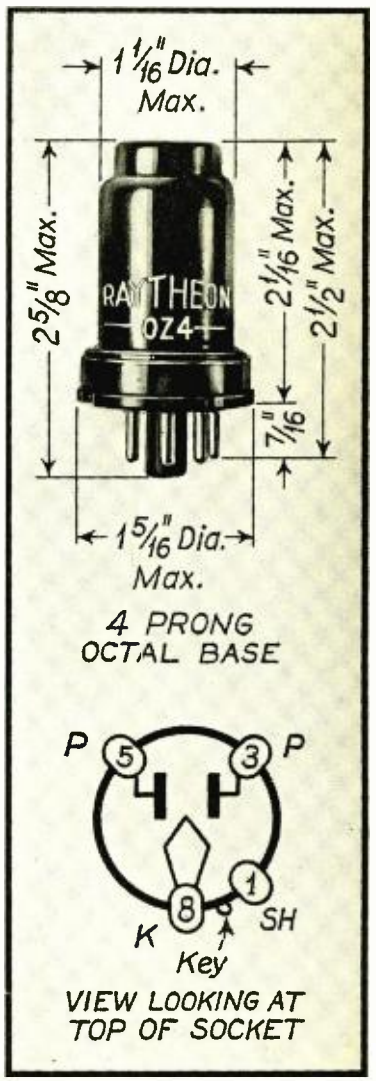
The 0Z4 was developed primarily for use in vibrator-type B-supply units for automobile receivers. It has the typical characteristics of all gas-filled rectifiers as regards a constant drop and ability to handle peak currents and a tendency to generate r-f noise. The r-f noise may be eliminated by proper filtering and by connecting the metal shell to the point giving the best shielding. The shielding and filtering commonly used to eliminate vibrator noise will usually be sufficient.

The 0Z4 is filled with a permanent gas rather than a vapor filling. The tube characteristics are independent of the surrounding temperature.

The 0Z4 has the same external form and dimensions as other tubes of the metal line. However, in this tube the metal shell serves chiefly as container and electrostatic shield for the glass bulb, which is required to insulate the contained gas from the grounded shell.

OPERATING CHARACTERISTICS

The operating conditions and characteristics are given in the accompanying table. Since no heater supply is required for the 0Z4, drain on the storage battery is reduced . . . an important consideration in the design of auto-radio receivers.



OPERATING CONDITIONS AND CHARACTERISTICS

D-C Voltage Output	300 max.	volts
D-C Output Current	30 min.	ma
	75 max.	ma
Peak Plate Current	200 max.	ma
Starting Voltage	300 min.	volts
Voltage Drop (Dynamic)	24 avg.	volts

(*Continued from page* 19)

a light-duty, 6-volt unit for automobile use. It was mentioned above that heat was the prime factor of destruction of a vibrator. This heat caused the destruction of the unit primarily because phosphor bronze and materials of that nature had always been used as a semi-stationary reed in the vibrator. This metal annealed at approximately 350° C. It was essential to adopt a metal that would withstand higher temperatures and would not fatigue or relax due to a hammering action or due to this heat. During the development of the high-wattage devices, a survey was made of various alloys and metals. This survey covered the field of phosphor bronze, copper, beryllium copper, beryllium bronze, and other alloys such as nickel and copper compounds and monel metal. It was necessary to adopt a metal which would have the best combination of characteristics. It was necessary that the metal have low electrical conductivity and it was found that monel metal was best suited for these requirements. Monel metal, although not as good in electrical conductivity as copper or some other copper compounds, was found to withstand a temperature in excess of 1200° C without losing its spring temper, or fatiguing. This metal was adopted as a side reed material and it was found that a vibrator when once adjusted would remain in adjustment throughout its normal life and that the small reeds which endure so many impacts every minute would no longer relax or warp.

It was found that by using monel metal as the backing for the tungsten contacts that a low resistance joint was made and that heat was readily dissipated from the surface of the contact.

GRAIN STRUCTURE OF CONTACT

The teachings in high-wattage applications showed that only a vertical grain structure in the tungsten contact point could withstand the high current density being imposed upon them by heavy-duty applications. The contact point having a horizontal grain structure was found to flake and disintegrate far more rapidly than when the grain structure was in a vertical direction. It is a known fact that a vertical grain structure will produce contact pitting unless on each impact the contacts are made to wipe themselves. This wiping action was incorporated in the design of the new low-voltage vibrator and it was found that during their life of 3,000 or 4,000 hours the contact point might wear but would never show signs of transfer of metal, commonly known as pitting.

REDUCTION IN VIBRATOR SIZE

Ever since the first development of vibrators for auto-radio units, radio manufacturers were requesting a small vibrator. Each year these vibrators have decreased in size and placed more burden on the developers in the vibrator industry. Unfortunately all vibrators produce some mechanical noise. Consequently, the reduction in size is limited, due to the fact that it is essential to provide sound insulating material around the vibrator elements. It was necessary for vibrator engineers to take up an entirely new art by studying sound, its reflection and how to dampen it out. New auto-radio vibrators have been reduced in size by decreasing the length of the vibrating member and by correspondingly reducing the size of all other parts. There is a limit to this reduction due to the fact that the vibrator members must carry a certain amount of current. But the efficiency of the unit has been maintained and even increased by the use of electrical sheet metal for the stationary parts of the units and by the improvements in the magnetic path provided for the actuating coil. The overall size of the unit has been reduced by applying reflection principles to sound dampening. Rather than using heavy grades of sponge rubber and felt, it has been found that if one can is placed over another can that the noise generated by the vibrator will be reflected and that heavy grades of felt and sponge rubber are not needed for this purpose.

CARTRIDGE CONSTRUCTION

Vibrator units have been made in a cartridge construction and permanently sealed and have been entirely taken out of the category of an item which has to be serviced continually. Manufacturers of vibrators today have provided long life and durability in their units and it is no longer necessary to continually replace or service the vibrator elements. The auto-radio vibrator of today has a much longer life than the tubes of a radio set. Ordinarily, a non-synchronous unit will have a life equalling approximately four rectifier tubes. Practically all of these advances have been due to the experience obtained in the development of high-wattage and high-voltage apparatus.

High-wattage experience in vibrators has accelerated the development of the low-voltage and wattage unit and undoubtedly the field of application for both will steadily increase.

RAYTHEON 6Q7 DUO-DIODE TRIODE

RAYTHEON has just announced a new combination type metal tube which has been designated type 6Q7.

Type 6Q7 is a duo-diode triode with circuit applications corresponding to those used with the type 75 glass tube. Reference to the characteristics of the new Raytheon 6Q7 shows noteworthy changes in the triode section. The amplification factor is 70 and the plate resistance 59,000 ohms—both lower than in the 75. The mutual conductance of the 6Q7 is slightly higher.

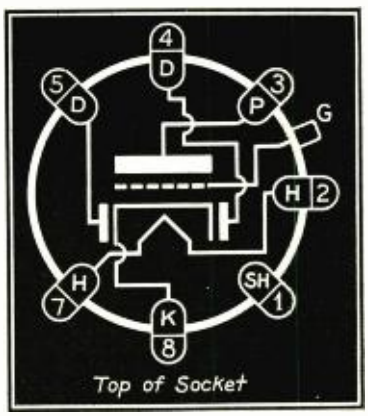
The result of these changes is a definite improvement in the signal handling capability of the 6Q7.

The triode section is a high-mu tube designed for resistance coupling. The coupling resistance may be any value up to approximately one-quarter megohm.

The two diode units are independent of each other and the triode unit except for the common cathode sleeve. The diode units may be used either as a half-wave or full-wave rectifier, or a half-wave rectifier with the other unit used for delayed avc.

6Q7 CHARACTERISTICS

Heater Rating	
Voltage	6.3 volts
Current	0.3 ampere
Triode Unit—Class A Amplifier Operating Conditions and Characteristics	
Plate	250 volts
Grid	—3 volts
Plate Current	1.2 ma
Amplification Factor	70
Plate Resistance	59000 ohms
Mutual Conductance	1200 umhos



Socket layout for the new Raytheon 6Q7 metal duo-diode triode.

RMA NEWS

NEW RMA TRADE DIRECTORY

STABILITY AND substantial growth of the RMA is recorded in the new October 1935 Association membership and trade directory just issued. In addition to wide circulation of the new RMA trade directory in the industry, both in the United States and Canada, copies have been furnished to national and foreign radio and commercial organizations, government officials, libraries, foreign importers, etc. Copies also have been sent to American Chambers of Commerce and U. S. Commercial Attaches of the Department of Commerce in all foreign countries, and to many other sources developing business for RMA members.

In distributing copies of the RMA revised radio industry directory the "BUY RMA" plan was emphasized. Under this plan, adopted by the Association's Board of Directors, RMA members are urged to patronize other Association members, when and if all things are equal, in their purchases of parts, accessories and raw materials. Copies of the new trade directory have been furnished to purchasing departments of RMA manufacturers.

PROGRESS ON RADIO INDUSTRY AWARDS

DEFINITE PROGRESS toward annual awards in broadcasting, similar to the Pulitzer prizes of the newspaper industry, was made at an initial meeting of committees of the National Association of Broadcasters and the Radio Manufacturers Association at the Hotel St. Regis in New York on October 16. The NAB Board of Directors on the following day considered various plans developed by the joint committee and it will continue work with a view toward launching the radio industry awards, if possible, in 1936.

The establishment of a Radio Industry Foundation is one of several plans under consideration. Its organization and procedure are to be further developed by the committees of NAB and RMA. At the preliminary conference on October 16 the NAB was represented by Lambdin Kay of Station WSB of Atlanta, chairman; representatives of the National Broadcasting Company, the Columbia Broadcasting System and Mr. Burridge D. Butler of Station WLS, Chicago. The RMA was represented by its president. Mr. Leslie F. Muter of Chicago; Powel Crosley of Cincinnati, chairman of the RMA committee; Commander E. F. McDonald of Chicago, Sayre M. Ramsdell of Philadelphia, and Bond Geddes of Washington.

RADIO EMPLOYMENT INDICES

THE LATEST report, for August 1935, of the Bureau of Labor Statistics, U. S. Department of Labor, on radio factory employment, recorded the sharp summer upturn in radio production, with large increases in employment and payrolls. The federal report, however, omitted the number of radio companies contributing reports and also omitted the exact number of employees.

An increase of 15.6 percent in radio factory employment was recorded in August over July, 1935, but the radio employment was 1.7 percent less than in August 1934. However, radio employment was 113.8 percent above the official three-year average of 1923-25.

Radio factory payrolls during August 1935 increased 18.6 percent over the preceding month and were 8.8 percent over August 1934. They were also 33.9 percent above the three-year average of 1923-25.

Per capita weekly earnings in radio factories reported in August 1935 were $19.12, an increase of 2.7 percent over the preceding month and 10.9 percent above those of August 1934.

Average hours worked per week during August 1935 were 37.2 hours, an increase of 6.3 percent over July 1935 and 11.9 percent above those of August 1934.

Average hourly earnings of radio factory employees during August 1935 were 51.4 cents, a decrease of 3.6 percent from July 1935 and 5.5 percent less than average hourly earnings during August 1934.

The federal labor report also noted the purchase of $144,717 worth of radio apparatus and supplies during August 1935 by the Public Works Administration, bringing the total of PWA purchases since inception of the public work program to $871,277.

EXCISE TAX COLLECTIONS FOR SEPTEMBER

U. S. INTERNAL Revenue Bureau collections of the 5 percent excise tax on radio and phonograph apparatus, not including automobile radio, during the month of September 1935 totaled $339,382.47, according to the latest official report. This was an increase of 11.2 percent over the tax collections of $305,391.91 in September 1934.

For the nine months' period ending September 1935 the total radio and phonograph taxes collected were $2,491,501.02, an increase of 12.8 percent over the taxes collected during the same nine months of 1934.

SEPTEMBER EXPORTS INCREASED

SUBSTANTIAL INCREASES of radio exports by American manufacturers is recorded in the September 1935 report of the U. S. Bureau of Foreign and Domestic Commerce and for the second time this year the American exports were beyond the two million dollar mark. The total value of radio exports in September 1935 was $2,143,756, compared with $1,856,501 in September 1934.

Receiving sets exported during September 1935 numbered 50,275 valued at $1,255,867, compared with 41,878 sets valued at $1,138,948.

Tube exports during September 1935 numbered 677,081 valued at $284,727, against 469.509 tubes valued at $214,501 in September 1934.

Receiving set components valued at $433,601 were exported in September 1935 against $358,147 in September 1934.

Loudspeakers exported during September 1935 numbered 15.491 valued at $39.945, compared with 15,554 speakers valued at $37,199 in September 1934.

Other radio accessories valued at $51,409 were exported in September 1935 against $50,340 in September 1934 and the September 1935 exports of transmitting apparatus were $78,207 compared with $57,366 in September 1934.

S. W. PROGRAMS EXPANDED TO CANADA

EXPANSION TO Canada is a new development of the RMA short-wave program service. A majority of the leading Canadian daily newspapers have recently requested the weekly short-wave programs which have proven such a popular new feature of the American press. Public interest in short wave in Canada is apparently on a par with the American trend and the British Broadcasting Company as well as the Canadian Radio Commission are expanding short-wave broadcasts. Many regular programs are available from Candian short-wave stations.

The list of American newspapers taking the RMA short-wave programs each week has grown to nearly 800.

Foreign governments, Washington embassies, the British, Canadian, Australian and other broadcasting agencies are extending their cooperation in furnishing material for the weekly short-wave programs and now frequently send by cable special late features and corrections.

CANADIAN SALES

CANADIAN SALES during September 1935, according to statistics received by the RMA in cooperation with the Canadian RMA, totaled 23,324 a-c sets with a list value of $2,546,633, and 7,539 battery sets with a list value of $610,054. Sales of automobile sets during September were reported at 493.

Inventories of Canadian manufacturers, jobbers and branches on September 30 were 21,413 a-c sets, 12,173 battery sets, and 1,056 automobile sets, while projected production of Canadian manufacturers for the period from October 1 to December 31, 1935, included 54,490 a-c sets, 8,482 battery sets, and 2,457 automobile set chassis, a total set production of 65,429.

RADIO ENGINEERS ACTIVE

THE ENGINEERING branch of the radio industry is now in an unusually active season, with many important new engineering developments in progress on which constructive work is being achieved. Progress on tube standardization and other tube problems was made at a meeting on October 24 at New York of the Vacuum Tube Committee of which Roger M. Wise of Emporium, Pa., is chairman. There will be meetings of a number of RMA engineering committees, under the direction of Virgil M. Graham of Emporium, Pa., chairman of the RMA Standards Section, at Rochester late this month during the annual convention of the Institute of Radio Engineers. The tube committee and also the broadcast

(*Continued on page* 30)

ALSIMAG 196

(*Continued from page* 16)

properties of various materials used as insulators for high frequency purposes are given in Tables I and II.

This comparison shows clearly what important headway has been made by improving the former steatite body Alsimag 35 to the present high-frequency body Alsimag 196. The outstanding mechanical properties of the Alsimag bodies have been preserved or even improved in the new material. The porosity has been cut down to nil even in pressed pieces. The power factor is nearly as low as that of transparent fused quartz, especially at short wavelengths. It may be mentioned at this point that the loss factor characteristic of this new steatite body is negative, in other words, the losses become smaller with higher frequencies.

APPLICATIONS FOR ALSIMAG 196

Where and how can this new ceramic material be used to advantage? This question may be answered shortly: everywhere in receivers and transmitters, where a rigid construction is desired which is permanent and not affected by time, atmospheric conditions, heat or external stresses. Everywhere in modern high-frequency apparatus where high-voltage resistance, low dielectric losses and high dielectric strength, are essential requirements.

It may be an interesting experiment for the designer of a radio set to replace all hardpaper and organic insulation in the high-frequency part of a set by low-loss ceramic insulators and compare the losses obtained in the first and second instance. This refers especially to the insulation of the connecting leads, the tuning condenser, the coil, the tube base, the tube socket and the bases of the trimmer condensers. The cut-down of total losses thus obtained with the ceramic insulating material naturally means a great improvement in the resonance curve of the circuit.

To illustrate this, two tests are given which have been carried out in the physico-chemical laboratory of the American Lava Corporation. For the measurement of the dielectric losses the "Q"-Meter, manufactured by the Boonton Radio Corporation, has been used. The apparatus measures the "Q" value of coils or condensers. Under "Q" value is understood the ratio of reactance to resistance of a coil (Q equals $2\pi fL/R$) or a condenser (Q equals $\frac{1}{2\pi fC/R}$). By a simple computation the power factor of an insulating material can be calculated from the "Q" value obtained. It has been found that by replacing a hard paper coil form by one made of Alsimag 196 the "Q" value of the coil can be improved 40% at 2,000 kc and considerably more at higher frequencies. The power factor of a trimmer condenser mounted on an Alsimag 196 base and set to a capacity of 50 mmfd was .04% and 0.25% for a trimmer condenser set to the same capacity but mounted on a porcelain base. The measurements were carried out at 2,000 kc.

It is not always possible to exchange an insulating part made of organic material by a product of ceramic material without changing the design of the insulator. Usually it is necessary to "tailor" the construction to the peculiarities of a ceramic material; e.g., wall-thicknesses frequently have to be increased in order to assure economical production. It is advisable that the ceramic engineer should work in close contact with the prospective user of his product and designer. Only by such cooperation all the improvements which can be gained from the use of a ceramic insulating material will be evalued to their full extent.

References

1. *Ceramic insulating materials for high-frequency purposes. Erich Schwandt, publ. by Hachmeister and Thal/Leipzig, Germany.*
2. *Insulators made of Quartz Glass, Franz Skaupy, Elektrotechnische Zeitschrift, Vol.* 51, 1930. *p.* 1745-1772.
3. *Coil testing methods, Edgar Messing, Electronics, August* 1935.
4. *Mineral Plastics in the Porcelain Field, Ceramic Industry, Vol.* 25, *Sept.* 1935, *p.* 128.

•

CRYSTAL FILTERS

(*Continued from page* 10)

The crystals in the series arms are identical and those in the shunt arms are identical, but the conditions for a single pass band is that the parallel resonant frequency of the series arm coincide with the series resonant frequency of the shunt arm. or vice versa.

The loss characteristic and bandwidth of the structure is essentially the same as that of the structure of Fig. 4. This structure has the advantage that the position of the high peaks of attenuation may be varied to some extent by juggling the resonant frequencies of the series and shunt arms with respect to each other. Of course, the pass band will be reduced if series or parallel capacities are associated with the crystals.

This type of structure has the disadvantage of being balanced and requiring the use of properly balanced coils for use with the usual cascade i-f amplifiers.

This line of reasoning may be used to show that the use of more crystals will not widen the pass band as long as crystals and condensers alone are used. We must therefore conclude that any filter structure in which crystals and condensers alone are used will be limited to pass bands of 0.8 percent of the midband frequency, or less. In general this bandwidth is much too narrow for broadcast or all-wave i-f systems.

INDUCTANCE IN FILTER CIRCUIT

Of course, inductance may be associated with crystals to form a band-pass filter structure. However, the Q of any inductance of reasonable size is limited to relatively small values for reasonable space limitations. At best a Q of 200 to 300 for a reasonable size coil is about all that can be expected. It is unfortunate that this may result in a loss which varies over the pass band of the filter unless considerable care is exercised in choice of the structure. If inductance is added in series with a crystal, its series resonant frequency will be lowered without affecting the parallel resonant frequency. However, it is possible to separate the series resonant and parallel resonant frequencies several percent in this way. Since the separation of the two resonant points determine the width of the pass band, this appears to be a step in the right direction.

BRIDGE CIRCUIT

Fig. 6 shows a bridge type band-pass filter structure of this type. By properly proportioning the crystals and inductances, the pass band may be made as wide as 10 percent or more of the midband frequency. This arrangement is therefore more suitable for use at the usual intermediate frequencies. A pass band of about 3.15 percent at 456 kc gives 16 kc. Therefore something of the order of 3 percent is required for ordinary use. Of course, the width of the pass band can be adjusted by adding series or parallel condensers to the crystal structure of Fig. 6.

CHARACTERISTIC IMPEDANCE

This type of filter has a low characteristic impedance. The more the band is narrowed the lower the impedance. In general the impedance is of the order of a few ohms to a few hundred ohms. This is a serious disadvantage since step-up by means of i-f transformers or tuned circuits will, in general, be required if any appreciable i-f gain is to result. This can be done, however, and if crystal sections are combined with tuned coupled circuits of proper constants, an excellent i-f filter can be designed.

CRYSTAL FILTER LOSSES

The loss per section of crystal filter varies from 70 to 100 db at the high attenuation peaks, to a minimum of 30 to 40 db at points outside these peaks. Very steep slopes may be attained of the order of 60 to 80 db per kc at the usual intermediate frequencies.

There are, of course, many other types of filter structures, most of them being derivatives of the simple structures discussed.

NEW PRODUCTS

"CROMODIZING"

Excellent rustproofing at low cost is claimed for Cromodizing, a new process of the American Chemical Paint Company, of Ambler, Pa. By preventing rust from forming beneath paint films, this treatment solves the problem of keeping steel units in serviceable condition. Cromodizing is adapted to protecting any type of steel surface regardless of size, shape or previous processing. Because the cost of the process is decidedly below that of other pretreatments, cromodizing makes available to a wide field of steel products the benefits of improved and more lasting finish.

Prominent automobile manufacturers now using this treatment have shown in tests that cromodizing will at least triple the life of the finish on steel units. These manufacturers also report that paint has a better luster when applied over cromodized steel.

The actual process is a departure from all previous conceptions of rustproofing. Instead of coating the steel with a layer of phosphates as do other commercial methods, cromodizing goes to the primary causes of rust and changes the steel so that the surface currents that induce rusting are stopped.

To obtain this unusual type of protection, steel products are dipped in a bath or sprayed with a solution of a proprietary chemical called Cromodine. Only one minute is required for this Cromodine treatment. As with any other rustproofing process, the metal is first cleaned and following the chemical treatment is rinsed and dried. However, less care is necessary in cleaning than is the case with other processes. Generally speaking, cromodizing has been made clean-cut and foolproof, so that it gives consistent results when supervised by production employees.

•

THE UNIVERSAL POLYRANGER

Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y. has provided a synopsis of the Universal Polyranger in the fifth issue of their house organ, "Electrical Measurements",

The Universal Polyranger has 27 internal ranges and provides d-c measurements in amperes, milliamperes, microamperes, volts and millivolts. The a-c measurements are in amperes, milliamperes, volts and millivolts.

•

NEW PORTABLE TEST UNITS

Particularly suitable for general testing, laboratory, and radio work is a new line of compact, lightweight, portable volt-ohmmeters and test units announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania.

Equipped with a new rugged type d'Arsonval movement and selector switches for range selection, the units simplify testing of circuit resistance, continuity and insulation. The volt-ohmmeter is probably the most useful tool for exploration and trouble shooting in complex circuits such as radios, public speech amplifiers, signal systems, talking movie sets, control systems, and other applications where detailed knowledge of circuit conditions and values must be obtained.

Several types are available, including simple ohmmeters, volt-ohmmeters, d-c test units and the more elaborate multiscale a-c—d-c test units. The instruments weigh approximately 2 pounds, have a 2.4 inch scale length, an accuracy within 2 percent for d-c volts and milliamperes and within 5 percent for a-c, and are mounted in a sturdy 7" x 4" x 3¼" Moldarta case.

•

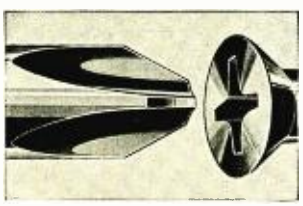
PHILLIPS SELF-CENTERING SCREWS

The American Screw Company, of Providence, R. I., is introducing a line of screws and bolts with a newly designed, recessed head.

In the Phillips head a tapered recess which exactly fits a tapered driver takes the place of the slot in the ordinary screw. Placed on the market after thorough tests under actual working conditions in a wide

variety of industries, Phillips Screws have shown a considerable increase in efficiency of the screw-driving job. Users find that they provide faster driving, better holding power, better appearance, reduced spoilage, fewer accidents and any other advantages.

The Phillips Screw holds on the point of the driver and may be moved into position for driving with one hand, a feature of particular importance when driving in "hard-to-get-at" places. Because of the



self-centering feature, there is three times as much purchase between driver and screw as there is between the ordinary driver and the slotted screw. There is no danger of the driver slipping sideways and marring the work or injuring the hands, as frequently happens when driving slotted screws.

ERIE RESISTOR ADDS TO INSULATED LINE

The Erie Resistor Corporation, Erie, Pa., announces the addition of ½-watt size to its line of ¼-watt insulated carbon resistors.

Positive over-all insulation is accomplished by enclosing the solid molded carbon resistance unit in a ceramic case. Tinned wire leads are brought out at the ends to facilitate wiring and insulation with spaghetti whenever desired.

These new ½-watt units are slightly smaller than the ordinary ¼-watt non-insulated resistors—over-all dimensions being 15/64 x 11/16. In spite of their unusual compactness they will safely carry overloads of 100 percent, it is stated.

The improved method of color coding

developed for the ¼-watt Erie Insulated Resistor is found on the larger size also. Difficulty in reading the resistance value when the conventional color dot is not in clear view is entirely overcome by using color bands that completely encircle the ceramic shell. The widest band, which is the normal body color, represents the first figure in the resistance value; the narrow superimposed band, which is the usual dot, represents the second figure; and the band next to the body color, equal to usual tip, indicates the number of ciphers following the first two figures in the resistance value. Standard colors designated by RMA are used. A third color band designating tolerance may be added.

The ceramic covering is so designed that it cannot be removed from the resistance pin, although it is purposely made slightly loose to compensate for contraction or expansion of the resistor inside it.

Both the ¼-watt and ½-watt insulated units can be obtained in all resistance values from a few ohms to several megohms. For samples write Erie Resistor Corporation, 644 West 12th St., Erie, Pa.

•

LAFAYETTE 24-TUBE SUPER

A new 24-tube superheterodyne, incorporating cathode-ray tuning, variable bandwidth selectivity and a dual high-fidelity speaker system, has been brought out by the Lafayette Radio Manufacturing Company, Inc., the manufacturing division of Wholesale Radio Service Company, Inc., 100 Sixth Avenue, New York, N. Y. The receiver is suitable for both the domestic and foreign markets.

This new Lafayette receiver consists of two individual units: an r-f chassis, which contains 13 metal tubes, and a separate audio-amplifier and loudspeaker unit, which contains 11 glass type tubes. Two loudspeakers are supplied, a 12" auditorium model and a 10" high-frequency type. The cathode-ray tuning device, which is visible directly above the main

(*Continued on page 30*)

News Of The Industry

WESTINGHOUSE OPERATIONS

Operations of the Westinghouse Electric & Manufacturing Company for the third quarter of 1935 compared with the third quarter of 1934 were as follows:

	Quarter Ended Sept. 30, 1935	Quarter Ended Sept. 30, 1934
Orders Received	$30,497,620	$25,213,271
Sales Billed	29,723,546	23,963,896
Net Profit	2,557,452	*332,062

* Net Loss.

Orders received during the 1935 quarter were 21 percent higher than for the same quarter in 1934. Sales billed were 24 percent higher.

Comparative figures for the two nine-month periods were as follows:

	Nine Months Ended Sept. 30, 1935	Nine Months Ended Sept. 30, 1934
Orders Received	$95,482,535	$79,105,881
Sales Billed	92,019,563	69,245,486
Net Profit	8,822,640	*363,787

* Net Loss.

Orders received during the nine-month period were 20.7 percent higher than in 1934; and billings were 32.9 percent higher.

•

G.E. OPERATIONS

Sales billed by the General Electric Company during the first nine months of 1935 amounted to $149,173,275.12, compared with $121,735,122.98 during the corresponding period last year, an increase of 23 percent, President Gerard Swope has announced.

Profit available for dividends on the common stock for the first nine months of this year was $17,205,332.37, compared with $11,714,247.20 for the first nine months of last year. This profit is equivalent to 60 cents a share for the first nine months of 1935 and 41 cents a share for the first nine months of 1934 on 28,845,927 shares outstanding in both periods.

A dividend of 20 cents a share was declared in September this year payable on October 25 to stockholders of record September 27. This makes 50 cents a share for the first three quarters this year, compared with 45 cents paid for the corresponding period last year. 185,816 stockholders will receive the October, 1935, dividend. This is an increase of 2,080 over the number of common stockholders a year ago.

•

G. E. OSCILLOGRAPH BULLETIN

General Electric Company, Schenectady, N. Y., has issued a bulletin on the G. E. Type HC-10-B1 Cathode-Ray Oscillograph. The technical details of the complete unit are provided.

•

TRIMMER CONDENSER BULLETIN

Complete information on the Varitor Line of dual and single trimmer condensers is contained in this four-page bulletin. Write to DeJur-Amsco Corporation, 95 Morton Street, New York City, for Bulletin No. 38.

RCA CATHODE-RAY MANUAL

RCA has published a 119-page manual on the RCA type cathode-ray tubes, covering general theory, features of tubes, installation, application, characteristics, Lissajous figures, tube patterns, typical oscillograms, cathode-ray tube terminology, etc. Data are also included on allied types of tubes.

Title of manual is: "RCA Cathode-Ray Tubes and Allied Types." Price is 25 cents.

•

FREED MOVES TO LARGER QUARTERS

Joseph D. R. Freed, president of the Freed Manufacturing Company, Inc., announces that due to the great success of the new line of sets manufactured by his company, the organization has been compelled to move to larger quarters.

On and after November 1, the factory, executive offices, and sales offices will be located at 44 W. 18th Street, New York City.

Construction work on the factory has already begun, and there will be no interruption in production. The new plant will afford production facilities three times greater than the present plant.

They have been manufacturing a very comprehensive line of promotional and private brand models, and a complete line of Freed-Eisemann sets for the jobbing trade has just been announced.

•

U. S. E. CATHODE-RAY TEST EQUIPMENT

United Sound Engineering Co,. 2233 University Ave., St, Paul, Minn., has issued three technical sheets on the latest U. S. E. equipment.

The sheets cover the Type CR-3 Cathode-Ray Oscillograph, the Type CR-4 Beat-Frequency Audio Oscillator and the Type CR-5 Frequency-Modulated R-F Oscillator.

•

"UNIVERSAL" DISC PRODUCTION

Improvements and enlarging of the Inglewood, Cal., factory of the Universal Microphone Co. in October created additional facilities for the manufacture of its line of Silveroid recording discs for instantaneous recording on its new professional recording machine.

A quarter of the first floor space has been set aside and constructed of fireproof material to house the coating department. The quarters have been made thoroughly dust-proof to eliminate lint and other foreign particles settling on the coated discs.

The coating rooms are temperature treated, constructed of airtight materials with complete air conditioning and a filtering system.

The new equipment and quarters will enable the factory to turn out the Silveroid discs in mass production with a consequent decrease in the dealer price, according to James R. Fouch, president.

RKO STOCK DISTRIBUTION

David Sarnoff, President of the Radio Corporation of America, and Floyd B. Odlum, President of Atlas Corporation, announced the sale by the Radio Corporation and the purchase by Atlas of a substantial portion of the Radio Corporation holdings in the Radio-Keith-Orpheum Corporation, with an option to purchase the remainder. Mr. Odlum stated that this purchase was made on behalf of Atlas Corporation and Lehman Brothers.

Proceedings are now pending for the re-organization of RKO under 77B. It is expected that a plan of re-organization will be promulgated shortly in these proceedings.

Merlin H. Aylesworth, President of RKO, expressed his gratification with the closing of the transaction.

•

NEW NATIONAL BULLETIN

The National Company, Inc., Malden, Mass., has released for distribution Bulletin No. 250, listing details and prices on the latest National products.

Of special interest in this bulletin is the data on the new National "One-Ten" Ultra-High Frequency Receiver, using Acorn and Metal tubes, and the Ultra H-F Tuning Unit.

•

DU MONT CATHODE-RAY DATA

Allen B. Du Mont Laboratories, Upper Montclair, New Jersey, has issued a folder of four pages dealing with the performance of the new Type 148 Du Mont Cathode Ray Oscillograph.

There is also described the Du Mont Model 150 Electronic Switch, a new development.

Copies of the folder may be had on request to the manufacturer.

•

BAKELITE SILVER ANNIVERSARY REVIEW

The Silver Anniversary issue of the Bakelite Review will be found particularly interesting. This issue covers the history of the Bakelite Corporation and many other interesting features, including data on the application of Bakelite materials in industry, and new developments in the molding fields.

•

NEW DE VILBISS CATALOG

The DeVilbiss Co., Toledo, Ohio, announces a new catalog, the "SF," covering the DeVilbiss line of specialty equipment. This includes portable air compressing units, spray guns and accessories for any light-duty application of paints, lacquers and other protective coatings, insecticides, motor car lubricating and washing, air brushes, and many other items in the extensive line of DeVilbiss specialty equipment. Copies are available.

WARD LEONARD BULLETIN

Magnetic Chuck Rectifiers, Bulletin 8651, for use with magnetic chucks. The bulletin illustrates and describes a full-wave rectifier for obtaining rectifier alternating current from 110-volt, 60-cycle service, and lists four sizes covering a range up to 1,800 watts.

Write to the Ward Leonard Electric Co., Mt. Vernon, N. Y.

•

STEWART-WARNER EARNINGS

Stewart-Warner Corporation reports consolidated net income of $1,329,423 for the nine months ended September 30, 1935, after deduction of all expenses including depreciation and reserve for federal taxes. This is equivalent to $1.07 a share on the 1,242,187 shares of common stock outstanding in the hands of the public at September 30, 1935, and represents a gain of 135 percent over the net profit of $565,782 reported for the nine months to September 30, 1934, which was equivalent to 45c a share on the 1,246,187 shares of common stock then outstanding.

For the three months ended September 30, 1935, consolidated net profits after all charges, were $308,931, equivalent to 25c a share on 1,241,187 shares of stock. In the three months to September 30, 1934. net profits were $25,523, or 2c a share on the outstanding stock. Net sales for the nine months ended September 30, 1935 were $15,887,194, as compared with $13,131,884 for the first nine months of 1934, an increase of 21 percent. For the three months ended September 30, 1935, net sales were $4,881,634, as compared with $3,891,200 in the corresponding three months of 1934, or a gain of 25 percent.

Consolidated balance sheet at September 30, 1935, shows current assets of $8,059,465 including cash of $2,875,074, as compared with current liabilities of $1,381,494, a ratio of 5.8 to 1. On September 30, 1934, cash totalled $629,075, with a ratio of 4.2 to 1.

Directors of the company recently declared a regular semi-annual dividend payment of 25c a share, together with an extra payment of 25c a share, both payable December 2 to stockholders of record November 1. This is the first dividend declaration by the Stewart-Warner Corporation since November, 1930.

•

NEW KOROSEAL BULLETIN

As a supplement to their recent announcement concerning a new synthetic rubber-like material known as Koroseal, the B. F. Goodrich Company, Akron, Ohio, have just released a twelve-page illustrated bulletin describing the various properties of this product, listing the various forms in which it is available and uses for which it has been successfully adapted. A copy of this bulletin may be obtained by addressing your request to the Mechanical Rubber Goods Division of the above company.

•

NEW AND LARGER QUARTERS FOR TACO

Forced to seek larger space for increased production whereby to meet the growing demand of old and new customers alike for Taco all-wave noiseless antenna kits, components and allied products, Technical Appliance Corporation has moved from Long Island City to 17 East 16th St., New York. The new quarters provide three times as much floor space, while new machinery permits stepping up production some 300 percent, it is said. Also, the new location is more convenient for callers and for shipments.

•

NEW PRODUCTS

(*Continued from page* 26)

tuning dial, operates effectively on both weak and strong signals and permits accurate visual tunings on all wavebands.

The output stage, which uses eight type 45 tubes in Class AB, is capable of delivering audio power up to about 50 watts. This maximum rating is far in excess of any ordinary home requirement, and assures the user of perfect reproduction without the faintest sign of strain or overload.

•

FERRIS MICROVOLTER

The Ferris Instrument Corporation, of Boonton, N. J., announces a new Microvolter, for laboratory use. This new instrument, designated as Model 17B, is a "big brother" of their well-known Model 10B Instrument.

It includes a rotating coil system, somewhat similar to that used in the 10B, but with 10 coils to cover 100 to 30,000 kilocycles, and with improvements in construction to make possible greater permanence of calibration.

A worm-drive condenser, with a total scale length of approximately ten feet, makes possible very close frequency settings, for selectivity measurements and other purposes.

An unusual feature of the Model 17B is that the power unit (not shown in the

illustration) is separate from the Microvolter, and is connected to it by a plug and cable. Very complete r-f filters are of course included in the instrument to prevent leakage. With this construction, the instrument can normally be used on the a-c line, but when special conditions, such as unusually severe hum tests, or operation away from a power source make it desirable to operate from batteries, this can be done without any change in the instrument.

Another feature of this construction is that it keeps the heat of the power unit away from the Microvolter proper, contributing to the stability of frequency calibration.

A direct-reading system of modulation measurement, which can be used with either the self-contained 400-cycle oscillator, or with an external audio source, is included in the 17B.

An illustrated circular describing the instrument in detail can be obtained from the Ferris Instrument Corporation, Boonton, N. J.

•

SOUND SYSTEMS CY-22 MICROPHONE

Sound Systems, Inc., 1311 Terminal Tower, Cleveland, Ohio, have introduced a new type crystal microphone housed in an exceedingly small case, about 3 inches high, 1½ inches wide and in thickness tapering to ½ inch at the top of the case.

While this microphone is of the sound-cell type of construction, it is said to have larger cells and a lower impedance than the conventional types of sound-cell micro-

phones now in use. This permits longer microphone lines, which is a desirable feature in all types of installations.

This new microphone is known as the CY-22, has a level approximately 10 db lower than the standard diaphragm crystal microphone, but with a flatter response. The frequency response is said to be flat from 30 to 6000 cycles with slightly rising characteristics to 12,000 cycles.

•

RMA NEWS

(*Continued from page* 24)

receiver and facsimile committees will meet November 20, following meetings on November 18 of the sound equipment and television committees.

On November 7 at the Edison Electric Institute offices in New York there was a meeting of the Joint Coordination Committee of EEI, RMA and NEMA to discuss interference problems. Mr. Graham, chairman of the RMA committee, presided. A broad scale program to reduce radio interference also has been authorized by the American Standards Association under the sponsorship of the RMA. The ASA has recommended participation by many radio, electrical, automotive and other allied organizations as originally projected in the interference work of the RMA.

COLOMBIAN TARIFF RATES

UNDER A RECIPROCAL trade agreement with Colombia, negotiated by the State Department. the Colombian tariff of 10 cents (Colombian) per gross kilo on radio apparatus will be continued and Colombia guarantees against future increase of the rate. The new treaty, however, provides for reduction of two-thirds from one and one-half pesos to 50 cents (Colombian) in the duty on combination radio-phonograph sets and gramophones. The Colombian reciprocal agreement will become effective when ratified by the presidents of that country and the United States.

RADIO ENGINEERING BUYER's GUIDE

A continuous, indexed recording of the reliable sources of supply of

Materials—Component Parts

ALLOYS, RESISTANCE
AMERICAN ELECTRO METAL CORP., Lewiston, Maine
CALLITE PRODUCTS CO., 542 39th St., Union City, N. J.
Cleveland Wire Cloth & Mfg. Co.
Consolidated Wire Corp.
Driver Company, Wilbur B.
Driver-Harris Company
Fansteel Metallurgical Labs.
Hoskins Mfg. Co.
Jelliffe Company, C. O.
Prentiss & Company, Geo. W.

ARRESTORS, LIGHTNING
Birnbach Radio Corp.
Knox Porcelain Co.
Johnson, E. F., Co.

BASES, VACUUM TUBE
AMERICAN LAVA CORP., Chattanooga, Tenn.
American Phenolic Corp.
American Record Corp.
ISOLANTITE, INC., 233 Broadway, N, Y. C.
Kurz-Kasch Co.
RCA MFG. COMPANY, INC., Camden, N. J.
Westinghouse Lamp Co.

BINDING POSTS
BANKS INTER-AIR PRODS., Woodside, N. Y.
Eby, H. H., & Co.

BRASS—COPPER
AMERICAN BRASS CO., THE, Waterbury, Conn.
ANACONDA COPPER CO., 25 Broadway, N. Y. C.
Baltimore Brass Co.
Bristol Brass Corp.
Copper & Brass Research Ass'n
Ryerson & Son, Inc.
Scoville Mfg. Co.
WATERBURY BRASS GOODS BRANCH, Waterbury, Conn.

CABINETS—WOOD
Adler Mfg. Co.
Alden Corp.
EXCEL WOODCRAFT CORP., THE, Columbus Rd. at Leonard St., Cleveland, Ohio
Peerless Cabinet Co.
Superior Cabinet Corp.

CATHODES (See Tubing, Seamless Cathode)

CATHODE RAY—TUBES
DUMONT LABORATORIES, ALLEN B., 542 Valley Rd., Upper Montclair, N. J.
General Electric Co.
HYGRADE-SYLVANIA CORP., Clifton, N. J.
RCA MANUFACTURING CO., INC., Camden, N. J.
WESTERN ELEC. CO., 195 Broadway, N. Y. C.
Westinghouse Elec. & Mfg. Co.

CATHODE RAY—OSCILLOGRAPHS
DUMONT LABORATORIES, ALLEN B., 542 Valley Rd., Upper Montclair, N, J.
General Electric Co.
RCA MANUFACTURING CO., INC., Camden, N. J.
RADIO INSTRUMENTS CO., 22 Wooster St., N. Y. C.
WESTERN ELEC. CO., 195 Broadway, N. Y. C.
Westinghouse Elec. & Mfg. Co.

CERAMICS
AMERICAN LAVA CORP., Chattanooga, Tenn.
Amerian Phenolic Corp.
Colonial Insulator Co.
Crowley & Co., Henry L.
Dielectric Products Co.
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Mycalex Corp. of Amer.
STUPAKOFF LABORATORIES, INC., 6627 Hamilton Ave., Pittsburgh, Pa.

CHOKES
ACME ELECTRIC & MFG. CO., 1440 Hamilton Ave., Cleveland, Ohio
ALLOY TRANSFORMER CO., 135 Liberty St. N. Y. C.
AMERICAN TRANSFORMER CO., 175 Emmet St., Newark, N. J.
General Transformer Co.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
KENYON TRANSFORMER CO., INC., 840 Barry St., N. Y. C.
UNITED TRANSFORMER CORP., 72-74 Spring St., N. Y. C.

COIL MACHINERY
UNIVERSAL WINDING CO., Elmwood Ave., Providence, R. I.

COILS—POWER
ANACONDA COPPER CO., Waukegan, Wisc.
ACME WIRE COMPANY, 1255 Dixwell Avenue, New Haven, Conn.
American Enameled Magnet Wire Co.
Belden Manufacturing Co.
Coils, Incorporated
Electrical Winding Company
General Cable Corp.
GENERAL ELECTRIC COMPANY, Schenectady, N. Y.
Roebling's Sons, John
Westinghouse Elec. & Mfg. Co.

COILS—RADIO RECEIVER
ALADDIN RADIO INDUSTRIES, INC., 466 W. Superior St., Chicago, Ill.
Alden Manufacturing Co.
Automatic Winding Co.
Coils, Inc.
ELECTRICAL WINDING CORP., 22-26 Wooster St., N. Y. C.
General Mfg. Co.
GUTHMAN & CO., INC., Edwin L., 1306 W. Van Buren St., Chicago, Ill.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
Meissner Mfg. Co.
National Company
Sickles Company

COILS—SPEAKER
ACME ELECTRIC & MFG. CO., 1440 Hamilton Ave., Cleveland, Ohio
ALLOY TRANSFORMER CO., 135 Liberty St., N. Y. C.
AMERICAN TRANSFORMER CO., 175 Emmet St., Newark, N. J.
ANACONDA WIRE & CABLE CO., Muskegon, Mich.
Chicago Transformer Corp.
Dongan Electric Mfg. Co.
GENERAL TRANSFORMER CORP., 500 S. Throop St., Chicago, Ill.
General Cable Corp.
Haldorson Company
JEFFERSON ELECTRIC COMPANY, Bellwood, Ill.
KENYON TRANSFORMER CORP., 840 Barry St., N. Y. C.
RCA MANUFACTURING CO., INC., Camden, N. J.
STANDARD TRANSFORMER CORP., 854 Blackhawk Street, Chicago, Ill.
Thordarson Elec. Mfg. Co.
UNITED TRANSFORMER CORP., 72-78 Spring St., N. Y. C.

CONDENSERS, FIXED PAPER
ACME WIRE COMPANY, 1255 Dixwell Ave., New Haven, Conn.
AEROVOX CORP., 90 Washington St., Brooklyn, N. Y.
CORNELL-DUBILIER CORP., 4388 Bronx Blvd., N. Y. C.
Cosmic Radio Co.
Dumont Mfg. Co.
ELECTRONIC LABORATORIES, INC., Indianapolis, Ind.
Flechtheim & Co., A. M.
Girard-Hopkins, Inc.
Magnavox Co., Ltd.
MALLORY & CO., P. R., Indianapolis, Indiana
Micamold Radio Corp.
Polymet Mfg. Co., Inc.
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.
Sprague Specialties Co.
TOBE-DEUTSCHMANN CORP., Canton, Mass.

CONDENSERS, FIXED ELECTROLYTIC
AEROVOX CORP., 90 Washington St., Brooklyn, N. Y.
Condenser Corp. of America
CORNELL-DUBILIER CORP., 4388 Bronx Blvd., N. Y. C.
CURTIS CONDENSER CORP., 3088 W. 106th St., Cleveland, Ohio
Magnavox Co., Ltd.
MALLORY & CO., P. R., Indianapolis, Indiana
Micamold Radio Corp.
Polymet Mfg. Co., Inc.
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.
Sprague Specialties Co.

CONDENSERS, ADJUSTABLE
DeJur-Amsco Corp.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
Meissner Mfg. Co.
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.
TOBE-DEUTSCHMANN CORP., Canton, Mass.

CONDENSERS, VARIABLE
CARDWELL MFG. CO., ALLEN B., 81 Prospect St., Brooklyn, N. Y.
DeJur-Amsco Corp.
General Instrument Co.
GENERAL RADIO COMPANY, 30 State St., Cambridge, Mass.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
OAK MFG. CO., 711 W. Lake Street, Chicago, Ill.
Precise Mfg. Co.
Radio Condenser Co.
Reliance Die & Stamping Co.
Scoville Mfg. Co.

CONTACTS, METAL
Baker & Co., Inc.
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
General Plate Co.
General Tungsten Mfg. Co.
MALLORY & CO., P. R., Indianapolis, Indiana
Wilson Co., H. A.

CORES, RESISTANCE COIL
AMERICAN LAVA CORP., Chattanooga, Tenn.
Colonial Insulator Co.
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Steward Mfg. Co.

CORES, TRANSFORMER
THOMAS & SKINNER STEEL PRODS. CO., 1100-1120 E. 23rd St., Indianapolis, Indiana

CRYSTALS, QUARTZ and ROCHELLE SALT
BLILEY ELECTRIC CO., 237 Union Station Bldg., Erie, Pa.
Ronton Research Labs.
RCA MANUFACTURING CO., INC., Camden, N. J.
BRUSH DEVELOPMENT CO., E. 40th St. & Perkins Ave., Cleveland, Ohio
SCIENTIFIC RADIO SERVICE, University Pk., Hyattsville, Md.

DIALS, ESCUTCHEONS
Crowe Nameplate Co.

DIAPHRAGMS, SPEAKER
Hawley Products Co.
Masland Mfg. Corp.
UNITED PRESSED PRODUCTS CO., 407 S. Aberdeen St., Chicago, Ill.

ELECTRODES, NEON
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
EISLER ELECTRIC CORP., Union City, N. J.
EISLER ENGINEERING CO., INC., 747 So. 13th St., Newark, N. J.
KAHLE ENGINEERING CORP., 330 Manhattan Ave., Union City, N. J.
SWEDISH IRON & STEEL CORP., 17 Battery Pl., N. Y. C.

EYELETS
Platt Bros. & Co.
United Shoe Mach. Co.
WATERBURY BRASS GOODS BRANCH, Waterbury, Conn.

FIBRE, PHENOL and VULCANIZED
(sheet, rod, tube)
Bakelite Corp.
Brandywine Fibre Products Co.
Continental-Diamond Fibre Co.
Formica Insulation Co.
Franklin Fibre-Lamitex Corp.
General Electric Co.
Mica Insulator Co.
National Vulcanized Fibre Co.
Resinox Corporation
SYNTHANE CORPORATION, Oakes, Penna.
Westinghouse Elec. & Mfg. Co.
Wilmington Fibre Co.

FLEXIBLE SHAFTING
Fischer Spring Company, Chas.
White Dental Mfg. Co., S. S.

FUSES
LITTLEFUSE LABORATORIES. 4238 Lincoln Ave., Chicago, Ill.

GENERATORS
Carter Motor Company
Columbia Elec. Mfg. Co.
ELECTRONIC LABORATORIES, INC., 122 W. New York St., Indianapolis, Ind.
MALLORY & CO., P. R., Indianapolis, Indiana
ONAN & SONS, D. W., Minneapolis, Minn.
PIONEER GENE-MOTOR CORP., 466 W. Superior St., Chicago, Ill.

GETTERS (See Nickel Tube Parts)

GRAPHITE
ACHESON COLLOIDS CORP., Port Huron, Mich.

HORNS
BUD RADIO, INC., 1923 E. 55th St., Cleveland, Ohio
HOPE MFG. CO., 401 Broadway, N. Y. C.
MACY ENGINEERING CO., 1452 39th St., Brooklyn, N. Y.
RACON ELEC. MFG. CO., 52 E. 19th St., N. Y. C.
WRIGHT-DECOSTER, INC., 2253 University Ave., St. Paul, Minn.

INSTRUMENTS (See Meters or Cathode Ray)

INSULATION, BEADS
AMERICAN LAVA CORP., Chattanooga, Tenn.
Dunn, Inc., Struthers
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Steward Mfg. Co.
STUPAKOFF LABORATORIES, INC., 6627 Hamilton Ave., Pitts, Pa.

INSULATION, CERAMICS (See Ceramics)

INSULATION COMPOUNDS
CANDY & CO., INC., 35th and Maplewood Ave., Chicago, Ill.
Dolph Co., John C.
Glenn & Co., J. J.
Mica Insulator Co.
Roebling's Sons Co., John A.
ZOPHAR MILLS, INC., Court, Lorraine and Creamer St., Brooklyn, N. Y.

INSULATION, FIBRE (See Fibre)

INSULATION, MOLDED
American Insulator Corp.
AMERICAN LAVA CORP., Chattanooga, Tenn.
American Phenolic Corp.
American Record Corp.
Chicago Molded Prods. Corp.
Formica Insulation Co.
General Electric Co.
Kurz-Kasch Co.
Macallen Co.
Watertown Mfg. Co.
Westinghouse Elec. & Mfg. Co.

INSULATION, TUBING
BENTLEY HARRIS MFG. CO., Conshohocken, Pa.
BRAND & CO., WM., 276 Fourth Ave., N. Y. C.
Glenn & Co., J. J.
Mica Insulator Co.

IRON, SWEDISH (Tube Parts)
SWEDISH IRON & STEEL CORP., 17 Battery Pl., N. Y. C.

LACQUER, PAINT, VARNISH
ACME WIRE COMPANY, 1255 Dixwell Ave., New Haven, Conn.
Dolph & Co., John C.
Impervious Varnish Co.
Irvington Varnish Co.
Mass & Waldstein
Rosalin Flexible Lacquer Co., Inc.
ZAPON COMPANY, 60 E. 42nd St., N. Y. C.
ZOPHAR MILLS, Court, Lorraine and Creamer Sts., Brooklyn, N. Y.

LAMPS, GLOW
LITTLEFUSE LABORATORIES, 4238 Lincoln Ave., Chicago, Ill.

LUGS
CINCH MFG. CORP., 2335 W. Van Buren St., Chicago, Ill.
Thomason-Bremer Corp.
WATERBURY BRASS GOODS BRANCH, Waterbury, Conn.
ZIERICK MACHINE WORKS, F. R., 68 E. 131 St., N. Y. C.

MAGNETS
THOMAS & SKINNER STEEL PRODS. CO., 1100-1120 E. 23rd St., Indianapolis, Indiana.

MELTING POTS
Dunn, Inc., Struther
STA-WARM ELECTRIC CO., Ravenna, Ohio
Trent Co., Harold E.

METERS; TESTING INSTRUMENTS
Apparatus Design Co.
Boonton Radio Corp.
BURTON-ROGERS CO., 755 Boylston St., Boston, Mass.
CLOUGH-BRENGLE CO., 1134 W. Auston Ave., Chicago, Ill.
Dumont Laboratories, Allen B.
FERRIS INSTR. CORP., Boonton, N. J.
General Electric Co.
GENERAL RADIO COMPANY, 30 State St., Cambridge A, Mass.
HICKOK ELEC. INSTRU. CO., Cleveland, Ohio
JACKSON ELEC. INSTRU. CO., Dayton, Ohio
RCA MFG. CO., INC., Camden, N. J.
RADIO CITY PRODUCTS CO., 28 W. Broadway, N. Y. C.
RADIO INSTRUMENTS CO., 22 Wooster St., N. Y. C.
RADIO PRODUCTS COMPANY, 145 Sunrise Pl., Dayton, Ohio
Rawson Elec. Instru. Co.
READRITE METER WORKS, Bluffton, Ohio
Shallcross Mfg. Co.
SUPREME INSTRUMENT CORP., Greenwood, Miss.
TRIPLETT ELEC. INSTRU. CO., Bluffton, Ohio
TRIUMPH MFG. CO., 4017 W. Lake St., Chicago, Ill.
WESTERN ELECTRIC CO., 195 Broadway, N. Y. C.
WESTON ELEC. INSTRU. CORP., 614 Freylinghuysen Ave., Newark, N. J.
Westinghouse Elec. & Mfg. Co.

MICA
BRAND & CO., WM., 276 Fourth Ave., N. Y. C.
Continental-Diamond Fibre Co.
Ford Radio Mica Co., Inc.
Macelien Co.
Mica Insulator Co.
New England Mica Co.

MICROPHONES
AMERICAN MICROPHONE CO., Los Angeles, Calif.
AMPERITE CORP., 561 Broadway, N. Y. C.
ASTATIC MICROPHONE LAB., INC., 40 Hubbard Road, Youngstown, Ohio
Beacon Microphone Co.
BRUNO LABORATORIES, 20 West 22nd St., N. Y. C.
BRUSH DEVELOPMENT CO., Cleveland, Ohio
Carrier Microphone Co.
ELECTRO-VOICE MFG. CO., INC., South Bend, Indiana
RADIO RECEPTOR CO., INC., 106 Seventh Ave., N. Y. C.
RCA MFG. COMPANY, INC., Camden, N. J.
SHURE BROS. CO., 215 W. Huron St., Chicago, Ill.
SOUND SYSTEMS, INC., 1311 Terminal Bldg., Cleveland, Ohio
Turner Company
UNIVERSAL MICROPHONE CO., LTD., Inglewood, Calif.
WESTERN ELECTRIC CO., 195 Broadway, N. Y. C.

MOLYBDENUM
AMERICAN ELECTRO METAL CORP., Lewiston, Maine
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
ELECTRO-METALS, INC., 1880 E. 40th St., Cleveland, Ohio.
Fansteel Metallurgical Labs.

MONEL METAL
International Nickel Corp.

NICKEL, TUBE PARTS (Also see Iron)
(plates, grids, wire cloth, cathodes, getters, hooks, heaters, base-pins, welds)
AMERICAN BRASS CO., Waterbury, Conn.
AMERICAN ELECTRO METAL CORP., Lewiston, Maine
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
Cleveland Wire Cloth & Mfg. Co.
Driver Co., Wilbur B.
Driver-Harris Co.
General Plate Co.
GOAT RADIO TUBE PARTS, INC., 314 Dean St., Brooklyn, N. Y.
Kemet Labs., Inc.
King Laboratories, Inc.
Newark Wire Cloth Company
Pequot Wire Cloth Company
Prentiss & Company, Geo. W.
SUMMERILL TUBING COMPANY, Bridgeport, Penna.
Superior Tube Company
Wizard Electric Company

PAPER, for CONDENSERS
Dexter & Sons Co., Inc., C. H.
Schweitzer, Inc., Peter J.
Strype, Fred. C.

PAPER TUBES
Chicago Paper Tube Co.
Cross Paper Products Co.
Paper Tube Company, The
Paramount Paper Tube Co.

PHOSPHOR BRONZE
Phosphor Bronze Smelting Co.
Riverside Metal Company
Scoville Mfg. Company
Seymour Mfg. Company
Waterbury Rolling Mills, Inc.

PHOTOELECTRIC CELLS
Burt, R. C., Co.
Continental Electric Co.
Eby, H. H., Mfg. Co.
General Electric Co.
G-M Laboratories
RCA MANUFACTURING CO., INC., Camden, N. J.
Westinghouse Elec. & Mfg. Co.
WESTON ELECTRICAL INSTRUMENTS CORP., 012 Frelinghuysen Ave., Newark, N. J.

PICKUPS, TRANSCRIPTION
ASTATIC MICROPHONE LAB., INC., 40 Hubbard Road, Youngstown, Ohio
AUDAK COMPANY, THE, 500 Fifth Ave., N. Y. C.
PROCTOR & CO., B. A., 17 W. 60th St., N. Y. C.
RCA MFG. COMPANY, INC., Camden, N. J.

PLASTICS (See Insulation, Molded)

PLUGS
Alden Mfg. Co.
American Phenolic Corp.
Cannon Elec. Development Co.
CINCH MFG. CORP., 2335 W. Van Buren St., Chicago, Ill.
Eby Mfg. Co., H. H.
Jones, Howard B.
MALLORY & CO., INC., P. R., Indianapolis, Indiana
REMLER CO. LTD., 2101 Bryant St., San Francisco, Cal.

POINTS, CONTACT
Baker & Company
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
Fansteel Metallurgical Corp.

RECTIFIERS
B-L Electric Mfg. Co.
GENERAL ELCTRIC CO., Bridgeport, Conn.
MALLORY & CO., INC., P. R., Indianapolis, Indiana
UNITED TRANSFORMER CORP., 72-74 Spring St., N. Y. C.
Westinghouse Elec. & Mfg. Co.

RELAYS
ALLEN-BRADLEY CO., 126 W. Greenfield Ave., Milwaukee, Wisc.
Automatic Electric Co.
Dunn, Inc., Struthers
ELECTRONIC LABORATORIES, INC., Indianapolis, Ind.
GENERAL ELECTRIC COMPANY, Schenectady, N. Y.
Kurman Elec. Co.
Mercoid Corporation
WARD-LEONARD ELEC. CO., 33 South St., Mt. Vernon, N. Y.
WESTON ELEC. INSTRU. CORP., 612 Frelinghuysen Ave., Newark, N. J.

RESISTORS, CARBON-COMPOSITION
AEROVOX CORP., 90 Washington St., Brooklyn, N. Y.
ALLEN-BRADLEY CO., 126 W. Greenfield Ave, Milwaukee, Wisc.
CENTRALAB, 900 E. Keefe Ave., Milwaukee, Wisc.
Chicago Tel. Supply Co.
CLAROSTAT MFG. CO., INC., 287 N. 6th St., Brooklyn, N. Y.
CONTINENTAL CARBON, INC., 13902 Lorain Ave., Cleveland, Ohio.
ELECTRAD, INC., 175 Varick St., N. Y. C.
ERIE RESISTOR CORP., Erie, Penn.
Globar Corp.
INTERNATIONAL RESISTANCE CO., 2100 Arch St., Phila., Pa.
MALLORY & CO., INC., P. R., Indianapolis, Indiana
Micamold Radio Corp.
Ohio Carbon Co.
OHMITE MFG. COMPANY, 4835 Flournoy St., Chicago, Ill.
Speer Resistor Corp.
Stackpole Carbon Co.
SOLAR MFG. CO., 599-601 Broadway, N. Y. C.
Tech Laboratories
WARD LEONARD ELEC. CO., 33 South St., Mt. Vernon, N. Y.
White Dental Mfg. Co., S. S.
Wirt Company, The

RESISTORS, WIRE WOUND
Atlas Resistor Co.
CLAROSTAT MFG. CO., INC., 287 N. 6th St., Brooklyn, N. Y.
Daven Company
ELECTRAD, INC., 175 Varick St., N. Y. C.
Hardwick Hindle, Inc.
INTERNATIONAL RESISTANCE CO., 2100 Arch St., Phila., Pa.
MALLORY & CO., INC., P. R., Indianapolis, Indiana
MUTER CO., THE, 1255 S. Michigan Ave., Chicago, Ill.
OHMITE MFG. COMPANY, 4835 Flournoy St., Chicago, Ill.
PRECISION RESISTOR CORP., 334 Badger Ave., Newark, N. J.
Shallcross Mfg. Co.
WARD LEONARD ELEC. CO., 33 South St., Mt. Vernon, N. Y.

SCREWS, SELF LOCKING
Parker-Kalon Corp.
SHAKEPROOF LOCK WASHER CO., 2501 N. Keeler Ave., Chicago, Ill.

STEEL
Allegheny Steel Co.
AMERICAN ROLLING MILL CO., Middletown, Ohio
American Steel & Wire Co.
Ryerson & Son, Inc.

SOCKETS
Alden Mfg. Co.
American Phenolic Corp.
CINCH MFG. CORP., 2335 W. Van Buren St., Chicago, Ill.
Continental-Diamond Fibre Co.
Eby Mfg. Co., H. H.
FRANKLIN MFG. CORP., ALBERT W., 137 Varick St., N. Y. C.

SOLDER
Dunton Co., M. W.
GARDINER METAL CO., 4820 S. Campbell Ave., Chicago, Ill.
Kester Solder Company
RUBY CHEMICALS CO., 56 McDowal St., Columbus, Ohio.

SOLDERING IRONS
ELECTRIC SOLDERING IRON CO., 342 W. 14th St., N. Y. C.
INSULINE CORP. OF AMERICA, 25 Park Pl., N. Y. C.
STA-WARM ELECTRIC CO., 508 N. Chestnut St., Ravenna, Ohio

SPEAKERS and SPEAKER UNITS
Best Mfg. Co.
Boudette & Co.
Jensen Radio Mfg. Co.
Magnavox Co., Ltd.
OPERADIO MFG. CO., 13th and Indiana St., St. Charles, Ill.
OXFORD RADIO CORP., 350 W. Huron St., Chicago, Ill.
RCA MFG. COMPANY, INC., Camden, N. J.
RACON ELEC. CO., INC., 52 E. 19th St., N. Y. C.
Rola Company, The
UTAH RADIO PRODUCTS CO., 820 Orleans St., Chicago, Ill.
Victory Speakers, Inc.
Voice Of The Air Co.
WESTERN ELECTRIC CO., 195 Broadway, N. Y. C.
WRIGHT-DE COSTER, INC., 2258 University St., St. Paul, Minn.

TAPE, VARNISHED FABRIC
ACME WIRE CO., 1255 Dixwell Ave., New Haven, Conn.
BRAND CO., WILLIAM, 276 Fourth Ave., N. Y. C.

TRANSFORMERS (Also see Chokes)
ACME ELEC. & MFG. CO., THE, 1440 Hamilton Ave., Cleveland, Ohio
ALLOY TRANSFORMER CO., 135 Liberty St., N. Y. C.
AMERICAN TRANSFORMER CO., 175 Emmet St., Newark, N. J.
Chicago Transformer Co.
Dongan Electric Mfg. Co.
GENERAL TRANSFORMER CORP., 5025 S. Throop St., Chicago, Ill.
HALLDORSON COMPANY, THE, 4500 Ravenswood Ave., Chicago, Ill.
JEFFERSON ELECTRIC COMPANY, Bellwood, Miss.
KENYON TRANSFORMER CO., INC., 840 Barry St., N. Y. C.
RCA MFG. COMPANY, INC., Camden, N. J.
STANDARD TRANSFORMER CORP., 866 Blackhawk St., Chicago, Ill.
THORDARSON ELEC. MFG. CO., 500 W. Huron St., Chicago, Ill.
UNITED TRANSFORMER CORP., 72-74 Spring St., N. Y. C.

TRANSPORTATION, EXPRESS
Railway Express Agency, Inc. Offices in all cities

TUBE PARTS (See Iron and Nickel)

TUBING, SEAMLESS CATHODE
General Plate Company
SUMMERILL TUBING COMPANY, Bridgeport, Pa.
SUPERIOR TUBE COMPANY, Norristown, Pa.

TUBING SPAGHETTI (See Insulation Tubing)

TUNGSTEN
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
Cleveland Tungsten Mfg. Co., Inc.

VIBRATORS (See Relays)

WASHERS INSULATING (See Fibre, Phenol)

WASHERS, METAL
SHAKEPROOF LOCK WASHER CO., 2501 N. Keeler Ave., Chicago, Ill.
Thompson-Bremer Corp.
WRDUGHT WASHER MANUFACTURING CO., 2203 S. Bay St., Milwaukee, Wis.

WAXES (See Insulation, Compounds)

WIRE, BARE
Alpha Wire Co.
American Braiding Co.
American Steel & Wire Co.
ANACONDA WIRE & CABLE CO., 25 Broadway, N. Y. C.
Belden Mfg. Co.
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
CORNISH WIRE COMPANY, 30 Church St., N. Y. C.
Crescent Insulated Wire & Cable Co.
General Cable Corp.
Holyoke Company, Inc.
Hoskins Mfg. Co.
Phosphor Bronze Smelting Co.
Riverside Metal Co.
Roebling's Sons Co., John A.
Scovill Mfg. Co.

WIRE, BRAIDED
American Braiding Co.
CORNISH WIRE COMPANY, 30 Church St., N. Y. C.
Holyoke Company, Inc.
Roebling's Sons Co., John A.

WIRE, COPPER CLAD
American Braiding Company
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.

WIRE, FILAMENT and GRID
AMERICAN ELECTRO METAL CORP., Lewiston, Maine
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
Driver Co., Wilbur B.
Driver-Harris Co.
Jelliff Mfg. Corp., C. O.
Newark Wire Cloth Co.
Pequot Wire Cloth Co.
Prentiss & Co., Geo. W.
SWEDISH IRON & STEEL CORP., 17 Battery Pl., N. Y. C.

WIRE, INSULATED
ACME WIRE COMPANY, 1255 Dixwell Ave., New Haven, Conn.
American Braiding Company
American Enameled Magnet Wire Co.
American Steel & Wire Co.
ANACONDA WIRE & CABLE CO., 25 Broadway, N. Y. C.
Belden Mfg. Co.
CORNISH WIRE COMPANY, 30 Church St., N. Y. C.
General Cable Corp.
GENERAL ELECTRIC COMPANY, Schenectady, N. Y.
LENZ ELECTRIC MFG. CO., 1751-1757 N. Western Ave., Chicago, Ill.
Rockbestos Products Corp.
Roebling's Sons Co., John A.

WIRE, MAGNET
ACME WIRE COMPANY, 1255 Dixwell Ave., New Haven, Conn.
American Braiding Co.
American Enameled Magnet Wire Co.
American Steel & Wire Co.
ANACONDA WIRE & CABLE CO., 25 Broadway, N. Y. C.
Belden Mfg. Co.
General Cable Corp.
GENERAL ELECTRIC COMPANY, Schenectady, N. Y.
Roebling's Sons Co., John A.

WIRE, RESISTANCE (See Alloys)

WIRE STRIPPERS
Carlander, Henry
WIRE STRIPPER CO., 1725 Eastham Ave., East Cleveland, Ohio

ZINC
New Jersey Zinc Co.
Platt Bros. & Co.

INDEX TO ADVERTISERS

SOLAR

Capacitors

WET
DRY
PAPER
MICA
TRIMMER

Reliable . . . in every climate throughout the world

WHEN IN NEED OF GOOD CONDENSERS-
SPECIFY THE BEST

Literature on request

WET ELECTROLYTICS

For unfailing filter service; not injured by momentary over-voltage. All standard values. Also special high capacity types.

DRY ELECTROLYTICS

Unsurpassed in ability to withstand difficult conditions of temperature and humidity. Standard sizes in stock. All special types, including compact high-capacity units, built promptly to specification.

PAPER CONDENSERS

Tubular and Block Bypass units, of best possible R.F. characteristics. Humidity-proof (triple-sealed).

MICA CONDENSERS

Molded Bakelite, containing only mica insulation. Highest resistance and permanence.

TRIMMER CONDENSERS

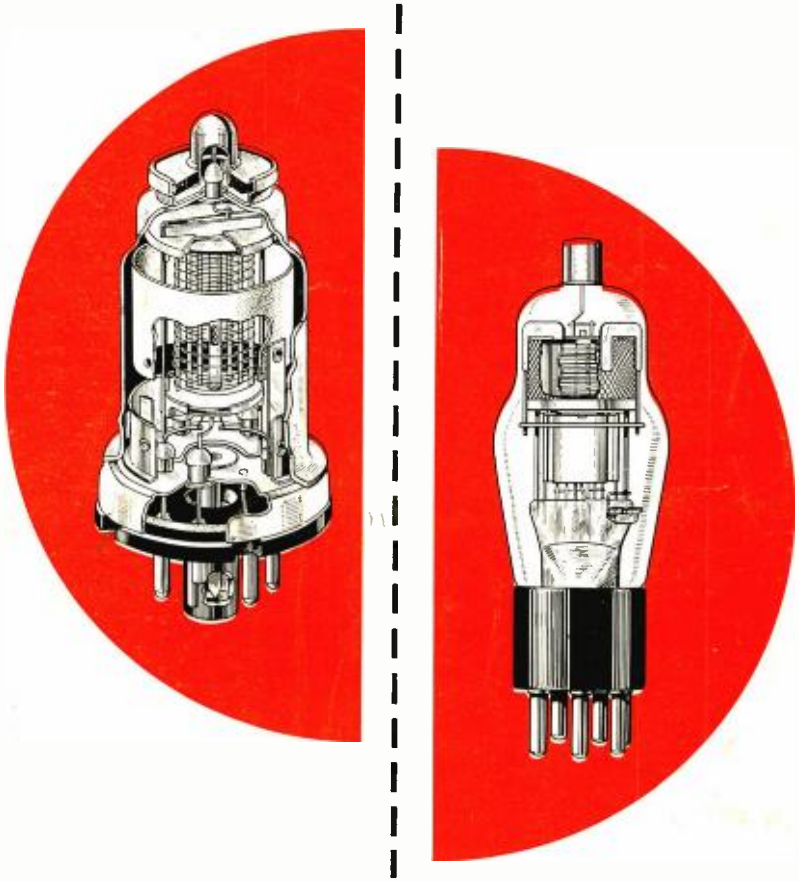
Standard and special types, made with original features which prevent drifting.

always . . . . we have stressed the four factors which determine reliability in a capacitor—high quality materials, accurate processing, experienced generalship and business integrity. The radio engineer who has use for capacitors of any type may specify SOLAR with complete confidence in quality and performance, regardless of climatic and other external factors. Prompt attention to your inquiries.

SOLAR MFG. CORP.
599-601 Broadway
New York City

Manufacturing Affiliates
in London, Paris
Berlin and Milan

SVEA METAL INSURES TUBE QUALITY



The Unseen Metal Parts of ALL Tubes Are VITAL PARTS!

47 Radio Set Manufacturers now use ALL METAL TUBES. The great majority of these tubes contain SVEA METAL in the internal parts where QUALITY counts and DEPENDABILITY is essential. The finest, most modern tubes use the finest, most modern metal.

Every progressive tube engineer should have his name on our mailing list for our monthly bulletin "SVEA-ONICS."

Do not forget our offer of ***personal engineering service*** to show HOW, WHY and WHERE to use SVEA METAL TO ADVANTAGE.

Over 1,000 miles of SVEA METAL strip have gone to make millions of radio tubes—both glass and metal. The smallest and largest types contain SVEA METAL parts. SVEA is being used not only in this country but in all parts of the world.

Although millions of tubes containing SVEA METAL were sold in 1934 our ***SALES IN 1935 have increased 400%.***

Why not investigate the advantages offered by this material and be convinced of the reasons for its widespread and ever increasing use?

SWEDISH IRON & STEEL CORP.

17 BATTERY PLACE NEW YORK CITY

Cable: SISCOSWEDE