Ninth Year of Service

RADIO ENGINEERING

Vol. IX JULY 1929 No. 7

IN THIS ISSUE

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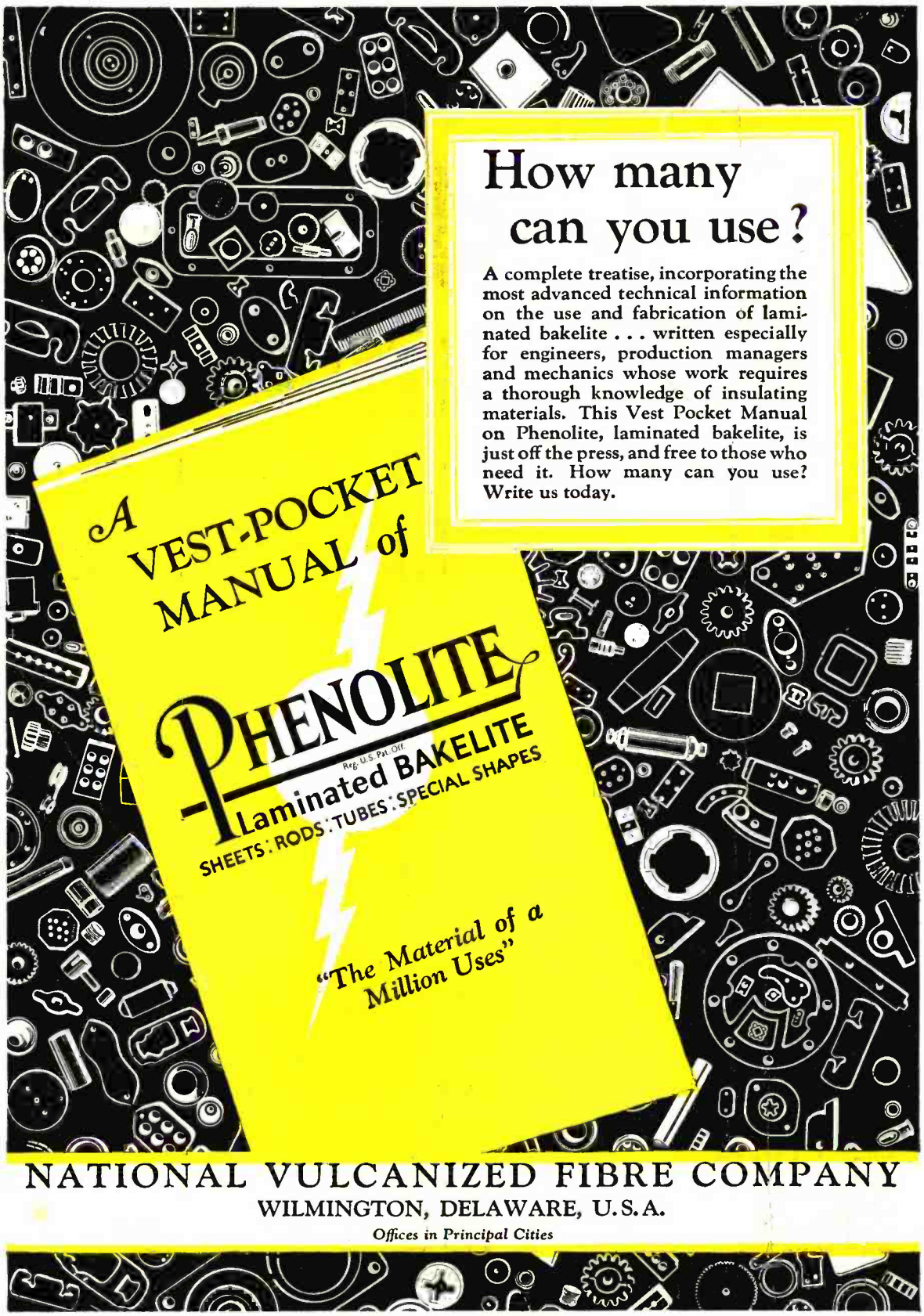
$2.00 per year

The Journal of the Radio Industry



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A complete treatise, incorporating the most advanced technical information on the use and fabrication of laminated bakelite . . . written especially for engineers, production managers and mechanics whose work requires a thorough knowledge of insulating materials. This Vest Pocket Manual on Phenolite, laminated bakelite, is just off the press, and free to those who need it. How many can you use? Write us today.

NATIONAL VULCANIZED FIBRE COMPANY

WILMINGTON, DELAWARE, U.S.A.

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WE HAVE SERVED *for* SIXTEEN YEARS

PRACTICALLY since the beginning of the industry Formica has been making Laminated Phenolic materials for American electrical organizations.

The names of many of the leaders have been on our books almost from the beginning.

This continued confidence can only be due to good and uniform materials promptly made and delivered.

We have steadily added to plant and equipment - - - even now a new factory building which will house new producing tools is under construction.

THE FORMICA INSULATION CO.
4626 Spring Grove Ave. Cincinnati, Ohio

FORMICA

RADIO ENGINEERING

Reg. U. S. Patent Office

Member, Audit Bureau of Circulations

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Radio Engineering Becomes a Member of Audit Bureau of Circulations

EFFECTIVE June 13, 1929, RADIO ENGINEERING became a full-fledged member of the Audit Bureau of Circulations, with the classification *business paper*.

A business paper, in line with the regulations of the Bureau must not only prove the paid status of its subscribers but must also prove the classification by occupation of at least 80 per cent. of its circulation. This ruling is a benefit alike to advertisers, readers and to the publication itself. With a known audience, the necessity for editorial groping and experimentation is obviated. Advertisers secure a definite picture of the market which they are reaching. The unknown quantity is largely eliminated.

The first audited circulation report of RADIO ENGINEERING (covering the period of July 1928 to December 1928) makes interesting reading. The paid circulation of the July 1928 issue was 3,924. That of December 1928 was 6,600. The issue of June 1929 (publisher's report now being prepared) shows a paid circulation of *over* 11,000—an increase of approximately 7,000 and a percentage increase of more than 175%.

The attainment of A. B. C. membership marks a distinct forward step in the progress of RADIO ENGINEERING.

Bryan S. Davis

PUBLISHER.

Published Monthly by

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52 Vanderbilt Ave.
New York City

Yearly subscription rate $2.00 in U. S. and Canada; $3.00 in foreign countries.

Instant Heating *versus* Humlessness In the Two-Twenty-Seven

A very little while ago Sylvania announced The Silent Sleeve Cathode 227 — a tube singularly free from hum and crackle — a tube also of considerably increased amplification.

This development Sylvania considers an important contribution to the Alternating Current Receiver by any comparison with previous characteristics in 227 tubes — a development vastly more significant than mere swift heating ability.

Sylvania Engineers believe that manufacturers and service experts will be content with a little less heating speed in a tube that owns such exceptionally quiet performance.

Sylvania will produce a swifter heating 227 only when that increased heating speed does not imply objectionable hum.

There are bulletins available to all who may be interested in the characteristics and advantages of the new 227 and other Sylvania tubes.

SYLVANIA PRODUCTS COMPANY

Emporium **Pennsylvania**

Sylvania

RADIO TUBES

Licensed Under RCA Patents

Glad to Send You Technical Details.
Please Use the Coupon.

MEMBER R.M.A.

EDITORIAL

July 1929

THE TALKING PICTURES

THE radio industry, in a large measure, is responsible for the institution and the rapid growth of the talking and sound pictures. This new form of entertainment, which appears to have a very bright future, was made possible through the early efforts of the engineers directly associated with the radio field. Aside from the means of synchronization, the system is close to being borrowed property.

The motion picture people continue to draw heavily from the radio industry. The radio industry is supplying the man power—the gineers, technicians, the servicemen—and radio periodicals are closely scanned for "radio" developments applicable to film technique. Thus, the film indus- the radio industry for its develop- th.

picture is, obviously, the largest rcial development" hitched to agon; it is not only a new t is also a new market—a possibilities for the sale of complete ssories, for use in pared with the g pictures for vehicle than me talking

st place, v desir- tion of phono- ion at guing cept- ance. eve

movie equipment, silent or otherwise, operate under a handicap. Silent films for the home have not taken hold of the public like radio has. Home talkies have not fared much better, due principally to the existing inertia and partly for the reason that the films obtainable are short, crude to a degree, and more of a simple novelty than real entertainment. With these points in mind, the public cannot but class home talkies as a luxury.

It is within the power of the radio industry to break down this present inertia by, first, producing such combinations in quantity, that they may be reasonable in price; second, through the sale or rental of talking or sound film through the medium of the huge network of radio dealers in the country; third, by selecting for these films, orchestras, singers and so on, well known to the public through their regular broadcasting. That this is effective has already been proven by the wide popularity of such sound films, in theatre runs, as Rudy Vallee and his Connecticut Yankees.

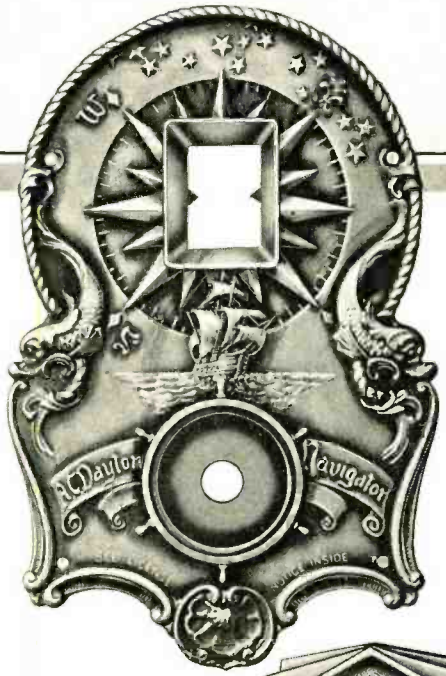
Manufacturers of home movie equipment, and films, cannot hope to break down the present sales resistance alone. It is too much like putting the wagon before the horse. We believe, however, that cooperation between the home movie and the radio manufacturers —or the consummation of a few financial mergers—will start a new sales sweep that will not end until it has spread over the entire country.

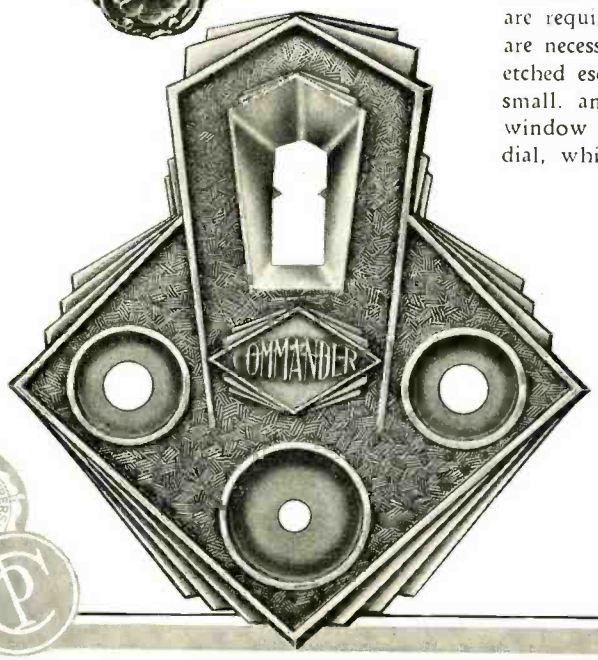
The general introduction of talking movies into the home holds another important advantage. If, when, and as television arrives, it will be accepted with less resistance, being literally a duplication of an existing form of entertainment. Whether or not television will sound the death of the talkie, we are in no position to say—but we doubt it. The talkie has too many good uses of its own.

M. L. MUHLEMAN, *Editor.*

CROWE

Escutcheons in the Modern Vogue





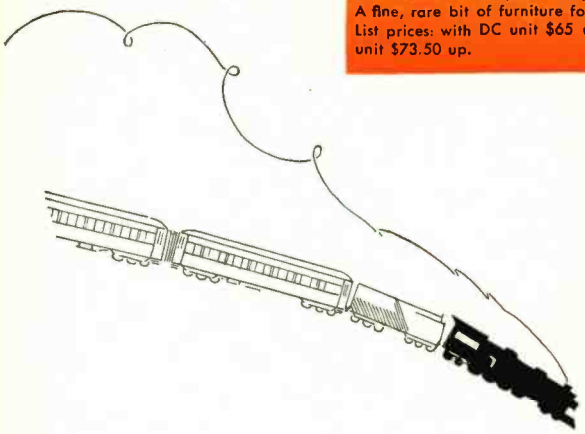
Both escutcheons shown on this page are coin embossed.

We also produce a great variety of etched escutcheons. When comparatively small runs are required, or when many changes in name are necessary for jobbers or dealers, the use of etched escutcheons is advised. The die cost is small, and we have many stock shapes with window formings to fit any stock drum or dial, which can be utilized with little or no die cost.

Our Engineering Department gives careful, personal attention to the measurements and dimension details of every escutcheon made by us, thus insuring windows of correct depth and shape and exact conformation to your drums and dials.

Correspondence invited. Send us sketch and we will submit samples or suggestions.

CROWE NAME PLATE & MANUFACTURING CO., .. 1750 GRACE STREET, CHICAGO



The CAMPANILE A handsome, massive, richly carved Italian Cabinet of fine Walnut. Skillful workmanship, masterly designing. A fine, rare bit of furniture for any home. List prices: with DC unit $65 up, with AC unit $73.50 up.

The STRATFORD A splendid Walnut Console of charming line and exquisite detail. Panels are of lacewood, rare and beautiful. Accommodates any table radio set, nicely harmonizing in effect. List prices: with DC unit $55.00 up, with AC unit $63.50 up.

Don't compromise. Quality . . . guarantee . . . tested policies . . . patent protection . . . dependable deliveries . . . less service troubles . . . a high name in radio speakers . . . all these Magnavox offers.

They appeal to the man who values his own good name and who builds for tomorrow.

THE MAGNAVOX COMPANY

Factory and Pacific Sales
OAKLAND, CALIF.

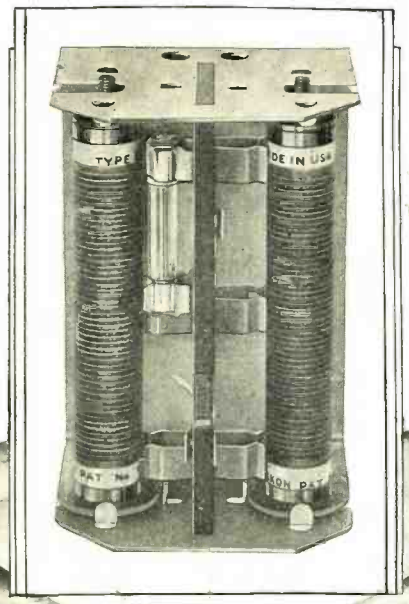
Factory and Sales East of Rockies
CHICAGO, ILL.

Also the Carillon (table model) and the Aristocrat (floor model) giving a complete range of cabinets and prices.

X-CORE DYNAMIC SPEAKER

This New Elkon Rectifier Eliminates the Power Transformer in Dynamic Speakers

This shows the size of one of the rectifier units. Two are required on each speaker.



The rectifier units can be easily replaced when necessary as may be seen here.

AGAIN Elkon leads the field. The new Elkon D-30 Power Supply is the outstanding development of the year in rectifiers for dynamic speakers.

This remarkable rectifier operates directly from the AC power line eliminating the Power Transformer and reducing the cost of assembly.

Supplied complete, ready to install, or the rectifier units (two required on each speaker) can be sold separately.

Wonderfully efficient, quiet in operation. The units can be replaced when necessary as easily as a tube is changed in a socket.

If you have not already sent us a sample of your new speaker, do so at once. We will equip it with the new Elkon rectifier and return it to you promptly.

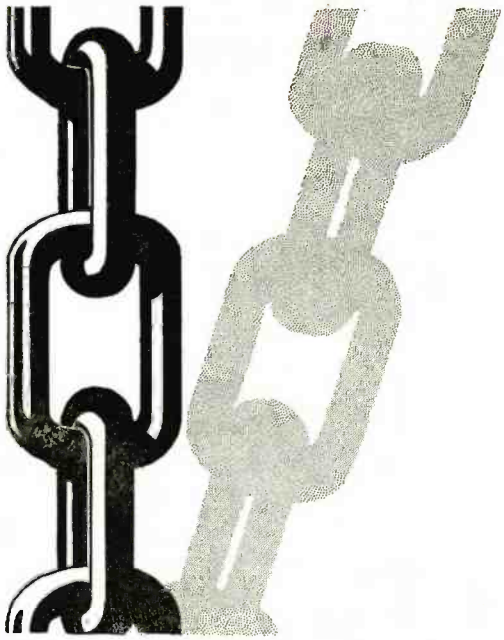
The Elkon D-30 Power Supply complete with cover.

P. R. Mallory & Co., Inc.
ELKON DIVISION
3029 E. Washington St.,
Indianapolis, Ind.

P. R. Mallory & Co., Inc., Elkon Division.
Radio Dept. E-62
3029 E. Washington St., Indianapolis, Ind.
Please send us complete information on your new Elkon D-30 Power Supply for Dynamic Speakers.

Name .....

Address .....



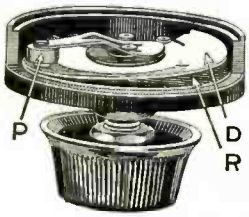
A RADIO RECEIVER IS LIKE A CHAIN....

A chain of parts, if you please . . . transformers, tubes, condensers, resistances and the like as links of the chain. Unless each link performs to perfection the whole receiver is condemned and your name with it.

A lot of grief can be traced to one little part . . . the volume control. Noises are set up . . .unevenness of control develops . . . locals are hard to handle.

You can save yourself plenty of trouble by seeing that the name "Centralab" is stamped on the volume control. The Centralab exclusive rocking disc construction prevents any change in the resistance or the development of noise. Centralab controls give a perfect control of all stations with an even, "velvety" smooth action.

This shows the exclusive rocking disc construction of Centralab volume control. "R" is the resistance. Contact disc "D" has only



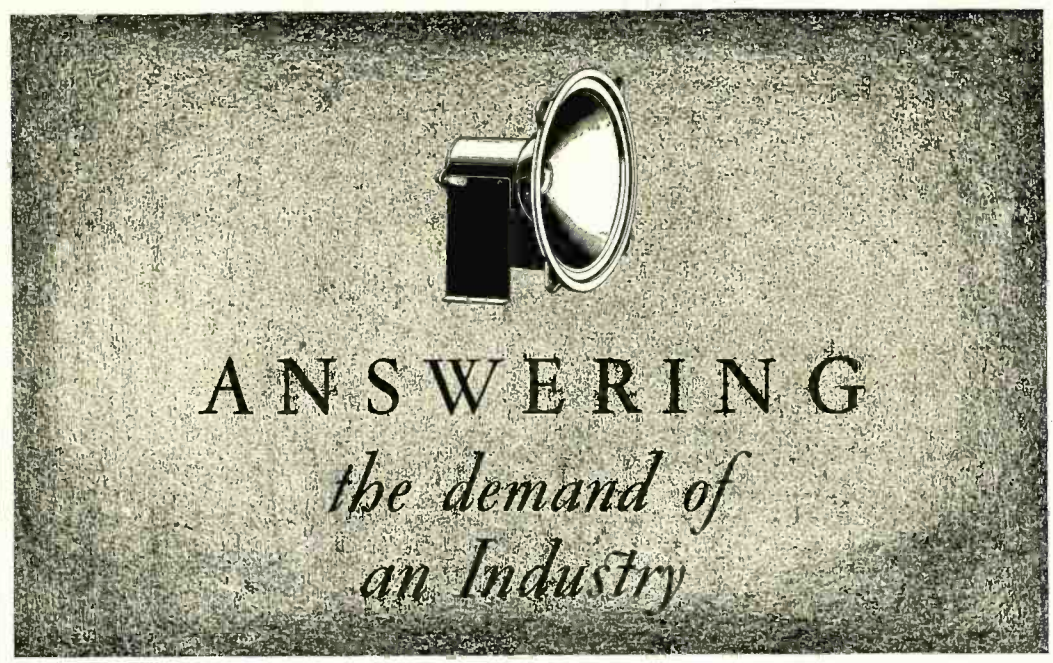
a rocking action on the resistance. Pressure arm "P" together with shaft and bushing is fully insulated.

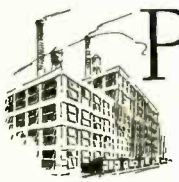
This is the action of the usual wire wound control after it has been in use for some time . . . like dragging a stick over a cobblestone pavement.

The tailor uses the same principle as Centralab. He does not want to ruin the garment by placing the iron on it so he places a cloth in between. Centralab controls cannot ruin the resistance because the rocking disc is in between the pressure arm and the resistance.

Centralab

CENTRAL RADIO LABORATORIES
20 Keefe Ave. Milwaukee, Wis.





PROVED superior in the most critical scientific tests known to America's leading radio laboratories the New Jensen Concert Dynamic Speaker won their immediate endorsement. Sixteen manufacturers at the R. M. A. Show last month announced their new radio receivers equipped with Jensen Electro-dynamic Speakers.

Individually, they in co-operation with Peter L. Jensen have adapted this speaker to their own specific requirements. Collectively, they have established a new era of *better* reproduction and Jensen has answered the demand of an industry for finer tone quality and greater dependability.

Equally as complimentary are the manufacturers of phonographs, talking moving picture equipment and other sound reproducing apparatus who find their requirements answered with either the Jensen Standard, Concert or Auditorium Speaker.

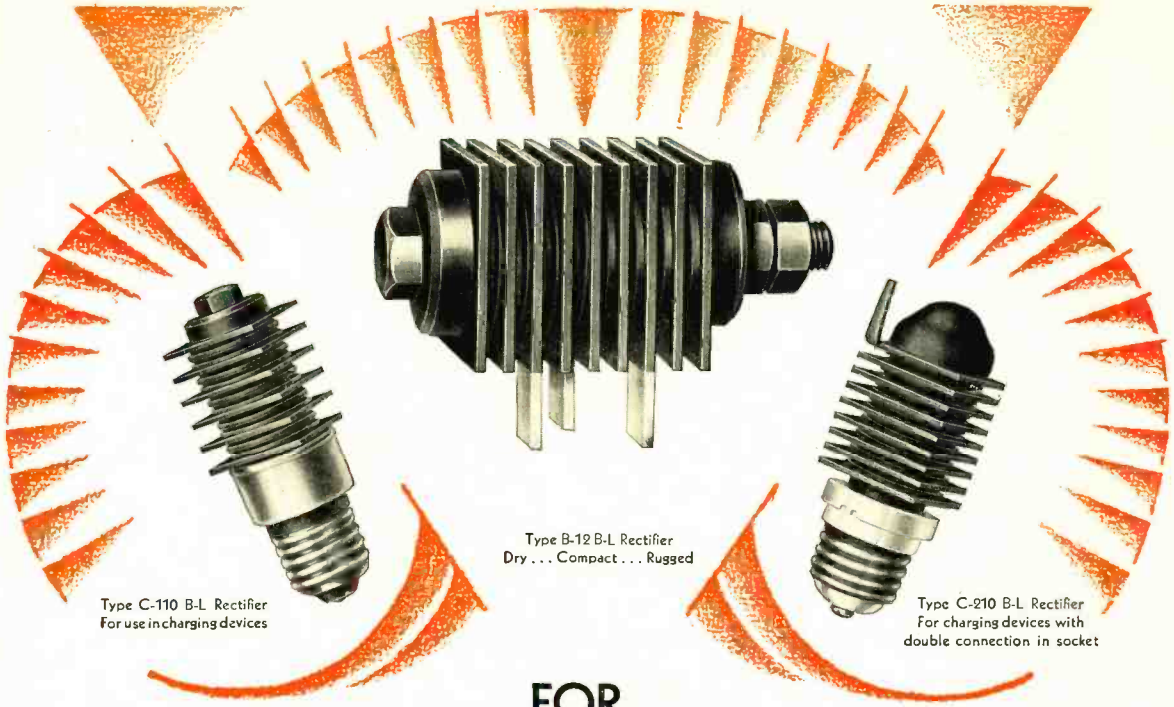
Jobbers and dealers will find new impetus to the sale of dynamic speakers separately or in radio furniture. And, of course, radio receivers Jensen equipped will sell better.

An attractive schedule of net prices is available to all members of the trade on this most complete line of speakers offered with eight, ten and twelve inch cones. List prices range from $25 to $55 on DC models and from $32.50 to $70 on AC models. Cabinet models range in price from $42.50 to $100.

LICENSE UNDER LEKTOPHONE PATENTS

Jensen
ELECTRO-DYNAMIC SPEAKERS

JENSEN RADIO MANUFACTURING CO. • 6601 S. Laramie Ave., Chicago, Ill. • 212 Ninth St., Oakland, Cal.



FOR
LOW VOLTAGE RECTIFICATION

Whenever a rectified current of low voltage is required, it can be obtained advantageously by the proper application of B-L Rectifier Units.

The B-L Electric Manufacturing Company maintain a complete engineering service, ready at all times to consult with you and advise on the right rectifier or assembly to most adequately serve your purpose.

Write for our complete new catalog about B-L Rectifiers.

***The* B-L Electric Mfg. Co.**
(Formerly Mfg. Div. of the Benwood-Linze Co.)
19th & Washington Aves. St. Louis, Mo.

B-L RECTIFIERS

DRY···DURABLE···COMPACT···COMPLETE···NOISELESS

WHY

POLYMET-EQUIPPED RADIOS ARE WORTH MORE

The FILTER CONDENSER ...RESERVOIR OF RADIO

The inside story of FADA

MAYBE you don't understand the insides of a radio . . . lots of people don't. But, just the same, it's those "insides" that make a fine radio. It's the "insides" that make Fada the instrument it is.

You may not know, for instance, what a power pack is. You may never have heard of a condenser or a resistance element. Nevertheless, they are there, and your ear can tell the difference in reproduction and tone, even though your engineering knowledge stops with the throwing of a switch.

But there are men who do understand these things—the Fada corps of radio engineers. For instance, certain famous Polymet Products are incorporated in Fada Radios. Why? Fada engineers answer, "We use Polymet Products because a specialized part is needed to complete the high quality of Fada sets."

A BRAWLING stream dashes down side ... realize the impor... condensers used in ... enser defection ca... and even the de... ensive parts. As ... ensed manufact...

Polymet Manu... condenser ma... modern pr... accurate ra... performa... roducer, ... nal set b...

set is ... uality.

RP... EV...

Here are some of the advertisements we have been running in the Saturday Evening Post — interesting, instructive messages, that acquaint the non-technical public with the functions of the condensers and resistances we manufacture, and, at the same time, awaken a nation-wide consumer acceptance of, and preference for, sets equipped with well-known Polymet Products. That's why these sets are worth more to radio manufacturer, jobber and dealer.

ZENITH RADIO

The Quality GOES "IN" before the name GOES "ON"

THIS beautiful Italian renaissance Zenith model is but one of the world-famous group of Zenith receivers, "thoroughly time tried and tested, coming to you from the great laboratories of the World's Largest Manufacturers of High Grade Radios." In these same laboratories, you will also find Polymet Products ready for incorporation in Zenith Sets—parts made by specialists in electric set essentials for high quality radios.

Zenith's enviable reputation has been built up in these very laboratories. Here Zenith engineers test and try and test again, to be absolutely certain that Quality does go in before the name goes on. When unbiased Zenith engineers, of Zenith calibre, say "We use Polymet Products because they are definitely

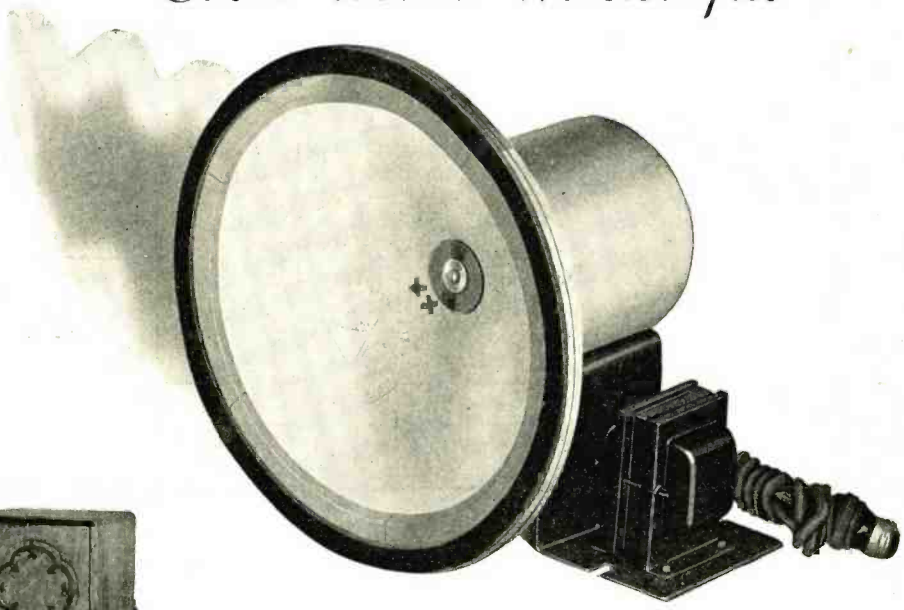
POLYMET PRODUCTS

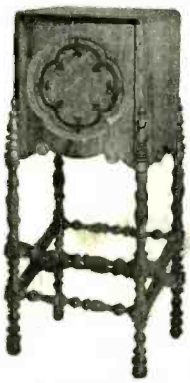
POLYMET MANUFACTURING CORPORATION 839-C East 134th St., New York City

Announcing the NEW

WRIGHT-DE COSTER REPRODUCER

Even More Wonderful





"E" Cabinet
Small Console Model

The Speaker of the year

NO HUM

DID you hear this speaker at the "R. M. A." show? Clear, distinct enunciation—no hum—Soft Mellow Music. Write Department R for descriptive matter and address of nearest district sales office. If you are in a hurry for a sample speaker order one at the same time.

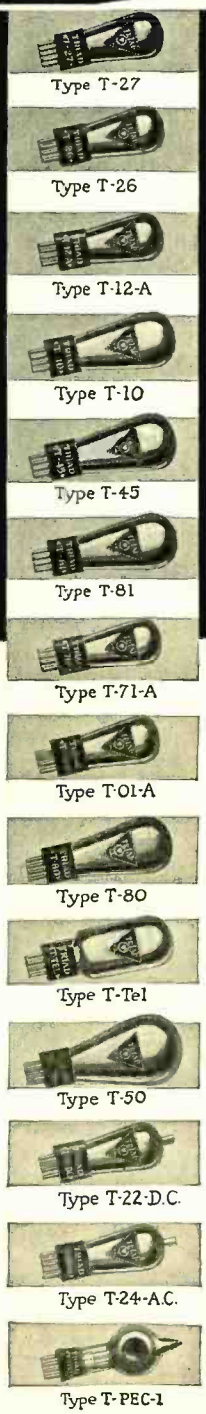
"D" Cabinet
Table Model

WRIGHT DECOSTER, INC.

MAIN OFFICE AND FACTORIES

ST. PAUL, MINN.

TRIAD



INSTANT... *nation-wide popularity* ....*won on quality alone!*

THE demand for TRĪAD is sweeping along to tremendous proportions—and TRĪAD quality has done it! Quality that eliminates all guesswork from tube buying and selling; quality backed by an actual bonafide guarantee of six month's perfect service or a satisfactory adjustment. Every dealer *knows* what that means —*reduced service calls*, easier and quicker sales, greater profits and absolute satisfaction for him and his customer. Here is the greatest achievement in radio tube history—accomplished by a group of nationally-known pioneers in the industry. The TRĪAD Line is complete, including even Television and Photo-Electric Cells. Don't delay — send in your stock order *now*. TRĪAD customers won't accept substitutes.

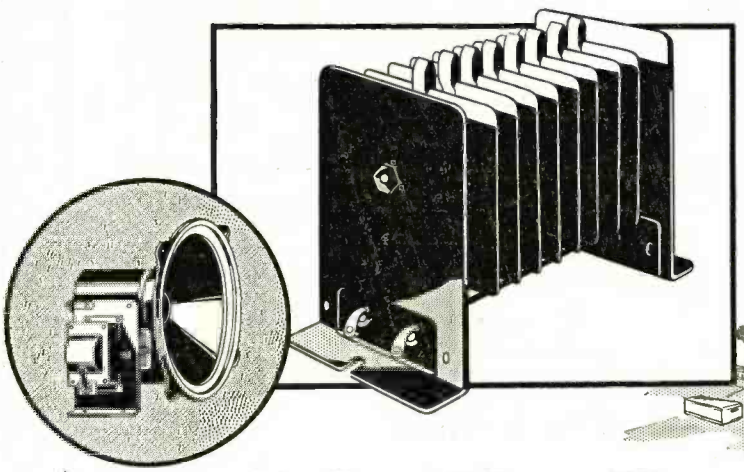
Call your jobber or write us direct for complete Triad dealer information

TRĪAD MANUFACTURING CO., INC.

Triad Building
Blackstone, Middle and Fountain Sts.
Pawtucket, R. I.

"Ask for the tube in the black and yellow triangular box."

A New Low Price Rectifier..



Lowers Production Costs

..Again Solves Your Rectifier Problem

Characteristics of *New* Low Price Kuprox

Catalogue No.	DS 225
AC Volts Input	4
DC Amps	2
DC Volts	2.5
DC Watts	5
Type of Assembly	DSJ
Number of Discs	8
Type of Discs	AA
Size of Discs	2″ sq.
Type of Bracket	"J"
Overall Length	4⅜
Mounting Dimensions	3 $\frac{5}{16}$

LAST season the large majority of Dynamic Speaker manufacturers used KUPROX Rectifiers as standard equipment. With this enviable experience record, with a full appreciation of the manufacturers' requirements, and with the realization of the need for a decrease in production costs, a new low price KUPROX unit has been developed by Kodel Engineers. And again KUPROX scores as the favorite Dynamic Speaker Rectifier.

This new dry copper oxide KUPROX Rectifier solves your Dynamic Speaker rectifier problem, making possible the least expensive AC Dynamic Speaker obtainable. The most popular rectifier manufactured—used by the majority, and by the most prominent manufacturers—now available in a new unit to provide minimum overall cost for field coil and field current supply.

The new KUPROX rectifier can be purchased at less than the manufacturer's cost of a rectifier tube. The transformer necessary to use with it needs only one secondary winding and that a 4 volt winding—a very inexpensive transformer.

The field coil may consist of a relatively few number of turns of wire, about 600 to 750 turns of No. 14 wire being used on the average pot. Heavy wire size, therefore low wire cost—few turns, therefore low winding cost—resulting in a much less expensive field coil.

There are no sockets or terminals to be provided. The KUPROX Rectifier is mounted directly on the speaker frame by two machine screws, and the loose leads from the transformer and field coil are soldered directly to the insulated terminals on the unit.

This new unit, known as KUPROX Rectifier Type DS225, has an output of 2 amperes at 2.5 volts and will produce from 1200 to 1500 ampere turns. Efficient operation—proven reliability—consumer acceptance—and minimum cost. It is just what you need for that new model speaker.

Write for complete data and samples, or better still let our laboratory apply this new rectifier to your speaker without obligation or expense to you.

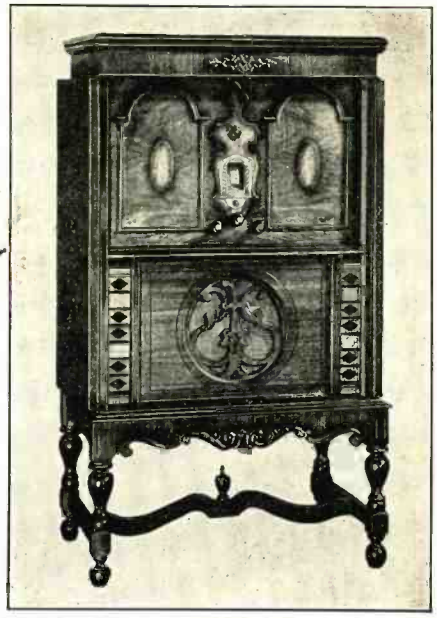
FREE! Our new Booklet "KUPROX Rectifiers for Dynamic Speaker Use," illustrating all the various KUPROX Units for such purpose and containing complete engineering data thereon, will be sent gratis to any speaker manufacturer, engineer or designer writing us upon his firm's letterhead.

The Kodel Electric & Mfg. Co., *Cincinnati, O.*

KUPROX

DRY COPPER OXIDE RECTIFIER

Steinite
ELECTRIC RADIO



MODEL No. 102 a massive walnut cabinet equipped with automatic phonograph and an improved radio receiver. The touch of an electric switch converts it from a radio into a phonograph.

Only DURHAMS are good enough *for this Great Receiver!*

DURHAM Metallized RESISTORS and POWEROHMS are available for every practical resistance purpose in radio and television circuits, 500 to 200,000 ohms in power types; 1 to 100 Megohms in resistor types; ratings for all limited power requirements; standard, pigtail or special tips.

DURHAM METALLIZED

RESISTORS & POWEROHMS

INTERNATIONAL RESISTANCE CO.

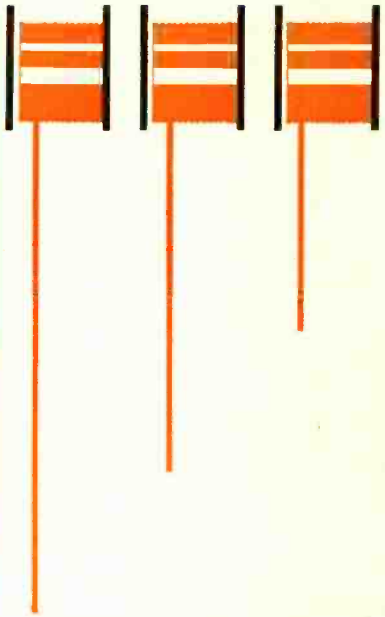
2006 Chestnut Street, Philadelphia, Pa.

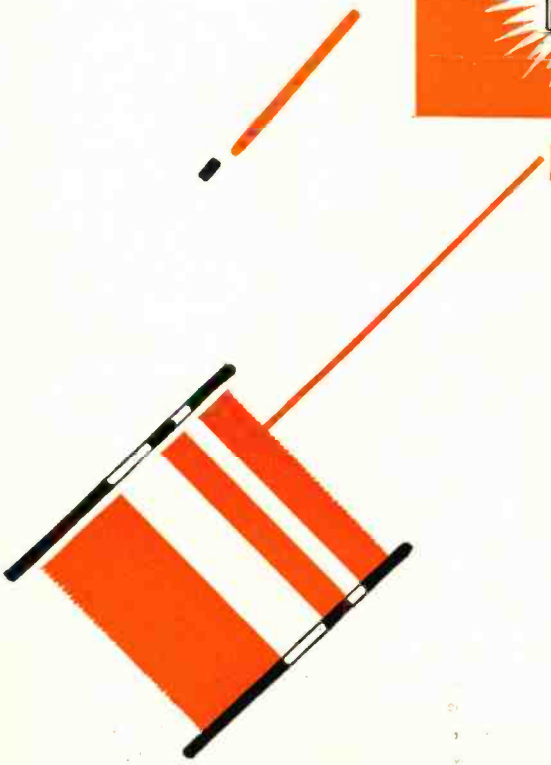
ANY manufacturer can cut his parts costs, but it takes leadership to aim at quality reception as a means of winning a quality market, such as Steinite has done in a few short years. Steinite operates on the principle that you can get out of radio only what you put into it. And so Steinite means a quality circuit embracing every practical modern idea, not the least of which is DURHAM Resistors and Powerohms — the metallized resistances which are endorsed and used by leaders in every division of the industry. Durhams may cost a trifle more than average resistances, but experience has proved that their slight additional cost is cheap insurance against imperfect performance and against dissatisfied purchasers. Ask Steinite! We shall be glad to send engineering data sheets and samples for testing upon request. Please state ratings in which you are interested.

THE LEADERS STANDARDIZE ON DURHAM RESISTANCES

GILBY WIRE

Assures Dependable Filaments





THE Filament must be dependable! Gilby Wire, composed only of the finest materials that money can buy, is a veritable synonym for dependability!

The continuing increase in orders from leading tube manufacturers means that they have found in Gilby a product that is **PRECISE, UNIFORM, HIGHLY EFFICIENT!** Manufacturer's requests for samples will be gladly and promptly answered.

GILBY BALLAST WIRE
GILBY RESISTANCE WIRE
PURE NICKEL WIRE
PURE NICKEL RIBBON

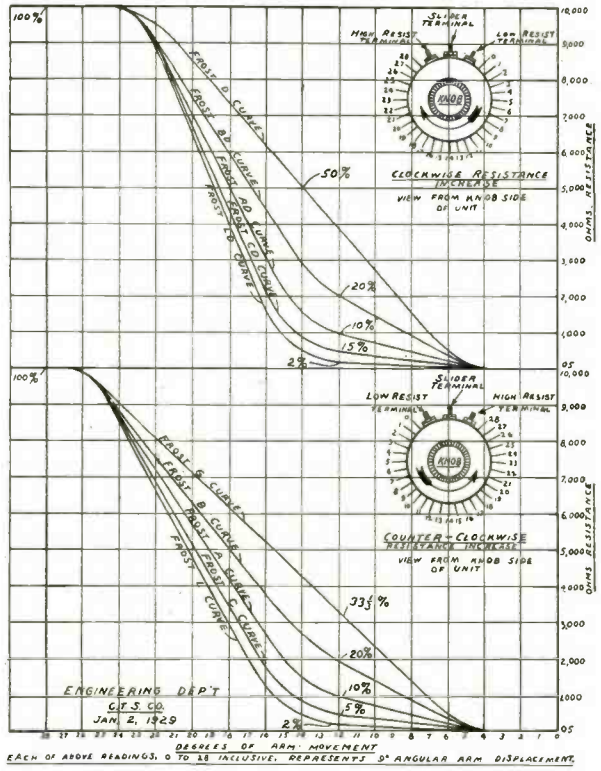
The large diameter aluminum spool is a Gilby Feature!

GILBY WIRE COMPANY

WILBUR B. DRIVER, *President*

NEWARK, NEW JERSEY

FROST-RADIO VOLUME CONTROLS supplied in any of these curves as well as special curves to meet your exact requirements



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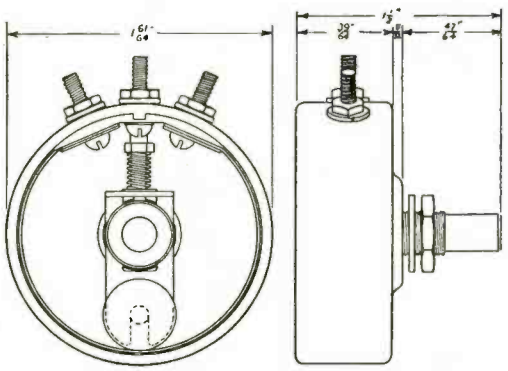

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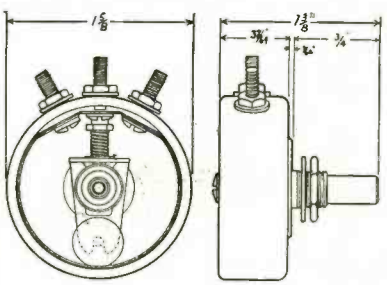

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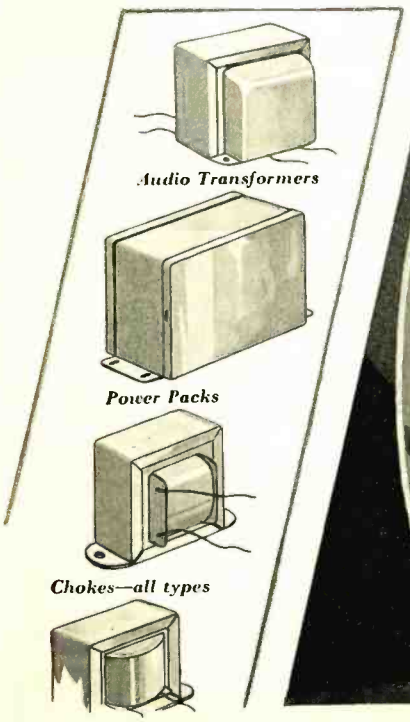

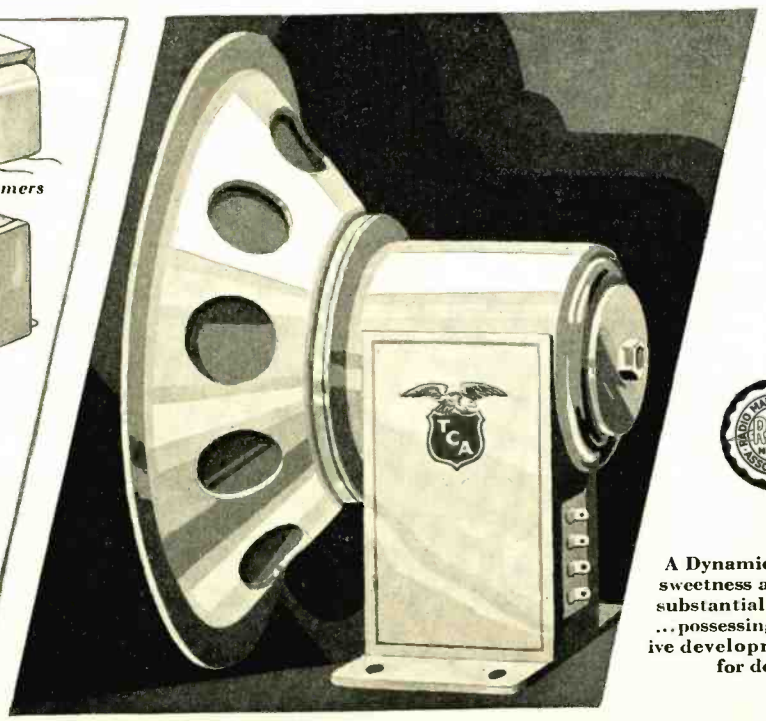

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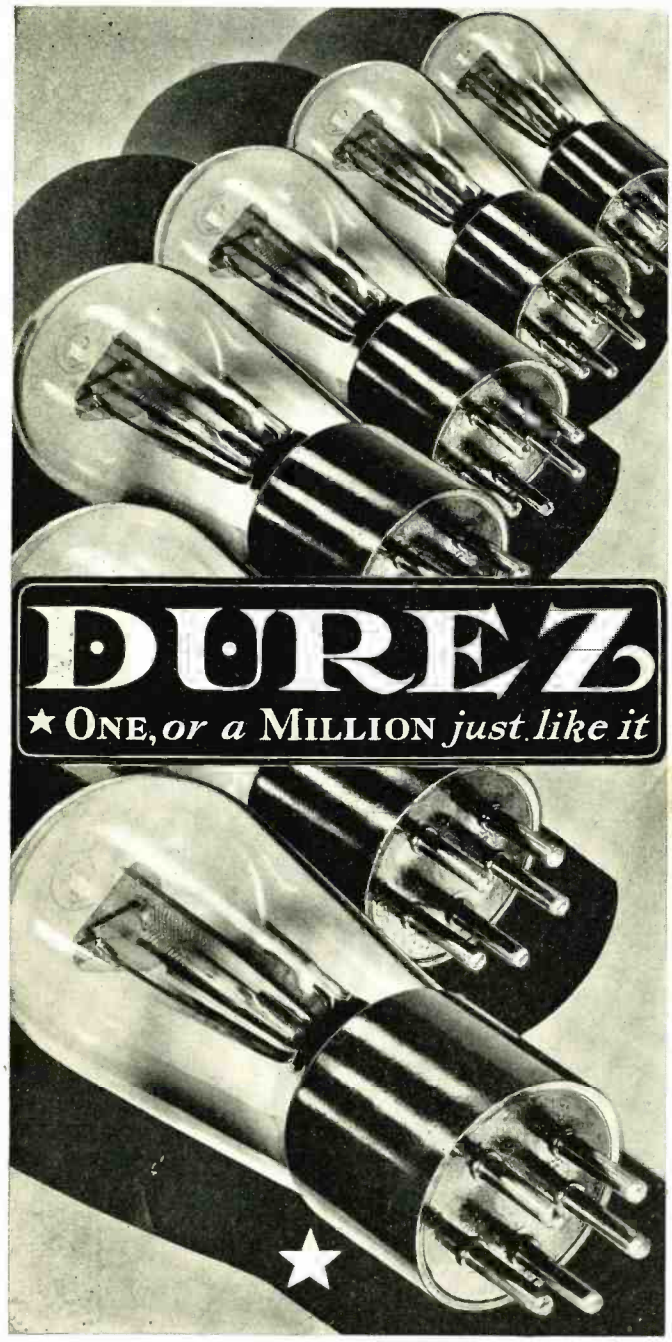

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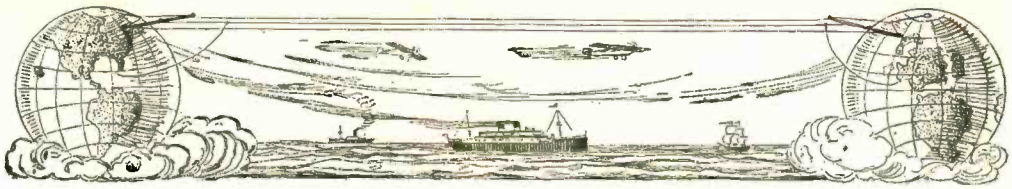


Band-Pass Tuning

The Reduction of Sideband Cutting in Radio-Frequency Amplifiers by the Use of Band-Pass Filters

*By Clyde L. Farrar**

THE formidable task facing the radio engineer at the present time is to design a receiving set which will reproduce with fidelity the programs transmitted from the broadcasting station, and at the same time make the selection of programs without interference from other stations.

Distortion or the lack of fidelity may occur in any one of the four component parts of a radio set, namely, the radio-frequency amplifier, which in the usual case is also that part which determines the selectivity of the set; the detector, the audio-frequency amplifier, and the loudspeaker.

The loudspeaker has undergone a great evolution. In spite of this there is considerable room for improvement, especially in the matter of efficiency, which, as is a well known fact, is extremely low. Probably the simplest method of obtaining a good frequency response is by the use of equalizing networks applied to the speaker, as is done in telephone systems to balance the different rates of alternation.

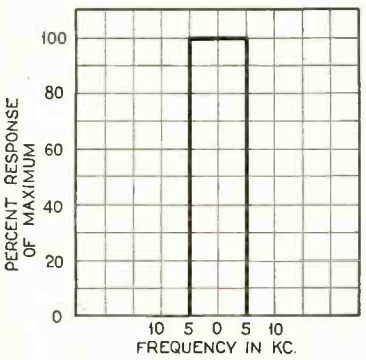


FIG. 1

The ideal form of resonance curve. It can only be approximated in practice.

Reducing Distortion

Distortion in the audio-frequency amplifier has been the subject of careful research, and at the present time transformers have been developed possessing excellent transmission characteristics. The present trend, looking toward reducing this distortion, seems to be in the use of only one stage of audio amplification in conjunction with a power detector. This system eliminates the inherent distortion of the second stage of audio-frequency amplification. This may not prove a desirable feature unless the radio-frequency amplification, which is added to compensate for the loss in volume, is obtained without distortion. The power detector does not introduce distortion of itself. Little is usually gained in the ordinary type of tuned circuits, since adding tuned circuits will usually cut the sidebands. This sideband cutting is especially noticeable if regeneration is allowed to occur in the radio-frequency amplifier circuit.

Distortion may occur in the detector circuit for several reasons; namely, due to the fact that the response of a detector varies with the square of the voltage[1].

This is an inherent characteristic of all detectors that operate on a non-linear voltage, current curve. There are various methods of overcoming this distortion[2]. Another form of distortion in a grid-leak, grid-condenser detector is due to the variation of the grid-leak, grid-condenser impedance at the various audio frequencies[3]. This distortion, which discriminates against the high frequencies, can be reduced by a proper choice of grid condenser and resistance values. The plate-circuit detection system eliminates this form of distortion as well as that caused by the time lag distortion, which is associated with the grid-leak, grid-condenser method[4].

The radio-frequency amplifier probably introduces the greatest amount of distortion in the modern receiver. This is true since selectivity and fidelity in the usual type of tuned circuits cannot be obtained at the same time, but one is obtained by sacrificing the other[5]. The concept of modulation is well established and need not be discussed at great length. Modulation, as most commonly used in radio broadcasting, may be briefly described as the production of a band of high frequencies on each side of the carrier frequency equal to the audio frequencies to be transmitted. These bands of high frequencies on each side of the carrier are termed sidebands. These sidebands are physically existent and must be transmitted. It is not necessary to transmit both carrier and sidebands; one band is sufficient, although practically all radio transmission is carried on by the two-sideband carrier method.

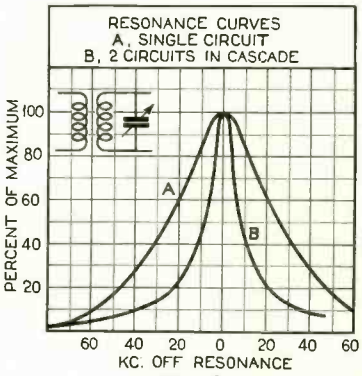


FIG. 2

Resonance curves of single and cascade, tuned circuits.

In order that distortionless amplification of the radio impulse take place these sidebands must be transmitted with no relative attenuation or phase change. That is, each frequency shall undergo the same change in level as well as the same phase shift. Considering faithfulness of reproduction or fidelity, a so-called square response curve would be desired. Fig. 1 shows the type of curve which would have the desired transmission characteristics. This form of curve would have the desired selectivity if it transmitted only the two sidebands, and excluded all undesired frequencies. Such a transmission curve could only be obtained with an infinite number of selective circuits. However, an excellent response curve can be approximated by a smaller number of low resistance selective circuits. In

**Asst. Professor of Electrical Engineering, University of Idaho.*

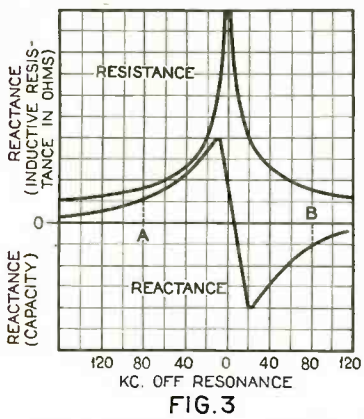


FIG. 3

Curves indicating the resistance and reactance of a simple tuned circuit in respect to frequency.

general it may be said that the more complex the selective circuit the more nearly the response curve will approach the ideal. It should be kept in mind that the resistance must be kept to a low value in all complex circuits in order that the ideal curve may be approached. Failure to keep this resistance to a low value will give a poor response curve, and in general explain the reason for the failure of many forms of so-called band-pass filters.

In the majority of cases, using the usual type of tuned circuits, fidelity is obtained by increasing the effective resistance in the circuit in order that a broad wave be obtained. More will be said later on the approximate selective circuits, which will approach the ideal selective circuit.

Tuned Circuits in Cascade

In a chain of tuned circuits the current response falls off exponentially through each stage or chain of the tuned circuits. This explains the reason for two stages of rather broadly tuned circuits responding to a relatively narrow waveband. Hence, in order to obtain good selectivity it is only necessary to introduce a large number of tuned circuits in cascade. It is with this use of cascade, tuned circuits that distortion is introduced. Consider Fig. 2. A typical single tuned circuit is shown, together with the frequency response of two such circuits in cascade. A considerable narrowing of the band may be noted, although the base of the wave is still broad. If this is carried through four or five stages it can be seen that considerable sideband cutting will result[5]. This sideband cutting is, of course, at the expense of the higher frequencies.

It is a well known fact that the sideband cutting becomes more serious for the usual type of radio-frequency transformer, as the frequency of the carrier wave is decreased[6]. This does not directly result from a study of resonance circuits. The decrement of a tuned circuit, which is a measure of its selectivity—that is, the greater the decrement the less the selectivity—is equal to

$$S = \pi R \sqrt{\frac{c}{L}} \quad . \quad (1)$$

where R equals the effective resistance of the circuit; and c and L are equal to the capacity and inductance. From an examination of equation (1) it would appear that decreasing c would decrease the decrement and hence would improve the selectivity. Actually R increases at a greater rate than c decreases. The effective ohmic resistance of the tuned circuit and the equivalent series resistance of the tube increases. In the usual type of radio-frequency transformer the applied frequency is considerably less than the resonant frequency of the primary. This makes the effective reactance of the primary inductive. As the operating point nears the resonant frequency of the primary the effective resistance of the circuit increases and hence this increases the

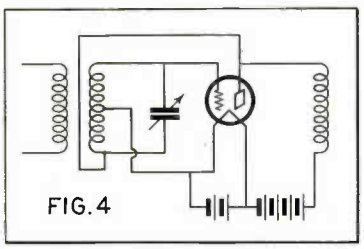


FIG. 4

The introduction of regeneration has considerable bearing on the shape and amplitude of the resonance curve.

width of the resonance curve which reduces the selectivity. The signal intensity is reduced at the same time, although in the usual case, due to the inductive reactance of the circuit, the capacity feed-back through the tube grid-plate capacitance is in such a direction as to increase the signal through regeneration. These characteristics are shown by Fig. 3.

If, instead of operating at point A, the primary inductance is increased until the normal operating point B is above the natural resonant frequency of the primary, the conditions mentioned above will be reversed and the circuit should tune sharply at the higher frequencies and broadly at the lower frequencies[7]. Due to the fact that the circuit has a capacity reactance at this operating point the energy fed from the plate to the grid through the grid-plate capacitance will tend to reduce the signal strength in place of increasing it, as was the case previously. In this case energy must be fed from the plate to the grid in such a direction as to cause regeneration. Regeneration must not be carried too far or the decrement of the circuit may be reduced to a lower value than desired; this will, of course, introduce distortions and if carried far enough will result in oscillation. This may be done by any of the usual methods of applying a reversed phased voltage to the grid. Fig. 4 shows a method which proves successful. Fig. 5 shows a set of curves obtained for such a transformer. No attempt was made to obtain the optimum constants of the circuit for the broadcast range, but was for the purpose of checking the theory. It will be noted that the inductance and capacitance of the primary was such that it was nearly resonant at the low frequency under which conditions it approached a band-pass filter.

Considerable work must as yet be done on this transformer before its constants are properly determined. It is felt that a great deal of work can be done profitably on this transformer, as it seems to offer a solution of proper selectivity at the higher frequency. In general, this transformer will not prove as selective in the higher band, as will a low primary inductance transformer at the lower frequencies, due to its higher resistance. However, careful design should overcome this difficulty, since two or three stages of low primary inductance transformers will, if properly designed, give good selectivity at the lower frequencies. Several stages of high primary inductance transformers could be well applied to such an amplifier to obtain high sensitivity and at the same time eliminate the sideband cutting, which occurs at the lower frequencies, with three or four stages of amplification using low inductance transformers[8]. This sideband cutting becomes large in some of the sharply tuned super-heterodyne, intermediate-frequency amplifiers due to the low frequency at which they operate. It is believed by the writer that there is no excuse for the simple tuned circuit in the superheterodyne receiver. A band-pass filter can be applied to this circuit. As a matter of fact, since the frequency band is fixed and in general the frequency being low, band-pass filters are relatively simple to construct.

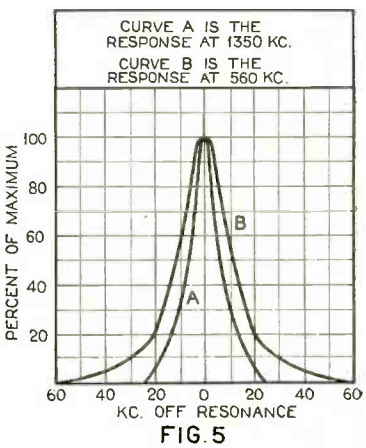


FIG. 5

Frequency curves obtained from the circuit of Fig. 4.

Combined Selective Circuits

There are several methods of combining selective circuits to obtain an approximate ideal response curve[9]. The simplest of these networks is shown by Fig. 6. This consists of a transformer with, for the usual case, equal primary and secondary inductances. The primary and secondary are each tuned by means of a condenser. Some of the more complex circuits are shown in other publications[10].

It was mentioned before that the efficiency of a band-pass filter is greater the less the resistance (by efficiency is meant the ratio of the area under an ideal curve to the area under the actual curve for the same band spread at maximum value). This fact makes the band-pass filters best adapted to the lower frequencies. It cannot be too strongly emphasized that the resistance of the band-pass filter must be kept low, otherwise its transmission characteristics will be poor. For tuned circuits in radio-frequency amplifiers there are several methods of obtaining so called band-pass filters. The one under discussion is shown in Fig. 6. Namely, a method that has been known for a long time, but only recently has it become of interest. If the resistance of each circuit and the capacity coupling between the circuits are neglected it can be shown that the frequency response of the circuit is given by the following expressions:

$$f_1 = \frac{f}{\sqrt{1+k}} \quad (2)$$

and by

$$f_2 = \frac{f}{\sqrt{1-k}} \quad (3)$$

where f_1 and f_2 are the two frequencies which make the reactance of the circuit zero, f being the frequency which makes the reactance of one circuit zero when alone, or it is the natural frequency of one circuit when not influenced by the other. k is the coefficient of coupling and is equal to

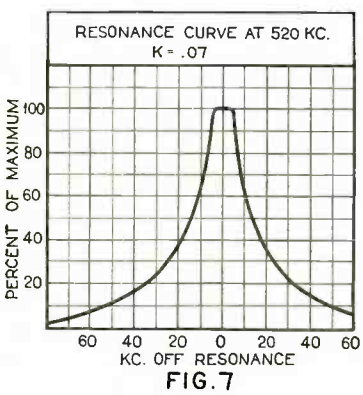


FIG. 7

Resonance curve of band selector circuit, taken at 520 KC.

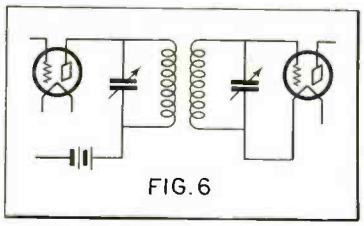


FIG. 6

Simple form of band selector circuit, having a tuned primary and secondary.

$$k = \frac{M}{\sqrt{L_1 L_2}} \quad (4)$$

where M is the mutual inductance between the coils, L_1 and L_2 the self inductances of each coil, and in our case $L = L_1 = L_2$, hence the formula reduces to

$$k = \frac{M}{L} \quad (5)$$

If the resistance is not neglected it can be shown that the maximum current in the secondary is given by equation (7) when the following relation holds true:

$$M^2 W^2 < L R_1 R_2 \quad (6)$$

$$i_2 = \frac{MWE}{R_1 R_2 + M^2 W^2} \quad (7)$$

where M is equal to the mutual inductance, W is equal to $2\pi f$; R_1 and R_2 are the primary and secondary resistance respectively. Equation (7) gives the value of current in the secondary for the usual circuit condition. If the circuits are so closely coupled that

$$M^2 W^2 > R_1 R_2$$

the maximum value of current is given by

$$i_2 = \frac{E}{2\sqrt{R_1 R_2}} \quad (8)$$

E in both cases being the signal voltage input. If the current flowing in the circuit is known the voltage applied to the grid is equal to $I_2 x_c$, where x_c is the reactance of the tuning condenser.

In the usual case equation (7) holds for the radio circuit and E is nearly equal to kEg, where k is the amplification constant of the tube, and Eg is the voltage applied to the grid. It is readily seen that by the proper choice of k it is possible to have f_1 and f_2 peak within any given frequency range. One obvious disadvantage of this circuit results from an inspection of equations (1) and (2), that is, if a band selection of 10-kc. is desired at 550 kc. a considerable wider band is obtained at 1200 kc. This is a general characteristic of all usual forms of tuning. This characteristic could be overcome by varying M at the same time that f is varied.

Consider that a band width of 10-kc. is desired at 550 kc. The substitution of these values in equations (1) and (2), results in a coefficient coupling of approximately .02. This coefficient of coupling results in a band selection of approximately 24 kc. at 1200 kc. Using a coupling coefficient .07, this will be a band of approximately 31 kc. in width at a frequency of 550 kc. and a width of approximately 72 kc. at 1200 kc. Fig. 7 shows a test curve taken at 520 kc. and Fig. 8 the same transformer at 1200 kc. It is noted that the band is approximately half the calculated width; this is due to the fact that the capacity coupling between the two coils, which had been neglected in the calculation, acts to reduce the effective coupling between the circuits. Fig. 9 shows a family of curves for various values of coupling obtained at a frequency of 925 kc.

It was mentioned before in a chain circuit the current in each succeeding circuit is equal to ie^{-x}, where x is the number of sections, hence, this type of

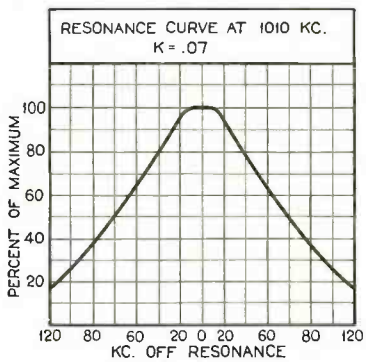


FIG. 8

Resonance curve of band selector circuit, taken at 1010 KC.

circuit can be used in a greater number of stages than the simple transformers without sideband attenuation. It should be mentioned that it is not possible to sharpen the tuning in this band-pass filter at the higher frequencies, as was done for the untuned primary transformer (except that the coefficient of coupling be reduced as the frequency is increased).

Three Practical Selective Systems

It is felt that the following conclusions are warranted from the above review of this question. If the trend of the radio engineers is in the direction of perfection of each component part of the radio receiver then a different system of tuning must be selected than that in general use at the present time. There are in general three systems that can be used. First, a combination of high primary inductance transformers, secondaries tuned, and low primary inductance with a broadly tuned response characteristic. Second, a combination of band-pass filter circuits. This system will prove to be quite complicated if it is to accomplish band-pass selection over a

wide frequency spectrum, if the same band at the peak is to be transmitted. When used with high primary inductance transformers it will give high class transmission characteristics, since in this combination good selectivity can be obtained at both ends of the frequency spectrum. Those companies that cannot use the superheterodyne principle can, by proper engineering, obtain a greatly improved frequency response. The third system makes use of the double detection or superheterodyne system. This system obtains its primary selectivity from a fixed frequency selective circuit and usually at a relative low frequency.

The superheterodyne lends itself very well to the use of band-pass filters, since the selectivity of a band-pass filter can be maintained to much closer limits at the low frequencies due to the higher value of WL

$$\frac{}{R}$$

The frequency response of a detector is drooping with respect to frequency (which by careful design can be kept quite low) and since the audio-frequency response can be changed quite easily it is perhaps better to treat the detector and audio amplifier as a unit and thus obtain a uniform frequency response.

At the present time it is probably

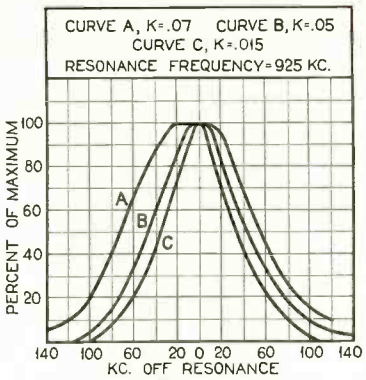


FIG. 9

A family of resonance curves, taken at 925 KC., for various values of circuit coupling.

true that the audio-frequency end of the receiver is much nearer perfect than the radio-frequency end and for this reason considerable work remains to be done in the r-f. channels. It seems that the low-frequency response of some of the radio receivers has been overdone. Some of the receivers over-emphasize the lower notes, as some of the older sets did the high notes. The use of the high-amplification constant tubes will aid in this work, as it will reduce the required number of tubes thus enabling the designer to use more complex selective circuits. It would then prove feasible to use a band-pass filter, in which the coupling is varied for the different frequencies. It would seem that the radio set should be engineered as a unit and that equalizing networks should be applied, as needed, in order to obtain a good frequency response—and as a part is improved, the network could be reduced with the resultant improvement in efficiency.

References

(1) Morecroft, Principles of Radio Communication, 2nd Edition, page 758.
(2) Laurer & Brown, Principles of Radio Engineering, 2nd Edition, page 272.
(3) E. L. Channing and G. H. Browning. A Theoretical and Experimental Investigation of Detection for Small Signals. *Proceedings*, I.R.E., February, 1927, page 113.
(4) F. E. Terman, Grid Leak Power Detection. *Radio Broadcast*, April, 1929.
(5) K. W. Jarvis, Selectivity of Tuned Radio Receiving Sets. *Proceedings*, I.R.E., May, 1927.
(6) Morecroft, Principles of Radio Communication, page 119.
(7) G. L. Beers and W. L. Carlson, Recent Developments in Superheterodyne Receivers. *Proceedings*, I.R.E., March, 1929.
(8) Leo J. Peters, Theory of Electric Wave Filters Built up of Coupled Circuit Elements. *Proceedings*, A.I.E.E., May, 1923.
(9) Dr. Vreeland, *Proceedings*, I.R.E., March, 1928.
(10) Transmission Circuits for Telephonic Communication, by K. S. Johnson, page 184.
(11) Electric Oscillations and Electric Waves, by George W. Pierce, Chapter XI.

What Constitutes a Good Loudspeaker?†

Dealing With the Response Measurement of Typical Speakers Under Average Conditions

By L. G. Bostwick *

WHAT constitutes a good loudspeaker? To answer this question there is needed a more precise method of ascertaining the capabilities of a loudspeaker than is provided through a mere listening test. While the ear is, of course, the final judge of the merits of a loudspeaker, it is quite unsatisfactory as a means of analysis. One loudspeaker may sound better or worse than another with which it is directly compared, but to describe or specify in a definite manner the peculiar characteristics which distinguish one from the other is usually extremely difficult unless the two are widely different. Furthermore, a direct comparison between two devices is necessary, and the magnitude of the difference is always a matter of opinion in comparisons of this sort.

On the other hand, acoustic measurements on loudspeakers are complicated by a wide variety of acoustic factors which must be properly considered in order that such measurements be indicative of the capabilities of these loudspeakers. Such factors as peculiarities in the distribution of the sound energy by the loudspeaker, and sound reflection, absorption and interference effects due to the measuring room enclosure, may cause large variations in the results obtained. When these factors are not taken into consideration, acoustic measurements may give entirely misleading information. The measurements and discussion which follow illustrate the magnitude and character of some of the more important acoustic considerations involved in determining what constitutes a good loudspeaker.

† *Courtesy of Bell Laboratories Record.*

* *Research Dept., Bell Telephone Laboratories.*

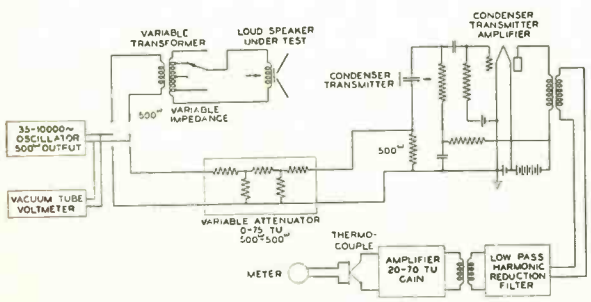


Fig. 1. Schematic circuit of loudspeaker response measuring system.

Response Measuring System

The system used in making these measurements is shown diagrammatically in Fig. 1. The available power-output of the oscillator is kept constant at all frequencies by means of a vacuum tube voltmeter. With the oscillator connected to a loudspeaker, through the transformer, the gain of the amplifier associated with the thermocouple is adjusted at different frequencies until a mid-scale deflection of the meter is obtained as a result of the voltage generated by the con-

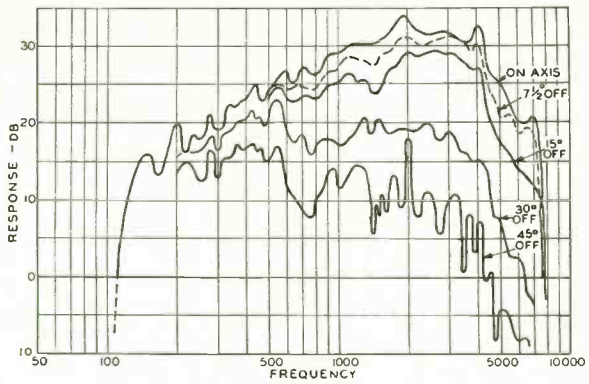


Fig. 2. Response - frequency characteristics of 115-cycle cut-off exponential horn with moving coil receiver. Measured outdoors 12 feet from horn mouth at specified angles to horn ax.s.

denser transmitter. After each adjustment, the oscillator is switched from the loudspeaker to the input terminals of the attenuator, and the attenuator is adjusted to give the same meter deflection. Variations in the attenuator settings with frequency show the variations in the performance of the loudspeaker in decibels.

Performance curves obtained for the same loudspeaker by such a procedure may differ widely, due primarily to three causes. These are: variations with frequency in the energy distribution of the sound field of the loudspeaker; wave interference at the condenser-transmitter position due to sound reflections from the walls of the measuring room or to a difference in distance from the transmitter to different points on the radiating surface; and variations with frequency in the energy-absorbing power of the measuring room.

The magnitude of variations in the sound field distribution can be shown from measurements obtained outdoors in an open field where the effects of any room enclosures are absent. Such measurements appear in Figs. 2, 3 and 4, for a 115 cycle cut-off exponential horn with a loudspeaker receiver of the moving coil type. Fig. 2 shows response curves obtained when the condenser transmitter is placed twelve feet from the center of the horn mouth and at different angles from the axis. As the transmitter is moved away from the horn axis, the response at the higher frequencies becomes lower, while at low frequencies the change is slight. This is because the angle subtended by the sound field becomes smaller the higher the frequency, and the sound energy is increasingly concentrated along the horn axis. Thus a response frequency characteristic of almost any desired trend may be obtained by suitably locating the condenser transmitter. Fig. 3 is a polar coordinate curve plotted from the data of Fig. 2, showing the sound-field angles for four frequencies.

Fig. 4 shows a curve obtained for the same loudspeaker, but with the condenser transmitter on the axis only two inches from the mouth. This curve is considerably more irregular than the axis curve of Fig. 2. These irregularities can be attributed to interference between sounds reaching the condenser transmitter from different points of the horn mouth. After a distance of about twelve feet has been reached, the sound paths from these points to the condenser transmitter become substantially equal, and therefore, the interference disappears. Thus, the two axial curves in Figs. 2 and 4 are quite different.

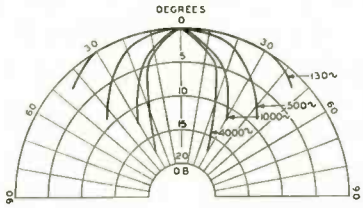


Fig. 3. Polar curves plotted from data of Fig. 2.

Indoor Response Measurements

The effect, on the indoor response measurements, of interference or standing waves due to reflections from the walls of the measuring room is illustrated in Fig. 5. These measurements are of a loudspeaker with a three-and-one-half-inch diaphragm of the piston type, with the condenser transmitter located about twelve feet away on a line perpendicular to the center of the diaphragm. The loudspeaker and transmitter were located equally distant from and on opposite sides of the center of the room, and mid-way between the ceiling and floor. The bounding surfaces of the room were covered with hair felt one-half inch thick. Although an attempt was thus made to reduce the magnitude of the reflections, the curve obtained is very irregular.

One method of compensating for the effect of standing waves, and of thereby obtaining indoors a curve that is representative of the performance of the loudspeaker, is to average the measurements at several positions or within a region rather than at one position. This is accomplished in these Laboratories by a machine pictured in Fig. 6. This machine rotates the condenser transmitter in a circle which is nearly six feet in diameter and whose plane is inclined at an angle with the horizontal. Fig. 7 shows a curve for the piston-diaphragm loudspeaker measured under the same conditions as the curve in

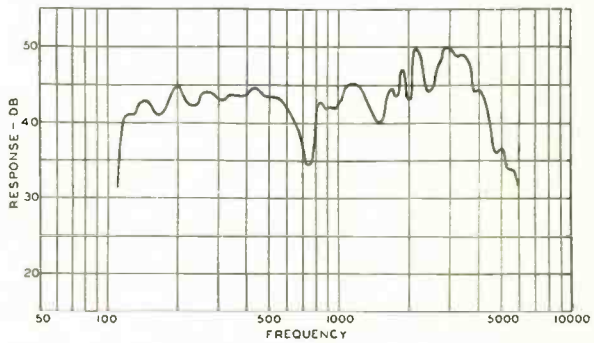


Fig. 4. Response - frequency characteristic of 115-cycle cut-off exponential horn. Measured outdoors on horn axis two inches from mouth.

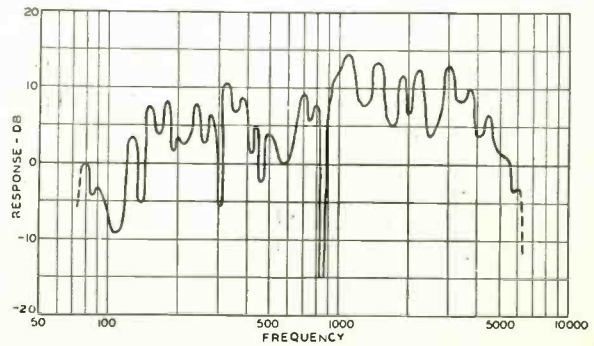


Fig. 5. Response - frequency characteristic of 3½-inch piston-diaphragm loudspeaker. Measured 12 feet from diaphragm, in highly absorbing room.

Fig. 5, but with the rotating condenser transmitter. The center of the circle was located at the same point as the condenser transmitter for Fig. 5. A comparison of the solid curve in Fig. 7 with the dotted curve, obtained outdoors for the same loudspeaker, shows the extent to which rotating the transmitter in this manner obviates the effect of wall reflections.

Reflection and Absorption by Walls

The uniformly greater response at low frequencies of the indoor curve in Fig. 7 can be attributed to the fact that the sound absorbing ability of the measuring room varies with frequency. Indoors the energy reaching the condenser-transmitter position directly from the loudspeaker is supplemented by energy reflected to the same position from the walls of the measuring room. Variations with frequency in the reflecting or absorbing ability of the walls of the room will, therefore, cause variations in the magnitude of the response measurements. From the difference between the two curves in Fig. 7 it is possible to calculate the ratio of the outdoor to indoor energy densities at different frequencies at the transmitter position and to obtain the solid curve shown in Fig. 8. The dotted curve is an average curve showing the trend. A comparison of this dotted curve, with the dot-dash curve of the absorbing ability of one-half inch of hair felt, shows an interesting correlation in the trends of the two curves. The difference in magnitude of the two curves can be accounted for by the fact that the sound passing through the transmitter position probably undergoes several reflections before returning to this position again.

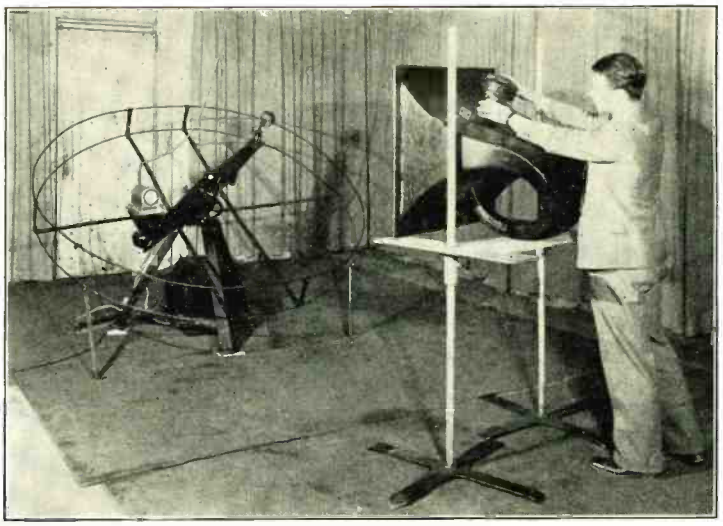


Fig. 6. Machine for rotating condenser-transmitter to make indoor loudspeaker measurements.

From the above illustrations it is obviously quite impossible to determine from acoustic measurements whether or not a loudspeaker is "good," unless the curves expressing the measurements are qualified by statements regarding the measuring conditions. Especially must information be given as to the position of the condenser transmitter relative to the loudspeaker, the method of measurement (whether pressures are measured at one position or averaged within a region), and the size and nature of the medium. In general, response measurements, to be most indicative of the capabilities of a loudspeaker, should be made with the condenser transmitter at a distance from the loudspeaker commensurate with or equivalent to the most likely listening distance of an observer. In addition, determining which of two loudspeaker response curves is the better requires an interpretation of the auditory significance of the magnitude and position in the frequency spectrum of departures in the curves from a straight horizontal line. Such an interpretation involves physiological considerations. Although complicated by such a wide variety of factors, the response-frequency characteristic has been found the most significant single criterion upon which to base a judgment of the merits of a loudspeaker.

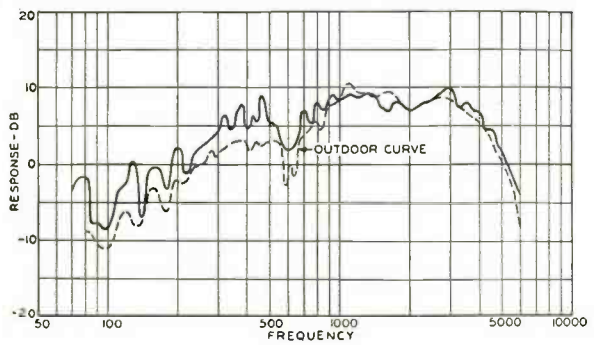


Fig. 7. Response - frequency characteristic of 3½-inch piston-diaphragm loudspeaker. Measured in highly absorbing room and averaged in small region 12 feet from diaphragm.

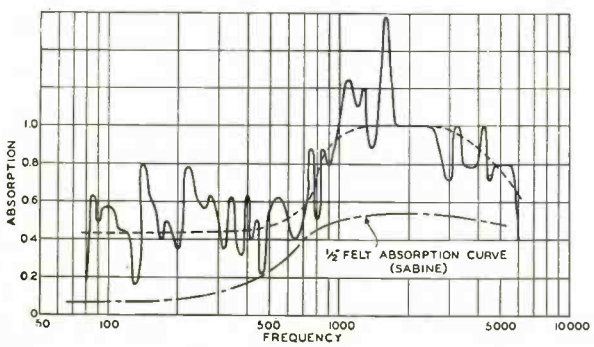


Fig. 8. Absorption - frequency characteristic of felt-lined room with respect to a region relatively near its center and the sound source. Calculated from data of Fig. 7.

RADIO OPERATING COSTS ANALYZED

WHAT does it cost, in electrical current consumption, to operate your receiving set?

According to test data compiled by engineers of E. T. Cunningham, Inc., it is shown that the average radio receiver consumes appreciably less current per hour than many, commonly-used, electrical appliances. For instance, the Cunningham figures show that the average receiver operates at a current cost of but one cent for every three hours of actual use. Compared with current consumption of the ordinary electric iron, which appliance manufacturers estimate at 3½ cents per hour.

The test figures were based on a receiver utilizing: One, C-327 detector tube; four, CX-326 amplifier tubes; one, CX-371A power tube; and one, CX-380 rectifier tube.

Treatment of Audio-Frequency Transmission Lines

Data on Impedance Adjusting and Equalizer Circuits to Meet Average Requirements of P-A and Talking Picture Installations

By Charles H. W. Nason *

WITH increased general interest in public-address systems and talking picture installations some question has arisen as to methods of treatment for audio-frequency transmission lines of varying length. Cases of coupling such lines into and out of other apparatus have been reduced to several standard instances and transformers for such service are now commercially available.

While the design of impedance-adjusting transformers for this purpose is a matter of general knowledge a few simple rules may be helpful in adapting available transformers to special purposes and their repetition may not be amiss.

For a transformer to work out of an impedance Z_1 into an impedance Z_2;

$$\frac{Z_1}{Z_2} = a^2 \qquad (1)$$

where "a" is the turns ratio. This holds good also for vacuum tube output transformers where the impedance of the load varies materially with the frequency—in moving coil speakers, however, the impedance/frequency characteristic is substantially horizontal and we may avail ourselves of the full portent of the fact that maximum undistorted power output is obtainable when the tube works into a load impedance of twice its Rp. Hence

$$\frac{2\ Z_1 \text{ (or } 2\ Rp)}{Z_2} = a^2 \qquad (2)$$

Naturally in push-pull circuits the two Rp's are in series and the full turns ratio must be taken as twice the value for the single tube as calculated.

Ratios for impedance coupling transformers may be written either as ratio of whole numbers, as "1 to 3" for step-up windings or as ratios of unity to some fractional part thereof, as "1 to .55" for a step-down transformer.

In the case of high ratio step-down transformers the power considerations are the same as for all other cases in transformer design and the necessity for guarding against excessive I^2R losses in the windings themselves and in the transmission lines through the use of insufficient copper becomes evident. This is highly important in the case of multiple connection of moving coils for dynamic reproducers and only exceedingly heavy and short connections should be employed. The metal shielded cable used in aircraft radio work is ideal for the purpose and will meet with the underwriters approval for theater use.

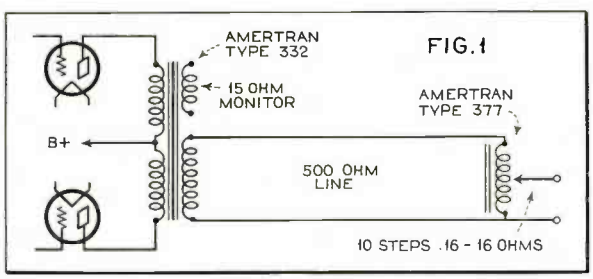


FIG. 1

Impedance adjusting circuit for working out of 250's in push-pull, into one or more dynamic speakers, through a 500-ohm line.

Impedance Adjusting Circuits

An impedance adjusting circuit for working out of two 250 tubes into one or more moving coil speakers, through a 500-ohm line is shown in Fig. 1. The transformers shown are of a special nature but are available on order from the manufacturer. Provision is made in the tube output circuit to incorporate a dynamic speaker as a monitor. As a digression from the main subject it is suggested that an ideal volume control for this monitor would be through a rheostat in the field excitation circuit or by a 200-ohm potentiometer across the voice coil. The exact value of this resistance would depend upon the speaker used. The output device is an auto-transformer tapped at ten secondary points for output to from one to ten 15-ohm speakers.

Fig. 2 shows a slightly different arrangement—perhaps of not quite so satisfactory a nature—employing transformers of a generally available character.

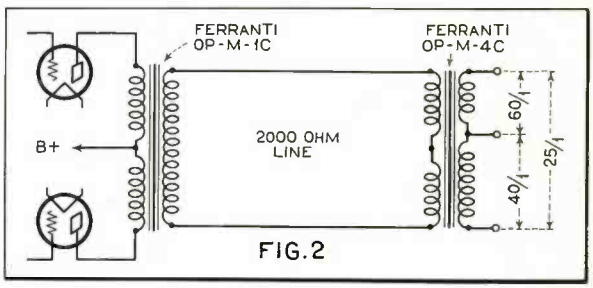


FIG. 2

Another impedance adjusting circuit, similar in form and adaptation to that of Fig. 1, but working through a 2000-ohm line.

Impedance adjusting transformers to work out of a microphone, line or phonograph pick-up into the grid of a tube are available and the existing transformers having variable ratios may often be adapted to special cases. For example, the OP-M-4c, shown in the circuit in Fig. 2 might be readily adapted to any of the following cases: out of a tube into multiple magnetic speakers; out of a tube into moving coil speakers in series; out of a tube into a transmission line; out of two tubes in push-pull in either of the foregoing cases; out of a transmission line into the grid of a tube, out of a line into various combinations of magnetic or moving coil speakers. In fact a study of the transformers now on the market will yield many such cases of adaptability. In some cases no such simplicity occurs—working out of a detector tube into a remote amplifier or from a microphone into line, mixer or tube presents a problem not so easily solved with makeshift equipment. Happily the Gods have been good and there is no lack of special transformers for such cases.

In Fig. 3 is shown a reproduction of a sheet issued by one of the better known manufacturers, demonstrating in part the adaptability of certain standard items.

Necessary Frequency Ranges

Transmission lines, though consisting merely of a resistance for normal

*Chief Engineer, Sound Service.

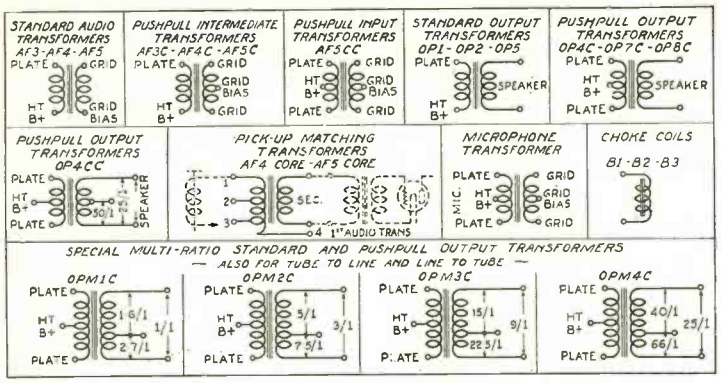
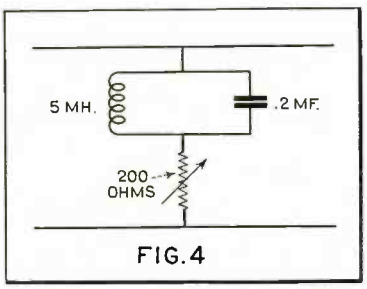


Fig. 3. Showing, in schematic form, a group of transformers well suited to meet the special requirements of audio-frequency transmission lines, etc. (*Courtesy of Ferranti, Inc.*)

power work represent complex networks for use at voice frequencies and are most effective filters in some cases. Proper and enjoyable reproduction of music calls for a frequency range of from fifty to five thousand cycles but the high quality reproduction of speech requires that the range be extended in the upper register to much higher on the scale. Recent advancements in wax recording make the transmission of frequencies in excess of eight thousand cycles a necessity if full advantage is to be taken of the new standard of quality and if the aspirates and sibillants of the spoken word are to be fully evident. "As silent as the 's' in 'Talkie'" is a recent "wise crack" amongst the Broadwayites—and it's no joke from the engineer's point of view because it's all too true in the majority of cases. Proper matching of the impedances of the different elements of an installation will take care of that—but the other frequencies must appear in their proper relations one to the other and to maintain an over-all response curve that is essentially flat. Peaks in the curve may be removed through the use of resonant circuits in shunt with the transmission line and tuned broadly to the offending frequency, the degree of absorption being made variable through the use of a variable resistance in series with the trap circuit, as shown in Fig. 4. The frequencies to which such trap circuits must be tuned are determined through the use of a beat-frequency oscillator and vacuum tube voltmeters. The run is coordinated on log paper, the frequency in cycles against the level in db's so as to evidence the true audibility characteristics of the system. The schematic set-up for such a run is given in Fig. 5 and is self-explanatory.

Frequency Runs

Beat-frequency oscillators are rare beasts and are not to be found in the average small laboratory. In as much as the sound installations in theaters are mainly concerned with operation out of a magnetic pick-up an alternate and simpler method is shown in Fig. 6. Constant velocity records covering the entire range of frequencies are now available and with the aid of a single vacuum tube voltmeter may be used to obtain a comprehensive curve of any amplifier system. Such a curve may be plotted in db's above of below the output obtained at some arbitrary frequency



Equalizer circuit to neutralize peak at 1000 cycles

(400 cycles, for example). It must be remembered that these runs are effective only up to the speakers and that over-all runs including the speakers are impractical save in well equipped laboratories—and even then are of a tricky nature. I think that this covers the field fairly well. In most of the installations that the author has been called into consultation on the outstanding trouble has been the utter absence of any attempt to equalize or match the line between the amplifier and speakers. In nearly every instance of this kind the substitution of a logical transformer for those furnished with the speaker at the termination of the line has resulted in understandable speech as opposed to unintelligible mouthings.

These few words are not to be construed as authoritative as the subject is too profound for the mention of more than a few practical facts. For those wishing to delve deeper into the subject the author suggests the purchase of "Transmission Circuits for Telephonic Communication," by K. S. Johnson, of the Bell Telephone Laboratories, published by Van Nostrand.

LAST FOUR MONTHS ACCOUNT FOR 56 PER CENT RADIO SALES

INFORMATION compiled by the Merchandising Division of the Radio Manufacturers Association indicates that the public buys 56% of its radio products in the last four months of the year. The three summer months of June, July and August account for a total of only 14 per cent of the year's sales. An analysis of 1928 retail radio sales, which approximated $650,000,000, shows that the monthly percentages are divided as follows: January, six per cent; February, seven per cent; March, eight per cent; April, five per cent; May, four per cent; June, four per cent; July, three per cent; August, seven per cent; September, thirteen per cent; October, seventeen per cent; November, twelve per cent; and December, fourteen per cent.

The sales curve in radio thus still has a decided slump in the summer months, although a comparison of the 1928 sales curve with those of previous years shows that more radio business is being done in the warm weather, while the winter peak is tapering off.

Previous to 1928, an average of only nine per cent of the total yearly sales was done in the summertime, while the fall and winter months accounted for almost 75 per cent of sales to the public.

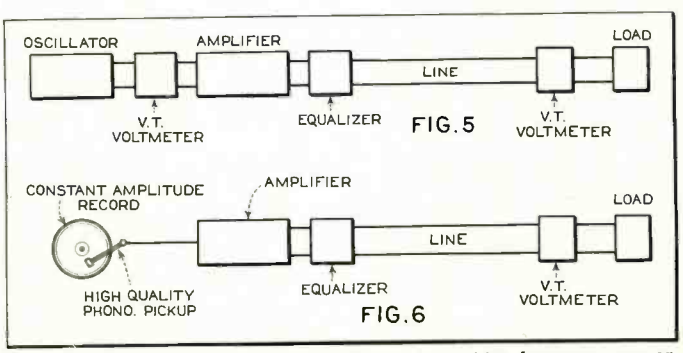


Fig. 5. Set-up, with beat frequency oscillator, for making frequency runs on transmission lines.

Fig. 6. An alternate method for making frequency runs, using a constant amplitude "frequency" record.

R.M.A. Trade Show Report

ALL attendance records were broken at the June Convention and Trade Show of the Radio Manufacturers Association in Chicago, when 31,589 members of the industry were registered. This exceeds by 6,989, the record-breaking attendance of 1928 with 24,600 registrations.

Pre-convention predictions that the present season would establish new sales records seem likely to be fulfilled on the basis of later reports by the same manufacturers, jobbers and dealers, at the conclusion of the convention. They pointed out that in all probability, Major Frost's estimate of close to a billion dollar year for the industry was not unduly optimistic, and probable of fulfillment.

Three hotels were required to hold the show this year, so great was the number of exhibitors. Being loose-coupled, it was rather difficult covering the various exhibits—but it is likely that the show will again be under one roof next year, or arranged in convenient divisions.

New R.M.A. Officers

Mr. H. B. Richmond, Treasurer of the General Radio Company, was elected president of the Radio Manufacturers Association for the coming year. He is the first R.M.A. leader to come from the engineering profession.

Mr. T. K. Webster, Jr., president of The Ekko Co., was elected treasurer of the R.M.A. The following were elected vice-presidents: Morris Metcalf, treasurer, American Bosch Magneto Corp.; Henry C. Forster, vice-president, Utah Radio Products Co.; William Sparks, president, Sparks-Withington Co.

Directors elected for three years are: H. C. Cox, president, Columbia Phonograph Co.; Henry C. Forster; George C. Furness, vice-president, National Carbon Co.; B. J. Grigsby, president, Grigsby-Grunow Co.; Ralph H. Langley, general manager, Crosley Radio Corp.; A. G. Messick, chairman of the board, U. S. Radio & Television Corp.; R. T. Pierson, president, Bremer-Tully Co., and H. B. Richmond.

H. B. Richmond, the newly elected president of the R.M.A., announced the chairman of the following committees: *Legislative:* C. C. Colby, Samson Electric Co. *Finance:* T. K. Webster, Jr., The Ekko Co. *Show:* Jess Hawley, United Reproducers Corp. *Broadcasting:* B. G. Erskine, Sylvania Products Co. *Contact:* L. E. Noble, Federal Radio Corp. *Statistics:* George C. Furness. *Merchandising:* Herbert H. Frost, Kolster Radio Corp. *Credit:* Donald MacGregor, All-American Mohawk Corp. *Engineering:* Walter E. Holland, Philadelphia Storage Battery Co. *Fair Trade Practice:* Morris Metcalf. *Foreign Trade:* G. H. Kiley, Farrand Manufacturing Co. *Membership:* N. P. Bloom, Adler Manufacturing Co. *Patent:* LeRoi J. Williams, Raytheon Manufacturing Co. *Public Relations:* William Sparks. *Traffic:* B. J. Grisby.

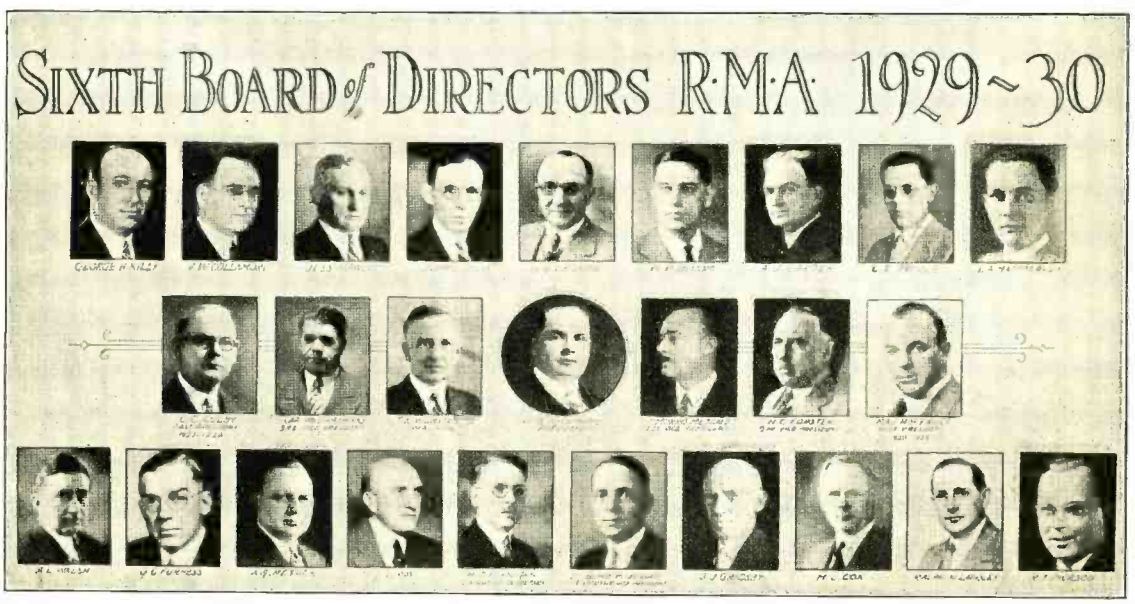
The Board of Directors re-elected Bond P. Geddes as Executive vice-president of the R.M.A.; M. F. Flanagan as Executive Secretary; Hon. John W. Van Allen, Legal Counsel, and Frank D. Scott as Legislative Counsel.

Optimistic Outlook

It was our impression that, after the first day or so, when one got the hang of the show, plus a sense of direction, things buzzed along just as nicely as the year before. We were also impressed—no, we learned this to be a fact; i. e., dealers, jobbers and servicemen have come to know their business and know it well. We hung around booths and rooms long enough to get a line on their talk and we heard very few senseless questions asked. Did anyone else notice this? It speaks well for the educational work instituted by the trade organizations, for the willingness of the manufacturers to cooperate with these men—and certainly, it speaks well for the men themselves. Doesn't it go to prove that they are more businesslike? With such a fine bunch of men in the field, it *ought* to be a banner year.

Receiver Design

The a-c. screen-grid tube is the predominating influence on receiver design. This tube has just missed making a clear sweep of the industry and there is still the possibility that it will conquer all design before the year is out—or when the annual "re-designing" is completed. At any rate, one can safely call it the "screen-grid year."



Reading from left to right, top row: G. H. Kiley, V. W. Collamore, Jess Hawley, J. C. Tully, B. G. Erskine, N. P. Bloom, A. J. Carter, L. E. Noble. L. A. Hammarlund.

Center row: C. C. Colby, Capt. W. Sparks, T. K. Webster, H. B. Richmond, Morris Metcalf, H. C. Forster, Major H. H. Frost.

Bottom row: A. L. Walsh, G. C. Furness, A. G. Messick, J. L. Ray, M. F. Flanagan, Bond P. Geddes, B. J. Grigsby, H. C. Cox, R. H. Langley, R. T. Pierson.

The 245-type tube runs the screen-grid a close second; most of the sets, including the table models, employ this tube in the power stage. And of the number using this tube, well over fifty per cent utilize it in a push-pull amplifier—meaning two of them for each set. Since this power tube does not require the high voltage necessary for the 250-type tube, the 280-type, full-wave rectifier has again come into its own. It looked for a while as though the 281 tube would hold the stage. It is now in the background and we bid it a happy goodbye—wishing it success in the p-a. and talkie field.

In designing their screen-grid receivers, most manufacturers have turned to band-selector circuits in order to obtain a satisfactory degree of selectivity. Some of these circuits do not work out so well—but there is a great deal yet to be learned about the design of a circuit of this nature; particularly in respect to coupling. But it is nothing to worry about.

And here is another sweep: with but few exceptions, the new receivers employ power detectors. This is made possible by the increase in the r-f. gain supplied by the screen-grid tubes.

Loudspeakers

The dynamic speaker is still the favorite. If they are not incorporated in the receivers, the receivers are designed for use with them. A number of sets are so designed that either a magnetic or a dynamic speaker can be used, depending, we presume, on the owner's purse, not on his ear. One receiver model can be used with either an a-c. or a d-c. dynamic speaker.

The new dynamics are greatly improved, most of the former mechanical difficulties having been ironed out. The majority of these speakers employ high-voltage rectifiers, with a high voltage field winding—and with preference towards the newly designed dry disc, high voltage units. The latter rectifiers appear to be very efficient though we know little regarding their operating life.

We were unable to determine much about the acceptance of the new, so-called electrostatic or condenser speakers. Whether they will be adopted by the set manufacturers remains to be seen. They differ greatly in design, yet all of them are really good—satisfactory frequency characteristics and able to handle considerable power. Evidently it is merely a question of time, when they will prove capable of meeting existing requirements.

Cabinets

Here is the rub. Cabinet design does not appear to be keeping pace with receiver design. Some manufacturers seem to lose sight of the fact that the sets are to be installed in the home, where they must, in some manner, harmonize with surroundings. Cabinet design cannot stand the same form of "individuality" design an automobile can. Their design must be "submissive" to surroundings. Yet, we continue to see modernism to the n'th degree, with no offer of choice—this mainly in table models—and the rococo touch in many of the consoles. One is nearly as bad as the other.

There is, likewise, a great deal of similarity of design in the console sets and there are decidedly more consoles than table models.

We are very much in accord with the idea carried out by a few of the set manufacturers who are marketing the chassis as a unit; like an expensive automobile—and offering the purchaser his choice of a whole slew of cabinets and consoles, made by various furniture manufacturers. After all, people *do* have taste. What pleases one will not, by any means, please another.

Parts and Accessories

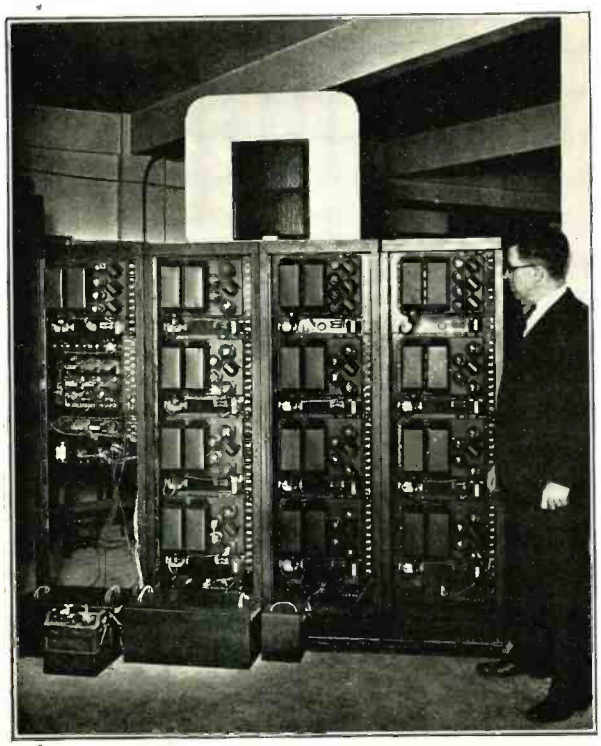
Some excellent engineering work has been accomplished in the parts and accessories field, as proven by the new designs exhibited and demonstrated. As the greatest portion of the manufacturers' output of these accessories is to the builders of receivers, nearly every new model this season carries several improvements — which, though small in themselves vastly better the operation of the set.

One of the most noticeable improvements among the accessories is in the variable resistor field. The wire-wound and composition resistors, which are used as volume controls or faders, have in the past been subject to several troubles, due principally to materials and methods of manufacture. These troubles have now been corrected. The new types of variable resistors are co constructed that they will safely carry a high current and still maintain uniformity in resistance.

Doubtless the greatest incentive given to the engineers, who have been working on electric phonograph pick-ups, has been due to the impetus given the industry by the talking motion pictures. Too, it is apparent that when the new pick-ups were designed, the engineers took into consideration the capabilities and limitations of the standard electrically cut phonograph records.

There are many new designs of power amplifiers, including, of course, two-stage push-pull amplifiers, employing a 227-type tube, two 245s and a 280 rectifier. Several amplifiers employ from two to four 250-type tubes in a push-pull output. These amplifiers were designed for use in public address work and in connection with talking picture equipment. Along with this equipment there were exhibited newly designed pick-up or microphone amplifiers, equalizer units and special line amplifiers. This type of equipment will be of great interest to those men who are working in the public address and talking motion picture field. The same companies manufacturing the amplifiers have designed special impedance-adjusting transformers to meet practically all requirements in this new phase of the industry.

One fact that was driven home at the Show was that this is an engineering year—not only from the point of view of the design but also from a production angle. It is obvious that engineering principles are being applied to every phase of the industry.



The giant public-address system installed in the three Chicago hotels housing the recent Radio Manufacturers Convention. The specially designed amplifiers were the product of the Samson Electric Company. The 150 speakers were Kylectrons, the new condenser type, just introduced by United Reproducers Corp., and shown at the top of the picture.

Recent Trend in Radio Development

General Report of the Annual Meeting of the American Section of the International Scientific Radio Union

By J. E. Smith *

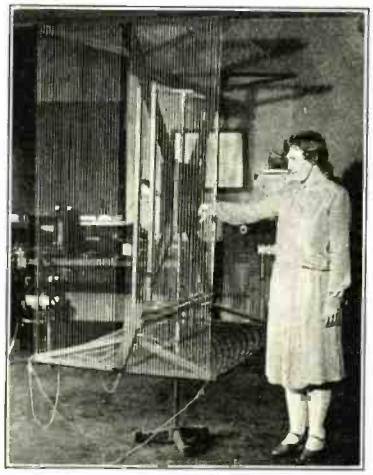
NOISE levels in radio receiving sets vary in magnitude from practically zero in rural areas to 2,000 micro-volts per meter in cities; the average radio-receiver sensitivity is 10 micro-volts per meter and in view of this limiting factor it has been suggested that future receiver-design may produce one type for the country and another for the city; a novel design of radio direction-finder (invented in England and duplicated in America) enables an observer to hear and see static simultaneously and this instrument may be a means of forecasting weather conditions by noting the direction of atmospherics; echo signals are not only disrupting dot-and-dash traffic but they loom as a threatening disturbance to facsimile transmission and reception; radio-communication tests between ground stations and with radio equipment on airplanes indicate that an increase of power by a factor of ten does not overcome the shadow or fading effect of signals; and a new instrument for tuning receiving sets as well as transmitters affords greater selectivity in separating signals from different broadcasting stations and means for the possible elimination of harmonics at transmitters.

The developments outlined above marked the annual meeting of the American Section of the International Scientific Radio Union, meeting in the Academy of Science, Washington, D. C., as a gathering of scientists whose deliberations were fraught with practical and constructive suggestions of value to the radio layman as well as mathematical equations of exclusive interest to the physicist. Against the background of such purely theoretical discussions (and only comprehended by mathematicians) as "Reciprocity in Electromagnetic, Mechanical, Acoustical, and Interconnected Systems," by Stuart Ballantine, of the Radio Frequency Laboratories of Boonton, New Jersey; and "Reciprocal Theorems in Radio Communication," by John R. Carson of the American Telephone and Telegraph Company, were practical discussions relating to the curtailment of interference in radio reception, the improvement of radio-receiver design, a new method of tuning receiving sets, an instrument for utilizing static as a medium of weather forecasting, and the inability of increased power by broadcasting stations to counteract the annoying effect of fading in our receiving sets.

* *President, National Radio Institute.*

Results of Interference Investigations

Investigation of 300 complaints of interference attributed to electric-power sources indicated that the average signal strength being received was 3,000 micro-volts per meter, whereas the noise level registered 500 micro-volts per meter. Norman Snyder of the General Electric Company, who assumed the role of interference detective, pointed out that leaking insulators in power-transmission lines act as a two-edged sword—they set up a disturbance in radio receivers and also



Miss Ivy Jane Wymore of the Bureau of Standards and the loop antenna used in studying static conditions.

squander electric energy for the power company. The noise level produced by this form of interference was as high as 2,000 micro-volts per meter, often dropping abruptly to 212 micro-volts per meter. In some instances the signal strength radiated by the broadcasting station was 120 micro-volts per meter, whereas the noise level was 500 micro-volts per meter. Trolley cars and elevators, according to Mr. Snyder, fall within the category of sources producing legitimate and unavoidable interference with radio reception. For instance, the electric sparks produced by the contacting of the trolley-car wheel with the rail is a form of noise which broadcast listeners, by the very nature of the interference, will have to endure.

The observation that the noise level in radio reception may range from virtually zero in rural areas to 2,000 micro-volts per meter in cities prompted the suggestion that future radio-receiver design should take this variable factor into consideration—designing receiving sets of varying sensitivity for users in country and city. However, R. H. Langley, chief engineer of the Crosley Radio Corporation, did not look with favor upon this suggestion. Major General George O. Squier, who is fostering the development of wired radio, on the other hand, advocated the design of receivers of different sensitivity for rural and urban areas. In fact, the former Chief Signal Officer of the United States Army advanced the liberal proposal that every user of radio should own at least two receiving sets. The average receiver sensitivity at present, members of the International Scientific Radio Union were informed, is 10 micro-volts per meter. This rating has tentatively been accepted by the Radio Inspection Service of the Department of Commerce in determining the "service areas" of broadcasting stations, although Radio Supervisor S. W. Edwards of Detroit indicates that the general increase of power consumption by broadcasting stations may permit of a reduction of this sensitivity level in receivers to 5 micro-volts per meter.

The Cathode-Ray Direction Finder

A radio direction-finder, designed by R. A. Watson Watt of England and duplicated by the American Telephone and Telegraph Company in its static-observation station at Houlton, Maine, traces the directions of atmospheric disturbances from several sources at the same time. Referred to as the cathode-ray direction-finder, the incoming crashes of static produce a spot on the cathode-ray tube—leaving its individual fingerprints or autograph, as it were. Thus, static may be heard and seen at the same time. This new type of direction-finder consists of two crossed loops, one responding readily to atmospheric disturbances from north-south and the other intercepts crashes of static from east-west. The two loops are associated with two receiving sets, the outputs of which are connected to the vertical and horizontal deflecting elements of a cathode-ray oscillograph tube. The screen of the latter is outlined with points of the compass and 10-degree graduations, in a clockwise direction. An incoming crash of static causes the beam in the tube to vibrate in a plane whose intersection with the screen produces a blot, and the direction from which the static originated is

also indicated. Previously used radio direction-finders, in which automatic recorders were associated with rotating loop-and-vertical antennas, were subject to the limiting factor of recording only the integrated effect of all sources of static.

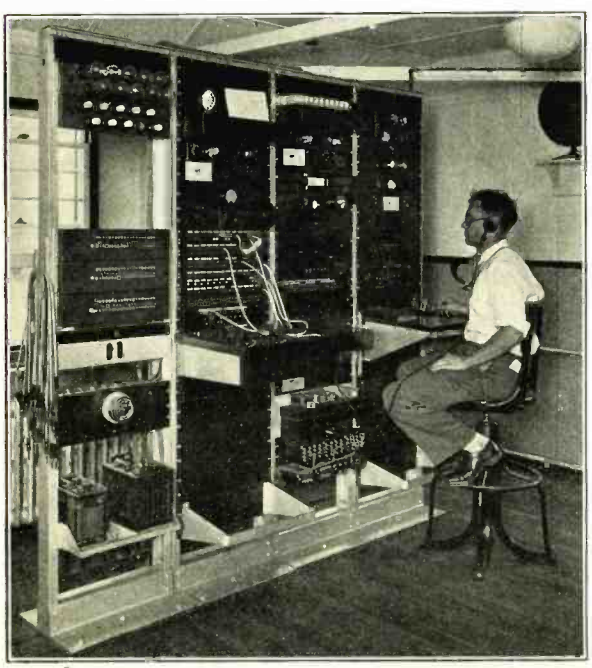
"Echo" Interference

Dr. A. Hoyt Taylor, Superintendent of Radio at the Bellevue Naval Research Laboratory and President of the Institute of Radio Engineers, warns of the threatening possibility of around-the-world signals, echo signals, and like wave-propagation vagaries interfering with facsimile transmission and reception. Dr. Taylor, in conjunction with Leo C. Young, also of the Naval Research Laboratory staff, is continuing the study of echo signals, and he has noted distortions on long-distance transmission, probably due to echo signals. South American short-wave transmitting stations whose around-the-world signals were absent in earlier tests, have been noted recently, signals from Buenos Aires having been received in Washington on a frequency of 21,500 kilocycles. The true signals and echoes were so overlapped as to make the signal unreadable. Echo signals, it has been found, are present on frequencies up to 30,000 kilocycles—in fact, the upper limit remains to be determined. "It is known, however," points out Dr. Taylor, "that the skip-distance increases with the frequency more or less, as might be expected.

". . . We find inconsistencies between effective heights of the layer as measured—say on 20,000 kilocycles—and as deduced from the frequency at which all echoes disappear. The effective layer height deduced from observations made in the 20,000 kilocycle band might indicate a height which ought to cut off completely at 28,000 kilocycles, but actually at the same time we are able to observe certain echoes on 28,000 kilocycles, indicating that it is not completely cut off although it has a very long skip-distance. We see nothing in our latest observations to cause us to change our opinion that short-time echo signals are returned not from a point in space away from the earth, but are thrown back from the surface of the land or sea by way, of course, of an intermediate reflection from the layer."

Action of Ground Signals

Major William R. Blair, Officer in Charge of Research and Engineering of the Signal Corps, War Department, in discussing the vagaries of wave-propagation, unfolded interesting results of tests at Monmouth, New Jersey; and at Dayton, Ohio. For instance, observations at Monmouth indicated that the reliable wave-propagation ground effect is obtained only up to 40 miles. Beyond this distance, the ground signals fade and even though the transmitting power is increased by a factor of ten the shadow or fading effect is not corrected. At Wright Field, Dayton, the wave-propagation tests involved the use of radio equipment on airplanes as well as ground radio stations. Above what Major Blair termed the tangent surface reliable radio reception was obtained and at considerable distances above this surface an absence of fading was noted. However, below the tangent surface the fading effect was present. Different antenna systems were employed and the frequencies used varied—it being observed that the distance of the reception varied with the frequency. Similar experiments with intermediate frequencies seemed to suggest an absence of fading. The tangent-surface effect disappeared in tests over water and over land it seemed to vary with the time of day and to some extent with different weather conditions.



Line terminal equipment at Netcong, used by the Bell Telephone Laboratories for short-wave radio telephony between the United States and Great Britain.

Lightning and Static

H. T. Friis of the Bell Telephone Laboratories, Inc., made the somewhat startling disclosure that for the entire earth there are 100 lightning flashes every second. This number, he believes, is sufficiently large to produce the static present in our radio receiving sets. S. W. Dean, in charge of the static-observation station of the American Telephone and Telegraph Company at Houlton, Maine, agrees with the viewpoint of Mr. Friis, when he states, "We are inclined to believe from these results, as well as from the work of others, that most atmospherics (static) are due to lightning discharges, although, of course, the evidence is too incomplete to permit us to draw positive conclusions." The results to which Mr. Dean refers were those observed at Houlton, Maine, where, he reports, "It has been possible to correlate observations with weather conditions in the vast majority of cases, excepting, of course, those occasions when the sources of atmospherics were in regions not covered by available weather data. In many cases, the directions from which atmospherics came coincided with the bearings from Houlton, of places were thunderstorms were reported. In many others, the sources of atmospherics were apparently low-pressure areas where thunderstorms may have occurred, though none was observed at Weather Bureau stations."

Push-Pull Quartz-Crystal Oscillating Circuits

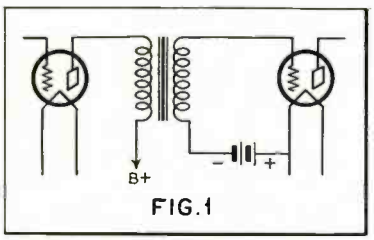
J. R. Harrison of Wesleyan University, Middletown, Conn., demonstrated the behavior of five different push-pull quartz-crystal oscillating circuits. Three of the latter employed four-electrode tubes: (1) Screen-grid vacuum tubes with the slab of mineral in a four-electrode mounting connected to the control grids and plates; (2) space-charge-grid tubes, crystal in four-electrode mounting connected to the control grids and plates; (3) space-charge-grid tubes, slab of crystal in two-electrode mounting connected to the control grids. Circuits (4) and (5) employed three-electrode vacuum tubes, namely, (4) crystal in four-electrode mounting connected to the grids and plates, (5) crystal in two-electrode mounting connected to the grids. The type UX-865 screen-grid vacuum tube was employed with three of the circuits, while type UX-210 was used with the other two circuits. The ratios of power outputs, at 90 kilocycles, for the five circuits were, respectively, 12.9, 1.68, 1.0, 10.7, and 9.6.

The Problems of Radio Servicing

IV. The Servicing of Audio Amplifiers

By John F. Rider, Associate Editor

AUDIO amplifiers in use today employ three distinct methods of coupling; transformer, resistance and impedance coupling, with variations of the second and third, where combinations of resistance and impedance and resistance and auto-transformer coupling are involved. However, no matter what the arrangement, the function of the system is always the same. This does not mean that the performance is the same. Our purpose is not to outline



Generalized diagram of a transformer-coupled a-f. amplifier stage.

the operating characteristics of various types of audio amplifiers. Instead, we will concern ourselves with troubles in audio amplifiers. We take for granted and we are justified in so doing, that the audio amplifier incorporated into any receiving system is best suited for that system. Furthermore, that the design of that audio amplifier is as good as can be made under existing conditions. Operating on this premise we eliminate the subject of amplitude distortion in audio amplifiers, wherein is involved the frequency characteristic of the amplifier in question.

Servicemen do not make changes in audio amplifiers employed in finished receivers, that is, change a transformer coupled system into a resistance coupled system or vice versa, for reasons which are self-evident. However, they do make tube changes and change battery operated receivers into a-c. "electric" receivers, hence we are interested in the utility of tubes in connection with audio-frequency amplifiers.

Application of Tubes

The vacuum tube employed in an audio system plays a very important role, because it manifests a great influence upon the performance of the amplifier and the attainment of satisfactory results. Unfortunately, space limits us to general discussion; hence the following:

(1) High-mu tube or tubes designed to possess high values of amplification constant are suitable for use in two types of audio amplifiers, resistance coupled and impedance coupled and are *not* suited for use in transformer-coupled systems. In this connection, this type of tube is best suited for use in resistance-coupled audio amplifiers.

(2) The conventional type of low mu tube, represented by the 201-A, the 226 and the 227 is suitable for use in all types of audio amplifiers but is limited for use in all stages except the output stage. This does not mean that a power tube cannot be employed in an intermediate stage in the audio-system, but it is mentioned so as to define the limits of the regular tube.

The d-c. tubes, such as the 199 and and 201-A are *not* suited for operation with raw a-c. filament potential, but may be employed in series filament connection when the filament supply is d-c. secured from the a-c. power line. The same applies to the 112.

(4) The screen-grid tube, utilized as a space-charge tube is *unsuited* for use with transformer coupling. This applies to the a-c. and d-c. tubes of this type. This tube is suited for use with resistance and impedance coupling when the resistances and the chokes are specially designed for the tube.

(5) The 226 and the 227 tubes are suitable for use in audio amplifier systems operating with raw a-c. filament potential, but greater satisfaction is secured with the latter.

(6) All types of tubes may be employed in push-pull arrangement providing that the system is designed for such work.

(7) The utility of power tubes such as the 171, 210, 245 and the 250 is governed by the required output power and the amount of voltage available for application to the grid of the output power tube.

(8) Output power tubes should not be interchanged unless the required operating potentials—grid, filament and plate—are available. The reason for this is that the output power is a function of the operating potentials.

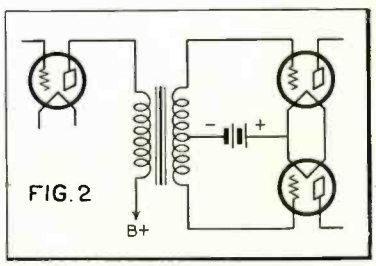
(9) It is necessary to remember that the operating characteristics of the output tube differs from the other tubes in the amplifier. This difference is found in the function of the output tube. Whereas the other tubes in the amplifier perform as voltage amplifiers, the output tube is a power amplifier and the power output varies as the square of the input. In other words, if a tube is rated at 4 watts output with a certain value of plate potential and 40 volts applied to the grid, the application of 20 volts to the grid reduces the output power to one-quarter of the maximum output, or 1 watt and *not* to one-half the maximum power, or 2 watts.

(10) The difference between the output power tubes and the other tubes in the audio amplifier is one of physical structure, which permits the application of higher values of plate potential and grid bias so as to enable the application of high signal voltages to the grid of the power tube without causing overloading and distortion. Furthermore, the design of the power tube is such that it affords best energy transfer between the tube and the speaker over the normal audio frequency range, therefore affording best tone quality.

(11) All tubes are suited for series or parallel filament connection, although it is not customary to employ the a-c. tubes in series connection.

(12) The design of all vacuum tubes is such that operating voltage specifications must be fulfilled and adhered to. Excessive operating potentials may cause irreparable injury to the tube. This is particularly true of the filament.

(13) Insufficient filament, plate or grid potentials will impair the operation of all vacuum tubes. The advent of the screen-grid tube makes necessary mention of the screen-grid voltage in addition to the other voltages quoted.



Circuit diagram of a transformer-coupled, push-pull amplifier stage.

(14) Amplification in a system should not be secured by increasing the operating potentials unless the value in use before the change is made is less than the maximum.

(15) Volume control should not be in the form of reduction of operating potentials, such as the filament or plate voltages. Reducing the grid voltage is out of the question. (The above applies particularly to the audio amplifier, since plate voltage volume control is used in radio-frequency amplifiers.)

(16) Vacuum tubes of all types have definite operating lives, determined by the operating potentials ap-

plied to the tube. The most vulnerable part of the tube is the filament and operating life is limited by the deactivation of the filament, or decrease in electronic emission. The 227-type of tube involves the cathode as the source of electrons.

(17) Operating characteristics of vacuum tubes are such that certain conditions must be fulfilled in order that the amplification be free from distortion. The first is the elimination of grid current. Direct current must not be permitted in the grid-filament circuit since it introduces distortion and reduces amplification by varying the characteristic of the tube and the coupling device. This applies equally

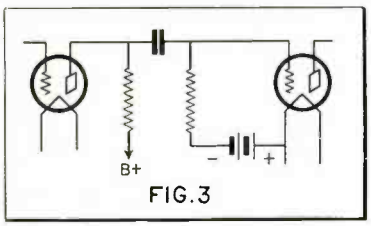


FIG. 3

General circuit of a resistance-capacity coupled amplifier stage.

to all forms of current variations in the plate circuit, which should be faithfully amplified reproductions of the signal voltage applied to the grid circuit. This means that every increase and decrease in signal voltage should be faithfully followed by plate current variations in the plate circuit. Since these plate current variations are a-c. the d-c. plate current must be steady, hence fluctuations of d-c. plate current should not be permitted during operation. They indicate lack of balance between the plate and grid voltages. Increase in plate current during the passage of the signal indicates tube overloading, distortion or insufficient grid bias.

(18) Where more than one tube is employed in a single stage, as in a parallel or a push-pull stage, it is best if the tubes are of like design and characteristics. This condition affords more stable operation. With respect to the plate current, drain is divided equally between the various tubes in the stage. This division of plate current is also advantageous with respect to the effect of the direct current upon the core of the coupling unit (if it employs a core) in the plate circuit.

(19) Vacuum tubes may be connected into parallel and push-pull arrangements when additional output is required. However, the power output of two tubes in parallel is not equal to twice the output of a single tube. Empirical determinations have shown an increase of about 30 to 40%. Furthermore, the use of tubes in parallel does not permit a signal voltage in excess of that permissible with one tube.

(20) Push-pull arrangements afford advantages not found in parallel systems. In the first place, it is permissible to apply a greater value of signal voltage, approximately twice that permissible with one tube. Second, the output is greater than that available with two tubes in parallel. Third, the operating characteristic of the tube is altered so that greater freedom from distortion is secured. Fourth, push-pull systems minimize hum due to potential variations in the grid-filament circuit due to the hum in the filament supply or induced into the grid circuit.

(21) The association between the vacuum tube and the device connected into the tube plate circuit is very important, so much so, that it is the difference between good quality reproduction and poor reproduction. Hence, haphazard replacement of defective coupling units is impossible. When one unit is removed, the replacement should be identical.

(22) With respect to the plate voltage applied to vacuum tubes, it is necessary to remember that a voltage drop takes place across the coupling unit located in the plate circuit. This means that the voltage at the tube plate is less than the voltage at the source of supply. Due to the current carrying capacity of the coupling units, plate voltage increase is definitely limited, since each increase in plate voltage increases the plate current and flow through the coupling unit. Excessive current flow will injure the plate coupling unit, regardless of its type.

(23) Do not remove tubes from series-filament installations unless the proper precautions are exercised to prevent overloading of the other tube filaments. The same is true of tubes in parallel connected across transformer windings.

Characteristics of A-F. Systems

The choice of any one type of coupling unit is a matter of like and dislike. Also of the required frequency characteristic. In this connection we can say very little since the receiver designer is the one who decides upon the type of coupling employed in the receiver and the serviceman or the receiver owner decides upon the type of coupling to be used in a home-built receiver.

With respect to trouble however, all amplifiers are alike. Not that the same trouble will be found in all types of amplifiers, since different types of coupling units are afflicted with different forms of trouble, but rather that the basic factors associated with trouble are present in all amplifiers.

To secure satisfactory operation with all amplifiers, certain requirements must be fulfilled. A defective condition means that one of the requirements has not been fulfilled. The conditions are:

1. Input signal voltage within operating limits of vacuum tubes in the system.
2. That the plate potential at the tube plate be correct.
3. That the grid potential at the tube grid be correct.
4. That the filament potential at the tube filament be correct.
5. That the coupling units be in perfect condition.
6. That circuit wiring be correct.
7. That connections in the circuit be perfect.
8. That all the amplifier components be in good condition.
9. That the filament supply be in good condition.
10. That the grid supply be in good condition.
11. That the plate voltage supply be in good condition.
12. That the tubes be the type suited for the receiver.
13. That the tubes be in good condition.

A cursory analysis of the above is sufficient to show that each of the subjects is allied with the other and also associated with certain phenomena. We say, without fear of contradiction, that with respect to trouble all amplifiers are alike. That is to say, the conditions of overload are applicable to all types; the effect of an open circuit is the same in all amplifiers; the effect of a short circuit is the same in all amplifiers, etc.

Viewed from one angle, it would be a fine thing to give an analysis of the various types of amplifiers available at the present time, but we believe that such an analysis should not be necessary. With respect to what we have in mind why should it be neces-

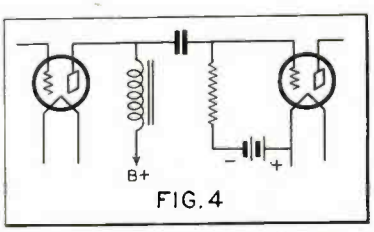


FIG. 4

Combination impedance-resistance coupled stage.

sary to spend time differentiating between a resistance coupled amplifier employing a grid and plate resistance and another amplifier employing a plate resistance and a grid choke. True that the operating characteristics with respect to frequency response differ, but is that our concern at this time? The effect of an open grid resistance or grid leak in the audio amplifier is the same as an open grid choke.

Amplifier Requirements

We will, of course, discuss data which is applicable to one type of audio amplifier and not to another, but the subject matter is not lengthy. Let us start the discussion pertaining to the aforementioned requirements. Bear in mind that what is to follow is applicable to all types of audio amplifiers regardless of circuit connection

and the number of tubes involved, assuming that the amplifier has at least one tube. The numerical designations refer to the requirements as enumerated.

(1) The value of grid bias employed in the receiver amplifier system limits the amount of signal voltage which may be applied to the tubes in the receiver. This is true of all types of installation, since the type of coupling does not influence the operating potentials. In other words, if a 112 requires a negative grid bias of 6 volts with 135 volts applied to the plate, the same grid bias is required in transformer, resistance and impedance coupled audio amplifiers. The appli-

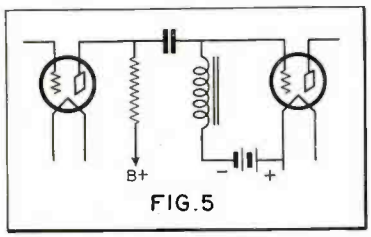


FIG.5

Another form of impedance-resistance coupling, with the impedance in the grid circuit.

cation of excessive signal voltage will cause tube overloading, grid current and distortion. In this connection it is necessary to consider the degree of amplification available in the system, so that overloading of the output tube does not take place. Incidentally, the most frequent complaint relative to tube overloading is that in connection with the output tube. The data relative to the action of the plate current is of utility when tube overloading is the subject.

(2) Incorrect plate potential causes several bad effects and may be due to several conditions. With respect to the value of potential, insufficient voltage applied to the plate will cause low amplifying level, permit overloading of the tube and consequently distortion. On the other hand, excessive plate potential will upset the balance between the grid and plate circuits and impair distortionless amplification. Also it will increase the plate current and if the increase is radical, permanent injury of the coupling unit is possible. If the injury is of such nature that it does not ruin the unit, it is possible that the damage will cause noisy operation. This is true in the case of resistances and transformer windings. In addition, it is necessary to accord detailed thought to the magnitude of plate current when the coupling unit is a transformer employing an alloy core. The design of the core is such that the permissible d-c. plate current through the transformer winding is limited. Excessive current will ruin the core electrically and impair the frequency characteristic of the transformer. The usual effect is the loss of low notes.

With respect to the causes for low plate potential, we might stress the units contained in the plate circuit, assuming correct B-power unit output, and low B-power unit output, assuming correct units in the plate circuit.

(3) Low grid potential is a frequent cause of distortion. The operating principals of the vacuum tube demand that a certain value of grid potential be employed for each value of plate and filament potential in order to create a state of stability between the grid and plate circuits. The attainment of distortionless amplification with the vacuum tube depends upon the elimination of grid current in the tube grid-filament circuit. This is true of all types of amplifiers without exception, transformer, resistance and impedance coupled; parallel tube filament wiring and series filament wiring. The elimination of grid current depends upon the use of the correct value of grid potential. The subject of correct grid potential, involves excessive potential, insufficient potential, circuit connections and associated apparatus. The possible reasons for incorrect grid potential have been outlined in another section, hence repetition is unnecessary, but it is necessary to mention that the grid bias controls amplification.

Effect of Grid Bias

In connection with the grid bias potential it is necessary to mention different conditions and their effects. Insufficient grid bias of correct polarity will cause tube overloading on strong signals only, but the condition will be shown by excessive tube plate current. Incorrect polarity of grid bias will cause extremely poor amplified operation and a great reduction in amplification. As a matter of fact it will paralyze the tube and the amplifier will be practically inoperative. The sign of this condition is a great increase in tube plate current in excess of the normal value. Excessive grid potential will cause distortion and if the bias is sufficient to reduce the plate current to zero, the amplifier tube will be inoperative and the amplifier will be inoperative. This condition is indicated by insufficient plate current.

(4) The value of filament potential governs the operation of the tube, the performance of the tube and its operating characteristics. In addition, it manifests an influence upon the operating life of the tube to the operating life of the filament. Excessive filament potential will cause premature deactivation of the filament and eventual burnout. Insufficient filament potential on the other hand will cause low amplification and distortion, such as tube overloading. In addition, the mutual conductance value of the tube is greatly reduced and the plate impedance value is greatly increased, impairing the operating characteristic of the tube with respect to the units employed in conjunction with the tube. Increased filament potential will not cause a marked effect upon the plate current, but insufficient filament potential will cause a marked decrease in plate current.

(5) The condition of the coupling units in the system, regardless of type, controls the amplifier performance. If for some reason, the grid or plate coupling units are "open", operating potentials will not reach the tube and the amplifier will appear "dead." If the grid voltage is lacking because the grid coupling unit is "open," various forms of trouble are possible. These are, hum, low amplification, distortion, and howling. If the coupling unit is defective, insofar as the individual plate and grid units are concerned, various defects will be evident, according to the type of defect. If the current flow through a transformer winding causes minute arcing between turns, crackling and frying sounds will be heard. If the core of the transformer is grounded and one of the windings comes in contact with the grounded core, hum and low amplification will be the result. In some cases possible short circuit of the operating potential may be the result. If, by chance the primary and secondary windings are in electrical contact with each other distortion will be the result due to the application of a positive bias to the grid. As a matter of fact the aforementioned condition may cause total paralysis of the tube and an inoperative amplifier—perhaps injury to the tube.

Imperfect contacts at the respective connecting terminals will cause crackling and sputtering sounds. The same is true with impedance and resistance coupling. With respect to the latter, overload of the resistance unit will cause hissing and frying sounds. Overload is usually encountered in the plate circuit and is due to excessive current flow through the resistance

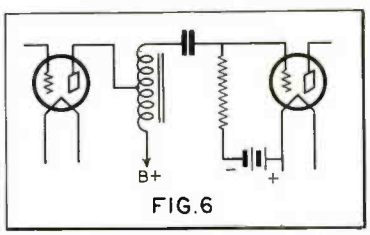


FIG.6

A semi-isolated coupling circuit, employing an auto-transformer.

and the inability on the part of the resistor element to carry the plate current.

The isolating condenser employed in resistance, impedance and in combination resistance—impedance coupled audio amplifiers, between the grid and plate terminals of these coupling units is a frequent cause of distortion, noise and low amplification. A leak in this condenser will cause noise and the application of a positive bias to the grid of the amplifying tube, resulting in low or no amplification in the system

—frequently a dead amplifier. The above is particularly true in the audio amplifier employing an auto-transformer in the grid circuit and a resistance in the plate circuit of the preceding tube, with the isolating condenser between the two. This system will be shown later.

Certain transformer-coupled audio amplifiers employ an isolating condenser in the plate circuit in conjunction with the regular transformer primary and another choke. The function of the condenser is to exclude d-c. from the transformer primary. A leak in this condenser will cause noise dur-

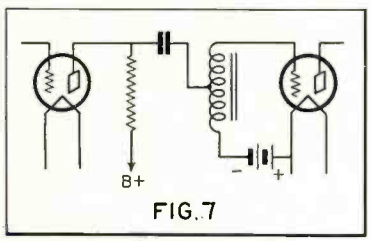


FIG.7

Another form of semi-isolated circuit, employing an auto-transformer.

ing the passage of signals and a short in the condenser may reduce amplification on the low frequencies. A good deal of the noise encountered in audio amplifiers is due to some imperfect condition in the coupling units and examination and diagnosis by replacement is recommended. This is particularly true of transformers operating at high potentials and resistances employed in high power audio amplifiers or resistances which are subjected to appreciable values of current load.

Circuit Wiring

(6) Very little need be said about circuit wiring. In the first place the receiver to be serviced was satisfactorily wired. . . . The possibility of wrong wiring is very remote considering the numerous tests at the manufacturing plant. Second, circuit connections do not change unless the change is made by someone. Hence it is not necessary to examine circuit connections. However, if the defect developed right after a wiring change had been made, a circuit continuity test is necessary.

It stands to reason that the circuit wiring must be correct. If the receiver owner admits changes in wiring it is necessary to seek incorrect polarity of battery, reversed transformer connections, wrong placement of by-pass condensers, open resistance connections, wrong tube connections, etc.

(7) Much trouble in radio receivers may be attributed to poor connections between the various elements. The average radio receiver is subjected to many jars and shocks during transit, even during the short trip between the dealer and the consumer. A poorly soldered contact is jarred loose. It makes contact until vibration encountered during operation opens the contact—then trouble. In many other instances, the contact is not permanently opened. Instead it breaks and makes intermittently during receiver operation. The result is electrical disturbance in the form of sputtering and crackling sounds and sometimes distortion and low amplification, depending upon the location of the poor contact.

(8) We discriminate between the coupling units in the amplifier and the other parts exclusive of the tubes. We refer to the resistances employed in filter systems, the condensers employed in the filter system, the by-pass condensers, the voltage reducing resistances, the tube sockets, etc. In order to secure satisfactory operation, it is necessary that all these parts be in perfect condition. Shorted by-pass condensers will short associated circuits, cause low amplification, short battery life, overloading of power supply devises, lack of plate potential, lack of grid potential, etc., depending upon the location of the by-pass condenser. These details are of interest after the trouble has been isolated with respect to a certain stage in the amplifier or a certain section of the amplifier.

Defects in voltage-reducing resistances will open the respective circuits. Defects in filter resistances carrying the tube plate current will either open the circuit, cause excessive voltage drop or will cause noise of the character mentioned in preceding sections of this chapter. Defective sockets will cause leaks between the various circuits and distortion, low amplification and sometimes stop operation of the amplifier. The latter condition involves the contact between the tube prongs and the socket prongs. Poor contact between the tube and the socket prongs is a frequent reason for fluctuating signal strength, hum, crackling and spnttering sounds and other forms of disturbance.

Imperfections in a by-pass condenser with respect to an "open" between the connecting terminals and the active surfaces in the condenser will influence amplifier stability, increase regeneration, cause hum and sometimes howling. This is particularly true in a-c. installations.

(9) The condition of the filament supply in a-c. installations plays an important role with respect to the hum in the system. Imperfect filtering in the A-eliminator will cause a bad hum. Overloading of the eliminator will cause the same condition. A defect in the eliminator will cause lack of filament potential or low filament potential. In this connection we refer the reader to the section devoted to A-eliminators, in this series.

With respect to battery types of filament potential sources, the condition of the battery controls the filament potential. A defective battery will cause low filament potential and in many cases sputtering and crackling forms of electrical disturbance. Such batteries have definite operating lives and after a period of time will become noisy in operation.

Transformer sources of filament potential are of interest in a-c. installations. An open transformer primary or secondary winding will cause lack of filament potential. Poor contact in the transformer will cause fluctuating filament brilliancy and fluctuating signal intensity. Insufficient current and voltage output will cause low filament potential, consequently low amplification and distortion. Incorrectly located transformer winding center taps will cause excessive hum. Incorrectly adjusted filament shunt resistance center taps will cause excessive hum. For further data we refer to the section devoted to filament shunt resistances, in this series.

In some cases the source of filament potential is the B-eliminator: the amplifier filaments being wired in series and supplied with operating potential from the B-eliminator. A defect in the B-unit may cause excessive hum or distortion because of incorrect bias and lack of filament potential.

(10) The source of grid potential must be perfect. If of the battery type, the electrical condition of the battery must be perfect. A defective battery will cause sputtering, crackling and other forms of disturbance. A run down battery will cause excessive regeneration, howling, squealing, hum, etc. With respect to eliminator sources of grid potential, defective operation of the eliminator will cause a bad hum and excessive regeneration. Lack of by-pass condensers will cause a bad hum and howling. Imperfections in the grid bias resistances will cause hissing and crackling sounds.

(11) What has been said about the source of grid potential is applicable to the source of plate potential. Run

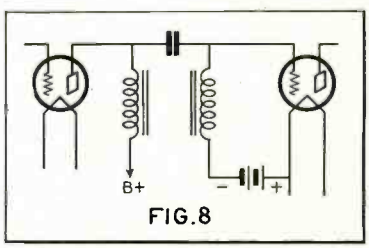


FIG.8

A double impedance coupled amplifier circuit, which may or may not be of the "tuned" type.

down B-batteries will cause howling and singing in addition to crackling sounds, accompanied of course, by reduced amplification. Defective B-supply units will cause hum, excessive regeneration, howling and other disturbing effects.

(12) The tubes employed in the system control operation and performance. If the tubes are not suited to the coupling units, amplification will be low and distortion will be very pronounced. Types of tubes suitable for use in certain types of audio amplifiers have been mentioned.

(To be continued)

The Engineering Rise in Radio

By Donald McNicol

Fellow A.I.E.E., Fellow I.R.E., Past-President, Institute of Radio Engineers

Part XIV

KDKA Begins Operation

A FEW months later Conrad's private station was closed and a new broadcast station (KDKA) set up at East Pittsburgh, by the Westinghouse Company, through the enthusiastic support and cooperation of Harry P. Davis, vice-president of the company. The station was opened on regular evening schedule on December 23, 1920.

The first intimation radio engineers in New York had of what was going on at Pittsburgh occurred on the evening of October 6, 1920, at a dinner in New York attended by L. W. Chubb, M. C. Rypinski, J. V. L. Hogan, Alfred N. Goldsmith, Donald McNicol, Lloyd Espenschied and Louis R. Krumm. From the eminence of time seven years later those who attended the dinner may recall the enthusiasm of Chubb and Rypinski relative to the anticipated outcome of broadcasting music regularly as a business undertaking.

Compared to the others present, Rypinski and Chubb were not old in the radio business. The radio business, as new arts will, had kicked the others around a bit. They listened attentively to the story of "Radiophones in a million homes," but the idea was new and perhaps more than one of the guests present thought of the request somewhere made by the Bard of Avon when he said:

Show me one scar charactered on your skin;
Men's flesh preserved so well do seldom win.

About two months later than this KDKA was launched upon the air and for radio a new and wonderful era had dawned.

Broadcasting Prior to 1920

Following the custom set in this work in the case of other notable departures, it is of interest to scan the accounts of prior attempts to broadcast by radiophone.

deForest, in testing the twenty-odd radiophone transmitters intended for the use of ships of the U. S. navy, in 1907, sent out music from a phonograph, and in the summer of 1907 phonograph selections were transmitted to fill in the gaps while the yacht races on Lake Erie were in progress. In the operatic season of 1908–09, deForest had a temporary installation of a radiophone broadcasting station on the roof of the Metropolitan Opera House, New York. An Acousticon type of transmitter was used to broadcast Caruso's voice. Thus was broadcast the first radio opera. The audience consisted mainly of radio operators on ships temporarily berthed at New York docks.

The first opera artist to sing directly into a microphone of a deForest radio transmitter was Mme. Mazarin, Oscar Hammerstein's soprano, who sang at a special performance at the deForest laboratory at 103 Park Avenue, New York.

On November 28, 1915, at a banquet at the Lotos Club, New York, the diners listened to music radioed from the Arlington, Washington station, to the West Street, New York, station of the Western Electric Company, thence to the Lotos Club by wire line. This was perhaps the first large social function supplied with music transmitted over long distance by radio.

In the fall of 1916, deForest, from his High Bridge, New York station, sent out news bulletins and musical selections, and in the 1916 political campaign, in cooperation with the New York *American*, election returns were transmitted to listening amateur experimenters within range of the station. On December 30, 1916, radioed music from deForest's High Bridge station was used as the dance music at a house party at Morristown, New Jersey, a distance of about thirty miles.

In 1916, also, Harold J. Power, of the American Radio Research Corporation, from his station IXE at Medford Hillside, Mass., transmitted music occasionally in December of that year.

Broadcasting in those early days was, as now, expensive and the entire cost of operation devolved upon the sending station, without any hope of return. The listeners were the amateur radio telegraph experimenters, whose sets would pick up the radiophone music, and the radio operators on ships within range. Radio receiving sets were not generally on sale and the public looked upon radio receivers as highly technical and complicated devices requiring expert knowledge in their operation. And, the loudspeaker had not yet made its appearance. Listening-in was accomplished by means of headgear ear-phones only.

In December 1919, Robert F. Gowen, of the deForest Company set up at his home, at Ossining, New York, a ⅓ kw. radiophone transmitter with which he transmitted music which was picked up at distances of 1,000 miles. These tests were carried out on a wavelength of 330 meters, with 2.4 amperes in the antenna, and were continued for several weeks on a schedule beginning at 11 p. m. daily.

In February, 1920, station CFCF at Montreal, Canada, under the technical direction of J. O. G. Cann, and with

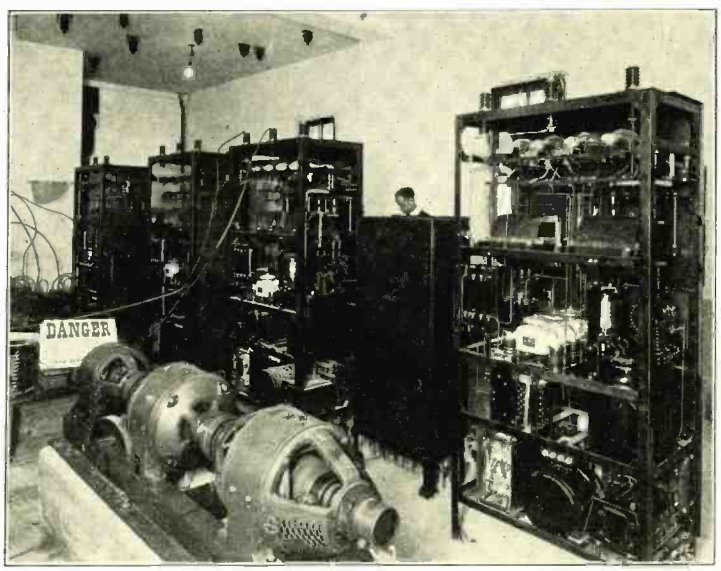


Fig. 20. Interior view of WJZ broadcast station, of the Radio Corporation of America, on 42d street, New York, installed in 1923. The station was designed to have simultaneous transmission on two wavelengths. The transmitting and modulating tubes may be seen on the top shelves of the power panels, of which a rear view is shown.

D. P. R. Coats as announcer, broadcast regularly on Tuesday evenings, later on two evenings each week and, ultimately, nightly. The station was operated on 500 watts.

The first newspaper to instal a radiophone broadcasting station was the *Detroit News*, which began service by sending out election returns on August 31, 1920. Musical programs were broadcast daily at 11:30 a. m., and 7 p. m. At first phonograph reproductions were transmitted, but later speakers and singers were enlisted to broadcast.

Broadcast Stations Opened After 1920

On May 20, 1921, the H. J. Power station WGI, at Medford Hillside, Mass., began a regular daily broadcast service.

The immediate success met with by the Westinghouse Company in operating station KDKA at Pittsburgh, prompted the company to establish a broadcast station in the vicinity of New York City with the result that station WJZ was opened at Newark, New Jersey, on October 23, 1921. In this plant greater power was made available by the use of two 250-watt oscillator tubes, three 250-watt modulator tubes and two 50-watt amplifiers.

There were various other individual demonstrations of broadcasting such as that of L. W. Elias of Chicago, in February 1920, and that from the California Theatre, San Francisco, in 1920.

The first broadcasting station (WDY) opened by the Radio Corporation of America was that at Roselle Park, New Jersey, in the fall of 1921, but about the beginning of 1922 the Radio Corporation and the Westinghouse Company jointly operated station WJZ at Newark, closing the Roselle Park station. In 1923 a new WJZ was opened by the Radio Corporation, on 42d St., New York, and in 1925 the 50 kw. station was opened at Bound Brook, New Jersey.

Then followed the installation of radio broadcasting stations at such a rate that by the end of the year 1922 there were about six hundred stations in service or under construction.

It may be recorded that Gowen's demonstrations of 1919 were satisfactory from the transmission standpoint. He had in use all of the essential elements of an efficient broadcast station, operating within the broadcast range of wavelengths. But perhaps the elements of radio's horoscope were in conjunction in 1921, on its twenty-fifth birthday, for it was in that year that the great art descended upon the earth after the manner of a great spiritual visitation.

The voluminous and widespread publicity given to the demonstrations from KDKA, WJZ and the other early stations, by the press of the country, at once created a world-wide demand for radio receivers which forthwith put twenty-four-hour shifts to work in all factories equipped to turn out the required apparatus. With hundreds of millions of dollars annually earned from the sale of radio receivers, the manufacturers were in a position to support the broadcasting stations to the end that the golden circle might be maintained and enlarged.

Number of Radio Listeners

In 1927 it was estimated that 6,000,000 of the 22,000,000 homes on the North American continent were equipped with radio receivers, and that an average of approximately 25,000,000 persons daily listened to radio broadcast matter.

In the United States there are 680 licensed broadcast stations, of which about 250 broadcast on daily schedules.

It is estimated also that the 16,000,000 homes on the continent not at this date equipped with radio receivers, are being supplied at the rate of about 1,000,000 sets per year.

The first license granted by the Department of Commerce, at Washington, for the operation of a broadcast station was issued in September 1921. In the use of a radio telephone transmitter to broadcast to a large number of receiving stations simultaneously, radio telephony found its immediate great field of usefulness; a field awaiting exploitation and not served by any other agency; a field cultivated by deForest, Logwood, Alfred N. Goldsmith, Robert F. Gowen and others, and entered triumphantly at a later date by Conrad, H. P. Davis, and other interests as recorded in the foregoing.

Broadcasting in Other Countries

In other countries the radiophone broadcasting idea was developed a year or two following the popularization of the service in America. From London and Manchester, England, beginning on November 14, 1922, at first, news bulletins and weather reports were broadcast. The British Broadcasting Company was incorporated on December 16, 1922, with J. C. W. Reith as general manager. The company was granted a monopoly of transmitting operations in the British Isles. The earnings of the company are derived from annual license fees charged all persons using radio receivers to pick up the matter transmitted from the British Broadcasting Company's stations. In January, 1923, 25,000 licenses had been taken out, in February the number had increased to 53,000, and following the opening of additional transmitting stations at Birmingham and Newcastle, the number of licensed listeners had by November, 1923, increased to 492,000. This same system of raising revenue to pay for broadcasting was adopted in the British dominions, the post office department issuing the licenses and collecting the fees.

In other European countries the enterprise was taken up slowly and cautiously by government departments, and within a few years radio broadcasting stations were serving the people in practically every country in the world.

Technical Advance in Radio Telephone Transmission

In America, within five years after regular scheduled broadcasting from permanent, powerful sending stations had been inaugurated, several millions of homes throughout the country had been equipped with radio receivers, varying in makeup from simple crystal sets to multi-tube sets of great sensitivity. Owing to the rapid multiplication of broadcast stations, serving all parts of the country, practically every purchaser of a receiving outfit was enabled to hear instrumental and vocal musical selections and other matter transmitted daily. The great wonder of the thing was thrilling, and for a time the novelty of "picking up" anywhere music transmitted from a station located perhaps hundreds of miles away, and the experience of selecting at will a program from any one of a dozen sending stations, was wonderful enough without requiring perfection of reproduction.

But as the number of receiving stations multiplied, and the people became accustomed to the service, observation became more critical, a result of which was that the broadcast stations automatically were given the benefit of a multitude of observation posts; which reported frankly and frequently on the "grade" of transmission.

In a short time millions of persons became familiar with the terms "static" "fading" and "interference." The collected data the engineers were able to gather from reports sent in made possible a study of the various phenomena on a scale which measured up to the needs of the situation.

Radio telephony, so far as the majority of broadcast listeners are concerned, has to do with transmission of electric waves overland, and while much had been heard in the early days of the art about the perfect medium for telephony; the "distortionless ether," the engineering investigations carried out by Pickard, Austin, Weagant, and the telephone company's engineers, in America, and by various investigators in other countries, early disclosed that space as a medium for speech transmission contains several elements (some of them transient and difficult to analyze accurately) which present difficulties less likely to respond to treatment than uniformly distributed factors such as those inherent in wire conductors.

The practice in broadcast telephony is to send out a modulated high-frequency wave, made up of a band of frequencies about ten kilocycles wide, but as pointed out by Bown, Martin and Potter,[1] "analyzed into its elements

[1] *Some Studies in Radio Broadcast Transmission, by Ralph Bown, D. K. Potter and R. K. Potter, Proc. Inst. Radio Engineers, February,* 1926.

and studied in detail, the modulated high-frequency wave is revealed as being an intricate fabric of elemental waves so interwoven with each other that no one of them can be disturbed without changing in some degree the complexion of the whole. For perfect results the whole band must arrive at the receiver with an amplitude continuously proportional to that leaving the transmitter, or the inflections or expression of the speech or music will not be correctly reproduced."

Out of the examinations and studies carried on by these engineers came the conclusion that interference between the components of the transmitted wave, in their travel from transmitter to receiver, is a major cause of signal variation.

In Chapter 4 something was said relative to elements of a radiated wave referred to as the sky wave and the earth wave. The investigators called attention to the fact that when two single frequency plane polarized waves start out at the same time from a common source and travel by separate routes, converging at a distant point, the nature of disturbance at that point (as indicated by a radio receiver located there) is determined by the relative space phases of the planes of polarization and time phases of the amplitude of the two incoming waves.

Commercial Radio Telephony

It was natural that the rapid progress made in developing satisfactory broadcast telephony should revive the idea of the possibility of establishing long distance commercial radio telephony. Obviously, there is no profitable field for radio telephony where wire telephony already is dependably established; that is, in the present state of the art of radio. Transocean radio telephony, on the other hand, held out a possibility for exploitation, and in this field the engineers of the American Telephone and Telegraph Company and the engineers of the British telephone system have for three or four years carried on series of experiments with a view to learning the requirements and to the development of terminal apparatus necessary to carry on two-way conversation. These experiments culminated in the inauguration of trans-Atlantic radio telephone service in January, 1927.

Much of the study of the phenomena involved in determining the requirements of transocean radio telephony was carried along simultaneously with examinations into the vagaries of broadcast transmission and reception and, the medium being the same and the apparatus employed being similar, it might be expected that a considerable amount of the new knowledge gained would have a bearing on the problems of broadcasting as well as of transocean telephony.

In the operation of commercial radio telephony and broadcasting a difference in system requirements is that in the case of the latter it is of fundamental importance that the matter sent out shall be transmitted in such form that practically any sort of a radio receiver may be used to pick up the radiated waves and transform these into sound, while with commercial telephony it is of considerable importance that the waves carrying the words shall actuate only the radio receivers necessary to the conversation.

Out of the concurrent studies carried on came the knowledge upon which much of the best of present-day radio broadcasting and commercial radio telephony is based. No little portion of this knowledge has been developed by the engineers of the American Telephone and Telegraph Company, previously mentioned, and also by Austin Bailey, C. N. Anderson, H. T. Friis, G. C. De Coutouly and G. D. Gillett of the same organization; by W. R. G. Baker of the General Electric Company and by Alfred N. Goldsmith, Julius Weinberger and Carl Dreher of the Radio Corporation of America.

Although as late as the year 1928, occasionally a competent engineer is not backward in stating that "we know very little about radio," viewed relatively there is no doubt that very important gains in knowledge have been made in the past seven years while broadcasting on a large scale has been carried on.

The significance of the word "carrier" as employed in radio telephone operation is related to an extensive prior art[2] which followed closely the building up of wire telephone and telegraph service from the early days almost up to the advent of the audion oscillator, but in telling the story of radio it is important to consider the use of the term "carrier wave" only as it applies to modern radio telephony.

Sidebands

An idea of the technique of radio telephone transmission may be gained by considering that when the high-frequency current produced by tube oscillators and proper associated circuits, and modulated by the voice wave, is sent out in wave form, the original high-frequency (carrier) wave is accompanied by a "sideband" of higher frequency than the carrier wave and a sideband of lower frequency. The sideband represents the frequency range necessary for the transmission of speech, but actually it is necessary only to transmit one of these, notwithstanding that usually both sidebands are transmitted.

In the trans-Atlantic radio telephone trials the single sideband method, due to John R. Carson, has been employed, the other sideband as well as the carrier wave is taken out by electric filters, due to G. A. Campbell, prior to amplification. In this transmission the entire power of the 100-k.w. amplifier used is concentrated in one sideband radiated from the sending antenna, the power level being about three times as great as it would be if the carrier wave and both sidebands were transmitted, as is customary in broadcast transmission.

With this system of transmission not only is a much greater power sent out from a given input, but there is a conservation of nearly fifty per cent. in the ether space occupied while transmission continues. That is, when transmission from a station is by single sideband nearly twice as many radio transmitters may be in operation simultaneously without undue interference.

Perhaps a clearer picture of what is here involved may be presented by recording that the present broadcast range in America is from 202.6 meters (1480 kilocycles) to 545.1 meters (550 kilocycles) and that the trans-Atlantic radio telephone service was established on a wavelength of 5,000 meters (60 kilocycles).

Ordinary speech frequencies range from about 300 to 3,000 cycles. When, therefore, the usual modulated carrier wave method is employed the frequency band in space occupied extends 3,000 cycles above and 3,000 cycles below that already occupied by the carrier wave. With single sideband operation the trans-Atlantic radio telephone service occupies the space between 5,125 meters and 4,875 meters; (58½–61½ kilocycles).

(*To be continued*)

[2] *Carrier Current Telephony and Telegraphy, by E. H. Colpitts and O. B. Blackwell, A. I. E. E. Journal, February, 1921.*

RADIO SIGNAL TRANSMISSIONS OF STANDARD FREQUENCY

THE Bureau of Standards announces a new schedule of radio signals of standard frequencies, for use by the public in calibrating frequency standards and transmitting and receiving apparatus. The schedule of standard frequency signals is as follows:

July 22, 10 p. m., E. S. T., 1,500; 10.12, 1,700; 10.24, 2,000; 10.36, 2,300; 10.48, 2,700; 11, 3,100; 11.12, 3,500; 11.24, 4,000.

August 20, 10 p. m., E. S. T., 4,000; 10.12, 4,400; 10.24, 4,800; 10.36, 5,200; 10.48, 5,800; 11, 6,400; 11.12, 7,000; 11.24, 7,600.

September 20, 10 p. m., E. S. T., 550; 10.12, 600; 10.24, 700; 10.36, 800; 10.48, 1,000; 11, 1,200; 11.12, 1,400; 11.24, 1,500.

October 21, 10 p. m., E. S. T., 1,600; 10.12, 1,800; 10.24, 2,000; 10.36, 2,400; 10.48, 2,800; 11, 3,200; 11.12, 3,600; 11.24, 4,000.

November 20, 10 p. m., E. S. T., 4,000; 10.12, 4,400; 10.24, 4,800; 10.36, 5,200; 10.48, 5,800; 11, 6,400; 11.12, 7,000; 11.24, 7,600.

December 20, 10 p. m., E. S. T., 550; 10.12, 600; 10.24, 700; 10.36, 800; 10.48, 1,000; 11, 1,200; 11.12, 1,400; 11.24, 1,500.

A PORTABLE PICK-UP AMPLIFIER

By Howard Allan Chinn

WHEN broadcasting a program originating at a point outside of the regular studio, it is usually necessary to provide a mixer and line amplifier at the pick-up point in order to permit the proper switching of microphones for announcements and program and to amplify the minute audio-frequency energy derived from the microphones to sufficient strength for transmission over the line to the broadcasting station. It can be easily appreciated that the apparatus should be readily portable and reasonably easy to install and operate.

In order that the quality of the transmission of the broadcast station be of the very best, it is necessary that individual or constituent units be of the highest grade. It is therefore, seen that the pick-up amplifier must be capable of high quality reproduction, that is, the frequency-response characteristic must be as good as it is possible to have with present-day conditions. Thus, the transformers used throughout the amplifier must be of the best quality and with this in mind those used in this amplifier were selected. Another point in favor of the particular transformers used is the fact that the cores are of special alloy steel and therefore high quality transformers are produced which are physically no larger nor heavier than the usual common grade of amplifying transformers. This point is of considerable merit in view of the fact that the amplifier is to be made portable.

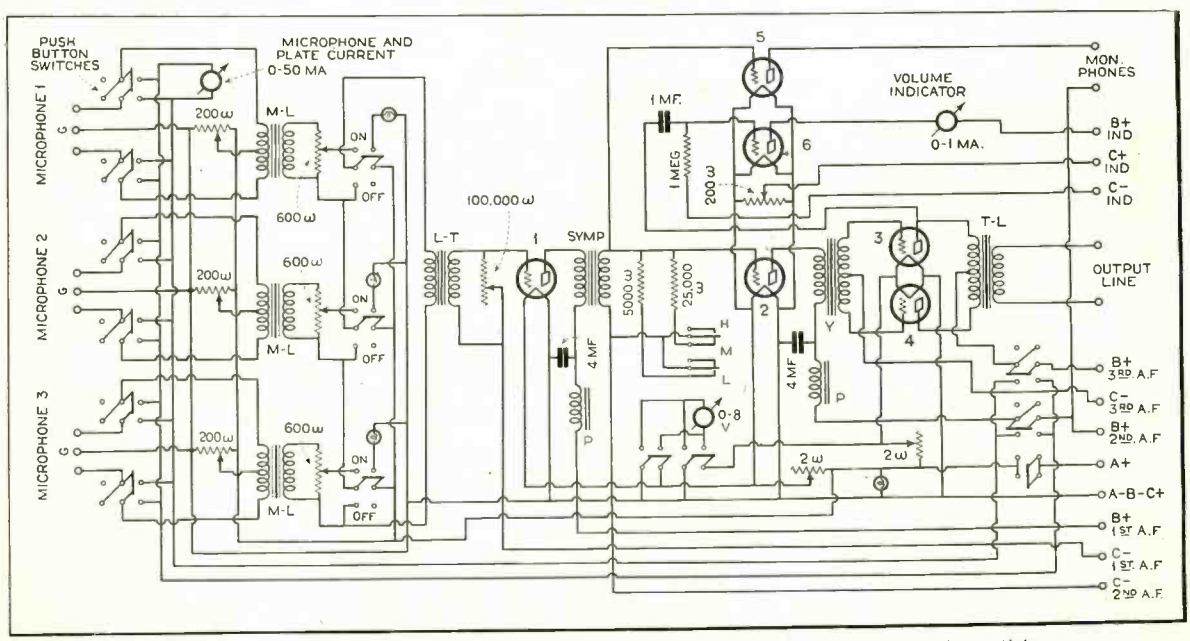
Panel Arrangement

The panel is laid out in such a manner that all the controls associated with a given circuit are mounted one above each other and therefore confined to a single column. Thus, consider the filament circuit controls in the first vertical column at the left of the panel, Fig. 1. At the top is the filament voltmeter (Weston, model 301) having a full scale deflection of 8 volts. Below this is mounted a pilot light (Western Electric, type 13) which indicates when the filaments are on and the amplifier is in operation. Below the pilot light are mounted two push-button switches (Western Electric, type 92-A) which connect the voltmeter either across the filaments of tubes 1 and 2 or tubes 3 and 4. Below the voltmeter switches is a 2-ohm rheostat (Yaxley, type 102-K) which is used to control the voltage across the filaments of tubes 1 and 2. Next is the filament switch which is a double pole, single throw switch (Connecticut) with the poles connected in parallel merely as a precaution against poor contacts. This switch is in the positive A battery lead and is indicated on the circuit diagram just to the left of the A plus terminal post. Below this switch is another 2-ohm rheostat which is in series with the filaments of tubes 3 and 4. All the controls in this column are therefore associated with the filament circuit. By pushing the proper voltmeter button and adjusting the corresponding rheostat, the filament voltage of the various tubes can be quickly and accurately adjusted to the proper value.

In the next, or second column from the left are the controls associated with microphone 1. This column is labelled "Mike 1" just under the pilot light which indicates when this microphone is connected to the amplifier input. Below the pilot light are the two microphone current push-buttons. By pushing one or the other of these buttons, the current in either of the microphone buttons may be determined as indicated on the center meter on the panel. This meter has a maximum scale deflection of 50 milliamperes (Weston, model 301) and is used to measure microphone currents and to check the plate currents of the amplifier tubes, as will be explained later. Below the microphone current buttons is a 200-ohm potentiometer (Yaxley, type 200) which controls the microphone current. Next is the switch (Connecticut, double pole, double throw) which connects the audio output of this microphone to the input of the amplifier and below this a potentiometer volume control for the microphone. These last two controls being in that part of the circuit which is normally termed the mixer. The instruments are so arranged that the microphone current buttons may be pushed and the microphone current adjusted, all with the same hand, thus making possible quick and easy adjustment of the microphone current.

The center column is for microphone 2 and the next column to the left is for microphone 3. The controls for these microphones are identical with those for microphone 1.

In the column at the right end of the panel is placed the over-all volume controls. The meter at the right is the volume indicator meter and has a full scale deflection of 1 milliampere (Weston, model 301). Below this are two push-buttons which permit the reading of the plate current of tubes 2, 3 and 4, on the same meter that indicates the microphone current. Next is the zero adjustment potentiometer (Yaxley, type 200) of the volume indicator



Complete schematic diagram of the mixer and line amplifier, described in the accompanying article.

meter and below this a switch which permits the adjustment of the volume in three steps: low, medium and high. The control at the bottom of the column is a continuously variable gain control and permits the selection of any level between the steps afforded by the step volume switch.

Circuit Arrangement

The push-button switches used are double pole, double throw switches which have no "open" position, and thus are normally thrown to one of the two possible positions. Upon pushing the button, the blades are immediately connected to the other set of jaws. In the case of the filament voltmeter switches, the buttons are used as double pole, single throw switches, as indicated on the circuit diagram directly under the 0.8 voltmeter. The microphone current buttons are, however, connected to operate as double pole, double throw switches and are shown in the circuit diagram at the extreme left under the 0-50 milliampere meter. These switches are connected so that when the button is in its normal position, the microphone circuit is complete and current flows as usual. When the button is depressed the meter is put in series with one of the microphone buttons and reads the value of the current flowing in this button. The normal or closed position of these buttons, as shown on the circuit diagram, would be with the blades thrown to the left.

Starting at the left of the circuit diagram, first are the terminals for the microphones 1, 2 and 3. Each microphone has three terminals, the one marked G being the common connection to the two buttons. The 6-volt A battery supplies the microphone current and this current is adjusted to the proper value by the 200-ohm potentiometer associated with each microphone.

In this particular amplifier the microphones are connected to the primary of Mike-to-Line transformers (Samson), although it would probably be more correct to use Mike-to-Mixer transformers in this position. The secondaries of these transformers are shunted by 600-ohm potentiometers which are used to regulate the volume level of each individual microphone. If Mike-to-Mixer transformers were to be used in this position, the volume control potentiometers would be of 200-ohm size. The switches which permit the selection of the various microphones are connected in this circuit, commonly called the mixer, and it is thus seen that they break only the audio output of the individual microphones and not that part of the microphone circuit that is carrying direct current. This arrangement is obviously necessary since a microphone would be quickly ruined, because of the arcing between the carbon particles, if the direct current were to be suddenly applied and broken each time it was desired to connect in and remove a microphone from the circuit. The individual volume controls on each microphone circuit permit the mixing of the microphone outputs in any manner desired when more than one microphone is being used simultaneously or if one microphone is being used for the program pick-up and another for the announcing the volume controls can be so set that the volume level of the program and the announcer is whatever is required for proper operation . . . . and when switching from one to the other of the microphones, the over-all gain of the amplifier would not have to be adjusted each time the change is made.

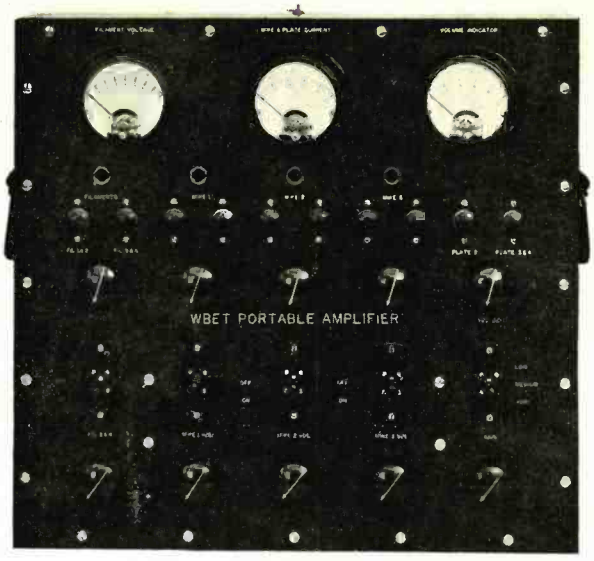


Fig. 1. Front panel view of the pick-up amplifier. The meters, from left to right are: filament voltmeter, mike and plate current milliammeter and volume indicator milliammeter. The latter is connected in the plate circuit of the volume indicator tube (6).

The mixer circuit is connected to the input of the amplifier through a Line-to-Tube transformer (Samson) which has a 100,000-ohm volume control (Frost, type 1895) across its secondary to give an overall continuous variation of the audio-frequency input to the amplifier. If Mike-to-Mixer transformers had been used instead of the Mike-to-Line transformers, then a Microphone Input transformer would have been used in this position.

The first stage of amplification is ordinary transformer coupled and utilizes a UX-112-A tube (No. 1). The plate circuit of this tube is provided with a 175-henry plate impedance (Samson, type P) and a 4-mf. by-pass condenser (Tobe, type 304) in order to permit the audio-frequency currents to return to the filament without passing through the B battery. Since a common B battery is used for all tubes this precaution greatly reduces the tendancy for feedback and self-oscillation of the amplifiers.

The second stage also employs a UX-112-A (No. 2) and is coupled to the first through a high quality transformer (Samson, Symphonic) across whose secondary is arranged two fixed resistors which are associated with the gain control switch and provides a step control of the volume in conjunction with the continuously variable volume control across the first stage. When this gain switch is set at "Low" the transformer secondary is shunted by the 5,000-ohm resistor (Tobe, 5 watt Veritas) in parallel with a 25,000-ohm resistor (Tobe, 5 watt Veritas). For the medium volume position, the secondary is shunted merely by the 25,000-ohm resistor and when set on the "High" position there is no shunting resistance across the transformer. The plate circuit of this stage is also provided with a plate impedance and a by-pass condenser.

The input to the monitor amplifier tube No. 5 is connected in parallel with the second amplifier tube and is used to provide an audio output for a pair of monitor telephones in order that the operator may have an aural indication of the quality and volume of the pick-up. The telephones being connected in the output of a tube which is entirely separate from the amplifier proper, the use of these telephones does not in any way impair the frequency-response characteristic of the amplifier. This tube is also a UX-112-A.

The third stage of amplification is push-pull transformer coupled (Samson, type Y) and employs Western Electric 104-D tubes or UX-171-A tubes. There is no plate impedance and by-pass condenser in the plate circuit of this stage, inasmuch as there is no audio frequency of fundamental frequency in the plate supply lead if the tubes are properly balanced. The output of this stage is connected to a Tube-to-Line transformer (Samson) in order that the output may be fed directly into the line connecting the pick-up point to the station.

In the plate circuit of the second and third stage, there are push-button switches which permit the reading of the plate current of these tubes in order to check the operation of the amplifier when in use. These switches are similar to those used to measure the microphone currents and are shown in the circuit diagram just to the left of the terminals marked 3rd AF B plus and 2nd AF B plus.

The grid of the volume indicator tube No. 6, a UX-240, is connected to the plate of one of the third stage tubes through a 0.1 mf. condenser (Tobe, type 310). Grid bias is supplied this tube through a 0.1 megohm grid leak. The C bias of the volume indicator tube may be varied over a range of five volts by adjustment of the 200-ohm potentiometer (Yaxley type) which is connected across the filament of the tube. By proper adjustment of this bias, the volume indicator meter may be made to give a good deflection for any particular volume level that is being used. Normally the bias of the tube is adjusted to give a

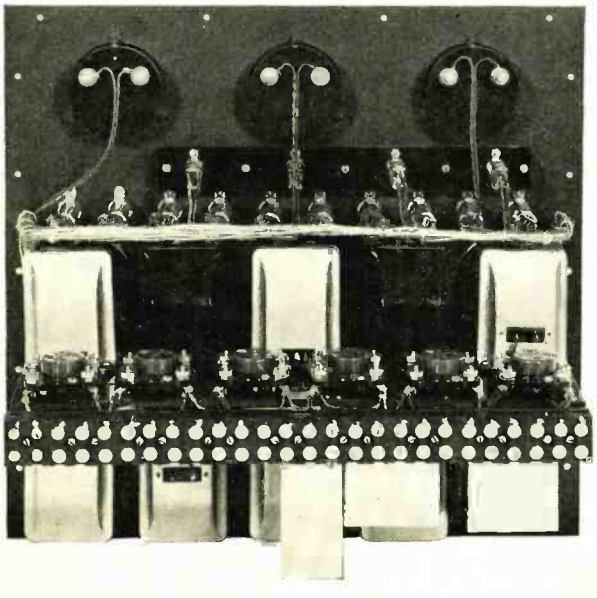


Fig. 2. Rear panel view of the pick-up amplifier, showing the resistor bank, the tube sockets, the connector strip and the special transformers and impedances. Note the bunched leads.

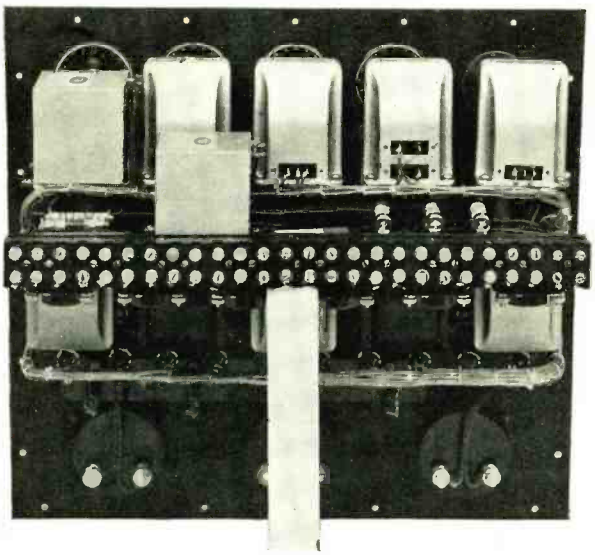


Fig. 3. Another rear view of the pick-up amplifier, which brings partially to view the microphone volume controls and the gain control. Directly in front of these controls are the Mike-to-Tube and Mike-to-Line transformers.

deflection of about 0.05 milliampere when there is no audio frequency being amplified. This arrangement for adjustable C bias necessitates the use of a separate C battery for the volume indicator tube as shown in the circuit diagram.

Construction Details

Fig. 2 shows the interior of the amplifier looking down on the bakelite shelf that carries the tube sockets and a row of transformers and impedances. In this photograph can also be seen the pilot lamps and the push-button switches.

The transformer at the extreme left of the shelf is the one that couples the first stage to the second (Marked SYMP. on the circuit diagram). The next one, in a black case of the plate impedance (Type P) for the first amplifier tube. The transformer mounted in the center is the push-pull input transformer (Type Y); next is the plate impedance (Type P) for the second stage and on the extreme right is the Tube-to-Line output transformer. Behind this row of transformers, but not visible in the photograph, are various potentiometers and rheostats.

The sockets (Benjamin) from left to right are, first stage, No. 1; monitor amplifier, No. 5; volume indicator, No. 6; second stage, No. 2; third stage, No. 3 and No. 4.

Just behind the shelf is mounted a strip of bakelite which carries 8 three-terminal connector blocks (Western Electric, type 12-C) and one two-terminal block (Western Electric, type 11-A) which provides 26 terminals for connection of batteries, microphones, monitor phones and the outgoing line. This strip is so mounted that it passes through a slot cut in the back of the cabinet and is flush with the back of the cabinet when the amplifier is mounted in place. This provides easy accessibility to the terminals from the back and does not necessitate making any connections inside the cabinet.

The shelf is mounted directly over the toggle switches (which cannot be seen in the photograph) and is supported by brass brackets attached to the front panel. The terminal strip, being also fastened to this shelf, when in place in the slotted cabinet provides a support for the back of the shelf.

Under the toggle switches and attached to the heavy frame of the switch is mounted another bakelite panel just wide enough to support another row of transformers. This is more clearly shown in Fig. 3 which is a photograph looking up at the under side of the lower shelf. The transformers from left to right are, Line-to-Tube input transformer, Mike-to-Line transformer No. 3, Mike-to-Line transformer No. 2, Mike-to-Line transformer No. 1, beside which is one of the 4 mf. condensers and behind which is the other. The fixed resistors for the secondary of the type Y transformer and the volume indicator grid leak are seen in front of the microphone transformer No. 3. Behind the transformers is just visible the lower row of potentiometers and rheostats.

The cabinet is constructed of ¾-inch wood and provides a very substantial housing for the amplifier. The upper half of the back of the cabinet is arranged to swing out in order that the tubes may be placed in the sockets. Handles are provided on the sides of the cabinet to facilitate portage of the amplifier. The panel size is 15 x 16 inches and the cabinet depth 8 inches.

The apparatus was wired with a cotton covered, parafined, enamelled wire. All leads carrying audio-frequency currents were run in copper braid and this shielding connected to ground. This effectively prevented audio-frequency feedback, although all the leads are bunched and tied in place, as is shown in the photographs.

Book Review

R.M.A. BETTER RADIO RECEPTION MANUAL—*Published by the Radio Manufacturers Association, 32 West Randolph St., Chicago, Ill. Price 25 cents.*

One of the major problems facing the radio trade is the elimination of the "man made static" which causes so much unnecessary interference with radio reception. These extraneous noises in the radio receiver are controllable and can be eliminated. How to do it is explained fully in the latest edition of the "R.M.A. Better Radio Reception Manual" which has just been published by the Engineering Division of the Radio Manufacturers Association.

The first edition of this important booklet was published by the Radio Manufacturers Association in 1927 and created a nationwide sensation through its disclosure of many methods of making radio reception more enjoyable for the public through the control of noises filtering into the receiver from outside sources. The latest edition of the Interference Manual is not a revised edition; it is a complete new work which tells in detail just how to locate and eradicate "man made static."

Radio retailers will find the Manual of incalculable value in impressing their customers with the fact that the radio industry is leaving no stone unturned to make radio reception as clear and enjoyable as is humanly possible.

The new Manual gives detailed information as to the various types of electrical appliances which are liable to cause interference, how the cause of the noise can be located, and, finally, how the noises can be eliminated through the installation of various types of filters.

The booklet contains over a dozen wiring diagrams, covering every major type of static producer and is the only information of its kind ever available in one book.

TELEVISION—*By H. Hoeton Sheldon, Ph.D. and E. N. Griswood, M.A. 194 pages. Illustrated. 5½ x 8½ inches. Stiff buckram binding. Published by D. Van Nostrand Co., New York City. Price, $2.75.*

With the celerity that the art of television is progressing at the present time, one is prone to wonder if there should not be some revisions made in a book on the subject no matter how recently published. In the present instance, however, the authors have given readers something more than a mere description of the latest systems of television—and this is why the book is of interest.

The average engineer and experimenter has most likely more or less of a vague idea about the historical background of television. He perhaps will say, "Why on earth should I browse around those old birds and see what they did?" "I want something new." Certainly he wants "something new" but why not profit by somebody's knowledge and mistakes? Then again some of the experimenters of the Mauve Decade had some good ideas wandering about and could not get them to operate because of the scarcity or crudeness of the tools with which they had to work. An excellent example of this is the remarkable development of the cathode ray tube by Dr. Coolidge of the General Electric Co., who, with the crude tube of Lenard as a starting point, fashioned a generator of cathode rays of almost unbelievable power. Dr. Coolidge achieved this by applying modern methods to an old experimenter's idea.

If present-day experimenters are to have a real engineering background, they should have an idea of what their colleagues of the past have done. They should be familiar with the work and apparatus of Balit, Korn, Leishman, Ruhmer and others. Who knows but that the pages of history might be pregnant with the germ of an idea that will mean the solving of some hitherto unanswerable question.

More and more experimenters today are turning to television to supply that problem for something new with which to work—and it makes little difference whether the worker have a million-dollar laboratory ar his disposal or merely a table in the attic—great things have been born in both places. Television has untold possibilities for fine work and in order to get real pleasure from it, we deem it necessary to know *why* the resistance of a photoelectric cell changes the intensity of light; *why* the glow of a neon tube surrounds the plate; *why* quartz lenses are preferable and so on, ad infinitum.

Then there are the television systems of Jenkins, Baird, Alexanderson and the others. These should be studied, compared and experimented with. It is possible today with comparatively simple apparatus to do all this, but first it is necessary to ascertain what it is all about. For the inquiring mind we recommend *Television*, because in non-technical language there are set forth the theory of the different parts of the television transmitter and receiver, the four modern systems of television and excellent information on lenses, mirrors, relays electromagnetic waves, light and other tools of the television experimenter.

FEDERATED RADIO TRADE ASSOCIATION CONVENTION

THE Convention held by the Federated Radio Trade Association in conjunction with the Radio Manufacturers Association Trade Show and Convention marked the turning point in the history of the Federated movements. At this time the Association reverted to its original form and became a national association of associations. Through this method, every local and territorial radio trade association or group whose purpose is the development of the radio industry and the betterment of conditions within it are eligible for membership.

The dues for local association are $25 per year which allows two delegates with their alternates. For every additional $25 paid into the Federated treasury, two additional delegates are allowed. In this way prominent local associations qualified, and able to carry on additional financial burdens, can register a large number of their members with the Federated and in turn for the increased dues can receive increased representation in the Convention through additional delegates.

The Radio Wholesalers Association is affiliated with the Federated as well as a national association of retailers and a national organization of manufacturers representatives.

Under the able leadership of Michael Ert, of Milwaukee, the Federated has grown greatly during the last few months and through the interest evoked by the retailers and the publishing of a booklet on "How to Organize a Local Radio Trade Association," there has been created over 65 local associations throughout the country. The Federated now has approximately 30 associations affiliated with its group.

One open meeting was held during the week by the Association which took place on Wednesday, June 5. At this meeting the heads of the retailers association, manufacturers representatives association and the Radio Wholesalers Association presented ideas and accomplishments of their group during the past year. Mr. D. E. Replogle, Chairman of the Radio Manufacturers Association Television Committee presented a very complete talk on the subject of television, outlining the great amount of work that was being done at the present time and that an enormous amount of research was being presented on this important subject by every prominent manufacturer. Mr. Replogle outlined the history of Television and the place it has already assumed in the eyes of the experimentors. He stated that Television was to become a very definite reality within a short period of time but that at the present time Television receivers were not in a commercial marketable stage that would give satisfaction to every owner.

The Hon. Frank D. Scott, of Washington, D. C., presented a very constructive talk on legislative problems. Mr. Scott stressed the importance and necessity for every radio tradesman that they watch all bills pertaining to Radio in their local legislatures, emphasizing this point by stating that one city in the south was now passing an ordinance that required radio sets to pass the fire underwriters approval and that only four makes of sets were at present allowed to be sold. He also cited the instance of several other cities about to levy a tax or license for owning a radio set which would greatly hamper radio sales. During the next few weeks, there will be built up a legislative committee composed of members of the entire industry. The Radio Manufacturers Association will furnish a field man to contact everywhere on local legislative problems and he will cooperate with every local association and tradesman in an effort to watch impending disastrous laws. In this way, a huge committee of prominent radio tradesmen would be watching legislation throughout the industry and helping it to guard against any disastrous measures.

The open meeting of the Federated was well attended and every one was pleased with the interest shown in the meeting.

On the following day, Thursday, June 6, the Radio Retailers Association held a splendid meeting at which time interest in local association activities was the chief subject for discussion. The radio retailers spoke of the necessity for watching dealer costs and urged the necessity of every radio retailer cooperating with his fellow merchant in order to make cleaner conditions in the city. President Henry M. Steussy, of Milwaukee, presided at this meeting.

John M. Redell held an open meeting of manufacturers representatives at which time ethics concerning the position of the manufacturers representatives in the radio field was discussed. Quite great interest was shown in this meeting by attending manufacturers representatives.

THE RADIO WHOLESALERS ASSOCIATION

THE Radio Wholesalers Association held a very successful closed membership meeting on Thursday, June 6, at the Stevens Hotel. Only members were admitted to this meeting. Various committee reports such as the Insurance Committee, Dealer Relations Committee and others were presented and discussed.

Martin J. Wolf, Chairman of the Tube Committee made a very comprehensive report on the tube situation and the results of a series of questionnaires which the executive offices have compiled.

President Peter Sampson outlined the activities of the Association for the coming year and the necessity for further cooperative action.

Many new members were taken in at this meeting and it was agreed that the Association is making the strides which are so necessary for every functioning group.

The association is working on fundamental activities that will help the individual wholesaler. In the future, committees working under the RWA will be organized in three groups. The first called that of Trade Relations, the second that of Market Survey and the third, Better Selling. In this way every committee will be able to closer analyze the situation with which they are dealing and will be able to make recommendations for the members that will be far reaching and of great importance. The Radio Wholesalers Association is a serious organization. Their purposes and aims are such as to justify membership of every legitimate wholesaler.

The Harper Research Laboratories of 500 Diversey Blvd., Chicago, Ill., were appointed as the official testing laboratory for the Association. Any wholesaler having work done by this laboratory will pay for the test individually but the findings of the investigation becomes the property of the RWA and will be filed in the executive offices. They will be available to members at a small charge and each new test conducted for any member will be immediately bulletined to the balance of the members so that they might take full advantage of the test.

The wholesalers meeting was well attended by members from coast to coast, showing the interest in this national organization which has grown so rapidly during the past year.

MIDWEST HOLDS ANNUAL ELECTION OF OFFICERS

THE Midwest Radio Trades Association recently held its annual election of officers at the Electric Club, 30 N. Dearborn Street, Chicago. It was one of the most successful meetings the association has ever held and the retiring President, Mr. H. E. Richardson was extended a vote of thanks for his wonderful activities in behalf of the Association, and was elected to serve as Chairman of the Board of Directors.

Mr. Harry Alter of the Harry Alter Co., 340 N. Dearborn St., Chicago, was elected President by a unanimous ballot. Mr. Alter undertakes his official duties immediately and plans an active campaign for the betterment of the radio industry within the Chicago and Metropolitan areas. He states that the Examination and Registry of Servicemen which is to provide the public with thoroughly experienced and technically qualified servicemen to cure their "radio ills" is progressing very rapidly, and within a short time local merchants will have registered men at the disposal of their customers.

Mr. Alter is well qualified in association affairs, having been one of the officers and directors of the national association in the radio industry, the Federated Radio Trade Association, as well as the Radio Wholesalers Association. It is believed that under his dynamic leadership the organization will assume its rightful place as one of the leading associations in the country.

The other officers and directors are:

Mr. Walter Pierce, Pierce Radio, Evanston, 1st Vice-President.
Mr. Ray York, Radio Vision Stores, Inc., 2nd Vice-President.
Mr. Ed. Williams, Elmhurst Majestic Co., 3rd Vice-President.
Mr. John M. Redell, Sonatron Tube Co., Secretary.
Mr. A. E. Simon, Diamond Elec. Spec. Corp., Treasurer.
Mr. J. A. Schwartz, Crystal Palace of Music.
Mr. G. M. Heinze, Heinze's Music Shop.
Mr. Leonard Cohn, Atlas Radio Stores.
Mr. E. T. Walsh, Radio Vision Stores, Inc.
Mr. Martin J. Wolf, Elec. Appliance Co.
Mr. Chas. Himmel, Hudson-Ross, Inc.
Mr. Richard Baskind, Manor Radio Co.
Mr. Allan Forbes, Triangle Elec. Co.
Mr. L. T. Johnson, Kimberly Radio Corp.
Mr. E. J. Brennan, Kellogg Switchboard & Sup. Co..
Mr. Harry Simmons, Sears Roebuck & Co.
Mr. Bert Ford, Manor Radio Shoppe.

U. S. CIVIL SERVICE EXAMINATIONS

The United States Civil Service Commission announces the following open competitive examinations:

Senior Radio Engineer.
Radio Engineer.
Associate Radio Engineer.
Assistant Radio Engineer.

Applications for senior radio engineer, radio engineer, associate and assistant radio engineer must be on file with the Civil Service Commission at Washington, D. C., not later than July 17.

The examinations are to fill vacancies occuring in the Departmental Service and in the field.

The entrance salaries are $4,600 a year for senior radio engineer; $3,800 a year for radio engineer; $3,200 a year for the associate grade, and $2,600 a year for the assistant grade. Higher-salaried positions are filled through promotion.

Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience and fitness.

Full information may be obtained from the United States Civil Service Commission at Washington, D. C., or from the Secretary of the United States Civil Service Board of Examiners at the post office or custom house in any city.

BUNNELL EXTENDS INTERESTS

J. H. Bunnell & Company, Inc., 32 Park Place, New York City, has purchased the recording equipment business for telegraph and submarine cable service, formerly owned by A. A. Clokey Company, Rutherford, N. J. This includes the Single, Double and Multiple Pen Direct Writing Recorders, and also the Motor Driven Tape Pullers and Tape Reels.

These instruments are in general use by the telegraph and cable companies throughout the world, and will tend to round out more broadly the lines of telegraph, pre-

cision and mechanical instruments manufactured by J. H. Bunnell & Company.

The Direct Writers and Tape Pullers will be manufactured at the new Bunnell plant in Brooklyn, N. Y.

H. J. WARPE AND ASSOCIATES PURCHASE TRAV-LER CORP.

Rumors of a change in the ownership and management of the Trav-Ler Mfg. Corp., Chicago, Ill., which have been circulated in radio trade circles since early this year, were definitely verified here this past week when it was revealed that Harold J. Wrape and a number of his business associates in the Benwood-Linze Company of this city purchased outright the entire interests of the former stockholders of the company.

New officers of the company are Mr. Wrape, president; C. Hambuechen, vice-president, and C. R. Ogle, secretary and treasurer. W. A. Butler, formerly merchandise manager of the Benwood-Linze Company, is general sales manager for the Trav-Ler Mfg. Corp.

Mr. Wrape and his associates purchased a controlling interest in the company last December and since that time have carried out a program of reorganization and expansion in the company's manufacturing and sales facilities. At the same time, development and research work on a new portable receiver chassis was started. According to Mr. Wrape, the new line of Trav-Ler portable receivers will be started in production this month.

GILBY EXPANDS PLANT SPACE

The great activity in the radio industry has necessitated the addition of two new units, at a cost of $100,000 to the plant of The Gilby Wire Co., at 150 Riverside Ave., Newark, N. J., William B. Driver, president of the company, announces. The company manufactures wire and tubing for the radio trade.

Contract for the design and construction of the new units has been awarded The Austin Co. of Cleveland. Construction is under way and the additions are to be ready for occupancy in August. The units are 90 by 160 feet and 50 by 28 feet, of one-story, steel-frame construction. Forty tons of steel will be required.

EISLER CO. CHANGES NAME

Owing to the tremendous growth and large expansion program in view, the Eisler Engineering Company, Inc., has become a public stock issue, and therefore has changed its name. It will be known in the future as the Eisler Electric Corporation.

The management of this new organization will remain intact, as in the past under the personal supervision of Mr. Charles Eisler.

ZETKA NOW RADIO UTILITIES CORP.

Coincident with the change in name of Zetka Laboratories, Inc., to Radio Utilities Corporation there is also announced a change in policy. The corporation is discontinuing the "ordinary" type of radio tubes and is concentrating its entire efforts on the production of power and rectifier tubes built up to a standard of excellence.

The following types of tubes so far have been perfected and are ready for public distribution: type 280 and 281 rectifiers and type 210 and 250 amplifiers.

The corporation is expecting to produce the 224 and the 245 very shortly.

PILOT ALTERS NAME

The name of the Pilot Electric Manufacturing Company has been changed to the Pilot Radio & Tube Corporation. The organization will continue to function as before, no changes in either management or policy being contemplated.

The officers of the corporation are Isidor Goldberg, president; Henri Sadacca, vice-president, and James I. Benjamin, secretary and treasurer.

"MAJESTIC" FACTORIES IN ENGLAND

Plans are under way for the organizing of a Company in England which will acquire exclusive rights for the manufacture and sale of radio sets under the trade mark "Majestic" in the Continents of Europe, Asia, and Africa. The Grigsby-Grunow Company will receive approximately one-half of the issued share capital in consideration of the granting of its trade mark "Majestic" and patent rights in that territory and a working arrangement between the two companies. The ramaining half of the capital to be issued will be offered for subscription on the London market to provide the necessary working capital. It is considered possible that the shares of the English company will also be traded in upon the New York Curb Market.

Members of the active management of the American company will be represented on the Board of the English company.

Conditions are considered excellent for the entry of the Majestic Set into the British market at this time. It is believed that the entire plan will be consummated in about six weeks, at which time further details will be issued.

"VISION TONE"—A NEW ARRIVAL

Of interest to radio dealers in the southwest comes the announcement that a corporation has been formed under the name Vision Tone Sales Company, of Texas, with headquarters at Dallas, Texas, exclusive distributors of the Vision Tone, a new combination radio, phonograph and motion picture machine with the added feature of records and films synchronized to create talking pictures in the home.

This new corporation is keyed to a sales volume of a hundred million dollars over a period of five years.

The sales volume is based on the population of Texas and Oklahoma with a per capita demand of 1 per cent. with an established radio demand of 10% the estimated total volume of $100,000,000 is conservative, for this is something new in radio and is destined to become immensely popular.

The Vision Tone will retail at $369.50 with dealers discounts more liberal than any so far offered the trade it is claimed. In addition to the profits on the Vision Tone itself the dealer will be offered a franchise for the rental of films and records. This new departure will prove most attractive to the dealers for they will net 80% of all rentals. Films with synchronized records will be rented at 10 cents a night on the circulating library plan.

A gigantic advertising campaign will be released just prior to the shipments and it is said this will be followed up with one of the most aggressive advertising efforts in the history of radio.

MARVIN ORGANIZATION ANNOUNCES TUBE PRODUCTION PLANS

A consolidation of seven independent tube manufacturers has given birth to a new and powerful factor in the radio industry under the name of the Marvin Radio Tube Corporation of Irvington, N. J., and Chicago, Ill., with sales office at 225 Broadway, New York City.

The officers of the new corporation are as follows: Chairman of the Board, P. D. Jackson; President, Thomas F. James; First Vice-President, William J. Bennert; Second Vice-President, Stephen F. Dunn; Treasurer, William F. Tait; Secretary, Harold T. Wakefield; Assistant Secretary, Raymond Pitchell; and General Sales Manager, F. A. LaHaw.

The Marvin Radio Tube Corporation will operate production plants at Irvington, N. J., and Chicago, Ill. The former plant has some 30,000 square feet of floor space, with additional space in view as the production demands increase. The Chicago plant will serve mainly for Western sales, and will serve also as a distributing point quite in addition to some fifteen F. O. B. points to be maintained throughout the country.

The organization, with a present production of 25,000 tubes per day, from the Irvington plant alone, plans to produce high grade tubes of every type, representing the best engineering technique and production skill. Typical of this program are the present Marvin MY224 and MY227 a-c. heater tubes. A large engineering staff is at work on new types of tubes, following the refining of the present standard types.

FRESHMAN TO ENTER COMMUNICATIONS BUSINESS

The Chas. Freshman Co., Inc., through its Freed-Eisemann Radio Corp. division plans to enter the communications field as soon as their Allwood, N. J. plant approaches capacity operation, according to Joseph D. R. Freed, President of the division.

Mr. Joseph D. R. Freed appeared before the Federal Radio Commission on May 22nd in behalf of the Inter-City Radio Telegraph Company of Cleveland advising the commission that both the C. A. Earl and the Freed divisions of the Chas. Freshman Co., Inc., stood ready to manufacture all the equipment, both receiving and broadcasting, necessary for the trans-continental communication work which the allocation of the channels requested by the Inter-City Company would require.

Mr. Freed's testimony at the commission meeting was to the effect that not only were the entire manufacturing resources of both organizations at the command of the Inter-City Company but that the entire experimental and research departments were also being placed at its command. This, Mr. Freed pointed out, placed the Inter-City Radio Telegraph Company in a position to comply with any and all commands of the Federal Radio Commission and to compete on even terms with any other organization requesting channels.

HYVAC TUBE CO. IN PRODUCTION

Comprising an amalgamation of several of the smaller radio tube manufacturing plants in the Newark, N. J., territory, the Hyvac Radio Tube Co., Inc., is now in production on its "super-vacuum" tube as well as a complete line.

The Hyvac Radio Tube Co. was incorporated in 1926 and was reorganized and refinanced by Gustav Binder, for three years sales manager of the Gold Seal Electrical Co., and George D. Duff, both of whom have had long and sound experience in the manufacture of radio tubes.

The company is specializing in the 245 and the new 224 screen-grid tube, in both of which a super-vacuum is obtained by a particularly efficient method of exhaust, using a separate Hyvac pump and mercury aspirator on each tube. This method of exhaust is expensive as regards the necessary outlay for experimental machinery, but, as designed by the Hyvac Company, is ideal for these types of tubes.

Production of the 245 and 224 tubes alone will soon run over 5,000 a day it is claimed.

Offices of the Hyvac Radio Tube Co., Inc., are located at the factory, 38 Spring Street, Newark, N. J.

EVEREADY-RAYTHEON TUBE DIVISION

Harry S. Schott, general sales manager of the National Carbon Company, has announced a new division of the general sales department to be known as the radio tube division. This department will have full charge of the merchandising of Eveready-Raytheon Tubes.

In making the announcement Mr. Schott also announced the appointment of Fred D. Williams, who has been vice-president of the Raytheon Manufacturing Company, as manager of the new division.

ZENITH AND WELLS-GARDNER SELECT OXFORD DYNAMIC SPEAKER

The Zenith Radio Corporation has placed a large order with the Oxford Radio Corporation of Chicago which it is understood will be the only Chicago factory to build the Zenith True-Dynamic Speaker for use on the Zenith 15th Anniversary radio sets this season.

The Wells-Gardner Radio Company of Chicago have entered into an exclusive contract whereby the Oxford Radio Corporation will build all the dynamic speakers to be used with the Wells-Gardner sets this season.

These speakers will be built under the patents of Frank Reichmann and the Lektophone Corporation.

REDUCTIONS IN TUBE PRICES

Radio-Victor Corp.

Reductions in the list prices of seven Radiotrons have been announced by the Radio-Victor Corporation of America. Effective June 12; UY-227 is reduced from $3.00 to $2.50, UX-226 is reduced from $2.00 to $1.75, UX-222 is reduced from $6.50 to $4.50, UX-280 is reduced from $3.50 to $3.00, UX-112-A is reduced from $2.50 to $2.25, UX-201-A is reduced from $1.40 to $1.25, and UX-171-A is reduced from $2.50 to $2.25.

In a communication to its distributors making known the price reductions on seven types of Radiotrons, the Radio-Victor Corporation of America announced a suggested increase in the resale discount on Radiotrons to 40 per cent. for dealers.

In making the announcement, Meade Brunet, vice-president in charge of Radio-

tron sales, said, "Carrying out its announced plans for a greatly expanded program of Radiotron production, the Radio-Victor Corporation of America is pleased to pass on factory economies made possible through increased public consumption and the use of improved tube manufacturing processes, not only to the set owner, but also to the trade."

Sonatron Tube Co.

The Sonatron Tube Company announces price reductions on the following tubes: 112A, 171A, 201A, 226, 222 D. C., 227, and 280. These reductions range from fifteen cents on the 201A tube to as much as $2.00 on the 222 D. C.

The new prices are as follows:

Type 112A, $2.25; type 171A, $2.25; type 201A, $1.25; type 226, $1.75; type 222 D. C., $4.50; type 227, $2.50; type 280, $3.00.

"This price reduction is in general line with our plans for producing quality tubes at as low prices as are consistently possible," said Harry Chirelstein, president of the company, in making the announcement.

De Forest Radio Co.

A reduction in the list prices of DeForest Audions, matching those of other large producers of vacuum tubes, has just been announced by Harry C. Holmes, general sales manager of the DeForest Radio Company of Jersey City, N. J.

"Without sacrificing in the slightest degree any feature of our production methods and rigid inspections and tests, but rather with the motive of passing along to the consumer a fair share of the benefits now being derived from vastly increased production facilities in our plants at Jersey City and Passaic, we have decided to reduce the list prices on all DeForest Audions with the exception of the 401-A general purpose battery type tubes, which still lists at $2.00. This Audion, while carrying the well-known -01-A designation, is really a totally different type of tube, with exceptional operating characteristics and long life, placing it in a class by itself.

Arcturus Radio Tube Co.

Concurrent with going into production in their new Newark plant, the Arcturus Radio Tube Company announces a reduction on their 071, 126, 127 and 180 tubes to respective prices of $2.25, $1.75, $2.50 and $3.00.

It is explained by engineers of the company that the greatly increased facilities of the new plant, with new economies and efficiency in manufacturing methods, makes possible this reduction in retail price.

The price cut does not affect the new seven second type 124 screen-grid nor the 145 power tubes.

VAN HORNE TUBE CO. EXPANDS

The Van Horne Tube Company of Franklin, Ohio, one of the oldest in the business, has emerged from an expansion program that was accomplished under cover of the utmost secrecy. In addition to announcing the purchase of another large factory, the biggest in the city of Franklin, it is known that this company, within the next month, will be working day and night to make deliveries on business already on the books. The president of the newly organized Van Horne Tube Company is David M. Kasson, who is directly in charge of sales and merchandising. John S. Van Horne, one of the best known scientists in the vacuum tube industry and holder of many basic patents now applied in the radio tube and electric illumination field, is vice president of the new company in charge of production. No announcement of secretary or treasurer has been made, although it is understood that one of the outstanding attorneys of the country has already accepted this position.

FINANCIAL REPORTS

CeCo Manufacturing Co.

CECO MANUFACTURING CO., INC., reports for the fiscal year ended March 30, net income of $389,050 after all charges including depreciation and federal taxes, as compared with $135,236 in the previous fiscal year. Last year's earnings were equal to $6.26 a share on the average number of shares outstanding as compared with $2.25 a share on 60,000 shares in the year ended March 31, 1928.

In Feb., 1929, the capital stock of the CeCo Manufacturing Co., was increased through the issuance of stock rights from 60,000 shares to 72,500 shares.

The balance sheet as of March 30, 1929, shows total assets of $1,563,946 of which $1,027,101 were current. Current liabilities as of the same date were $248,333, leaving net working capital of $778,768.

Polymet Manufacturing Co.

N. C. Greene, vice-president of Polymet Manufacturing Corporation, announces that sales in May amounted to $318,300 compared with $36,475 in May of last year. This is a new high monthly sales record. Orders on hand amount to over two million dollars. The addition to the Coilton plant at Easton, Pa., will triple the output of the Coilton Division.

Grigsby-Grunow Co.

At a meeting of the Board of Directors of the Grigsby-Grunow Company, the regular quarterly dividend at the rate of $4.00 per share per annum was declared. The Company's fiscal year ended May 31, and total sales for the fiscal year were $49,275,990.97.

Operations have been begun in the new plants. Production is now proceeding on the scheduled basis of 4,400 sets per day, and the outlook in sales for the balance of the calendar year is extremely satisfactory.

The Potter Co.

The Potter Company for the fiscal year ended April 30, reports net earnings after all charges including depreciation and federal taxes of $163,524, equal to $3.07 a share on the 53,188 shares of common stock outstanding, as compared with $188,147 or $3.73 a share on the 50,388 shares outstanding at the end of the previous fiscal year. The balance sheet as of April 30, 1929 shows current assets of $238,165 and current liabilities of $51,540. Unfilled orders on hand were more than 6 times greater than on April 30, 1928. Over 30 per cent. of the company's products were sold for industrial uses outside of the radio field.

During the year the company acquired a substantial interest in a group of valuable patents. It immediately started development work on one of these patents. As a result it is offering the trade two new products. First, a new electrolytic condenser. Second, an entirely new type of loudspeaker.

Zenith Radio Corp.

Operations of the Zenith Radio Corporation in the fiscal year ended April 30 resulted in a net income of $1,109,602 after all charges including depreciation and federal taxes. These earnings are equal to $2.77 a share on the 400,000 shares no par capital stock outstanding. The fiscal year of Zenith Radio Corporation was changed in 1928 so that only earnings for the ten month period ended April 30, 1928 are available. These earnings were $727,995 or $1.81 a share on the present capitalization.

The balance sheet as of April 30, 1929 shows current assets of $2,332,958 and current liabilities of $853,199, as compared with $1,650,329 and $349,773 respectively, at the close of the previous year. Inventory is carried on the 1929 balance sheet at $1,380,673.

Temple Corp.

Substantial gain in the business of Temple Corporation was revealed to stockholders by Alfred Marchev, president, sales in the six weeks from May 1 to June 15, this year, amounting to $535,881. In the seven months period from Oct. 1, 1928 to Apr. 30, 1929, sales amounted to $536,170, or barely more than the recent six weeks figures.

At the same time, Mr. Marchev stated that the company is in unusually strong financial position, the balance sheet of April 30, last, showing current assets of $1,227,530 against current liabilities of $481,298.

With a present daily production of 400 sets it is expected that this figure will be increased to 1,500 radio units per day by the end of 1929, Mr. Marchev said. The company has shipping instructions for more than $2,000,000 worth of sets between now and Sept. 1 and with contracted bookings, more than $12,000,000 before the holidays.

Net earnings accruing to the new Temple Corporation for the seven months from Oct. 1, 1928 to Apr. 30, 1929 were $35,858. This amount will more than cover the dividend requirements during a non-productive period in which the Temple plant was being moved into its present new quarters.

The regular quarterly dividend of 45 cents a share on the convertible preference stock, payable July 15 to stockholders of record July 1, was declared.

All directors and officers were reelected.

APPOINTMENTS

Duovac Tube Corp.

The Arthur Rosenberg Co., Inc., of New York City has been appointed as advertising agent for the Duovac Radio Tube Corp., of Brooklyn, N. Y., manufacturers of Duovac Radio Tubes.

Marvin Corporation

The Marvin Radio Tube Corporation, with main offices at 225 Broadway, New York City, announces the appointment of several new district sales managers at this time, through F. A. LaBaw, general sales manager.

Paul C. Smalley has been appointed district sales manager for the New York and New Jersey Metropolitan area. Mr. Smalley has long been associated with the radio industry. Before coming to Marvin, he was New York sales manager for the Raytheon Manufacturing Company.

Jack Downey has been appointed sales manager for the Philadelphia territory, which includes all of the States of Pennsylvania, Maryland, Delaware and the District of Columbia. Mr. Downey formerly had charge of the same territory for Raytheon.

All of New York State, outside of the metropolitan area, and also all of the New England States, will be covered by Dan Betts, who formerly covered this territory for Amrad.

Leslie Lown, formerly of Chas. Freshman Co., has been appointed sales manager for the Michigan and Indiana territory.

District sales managers for the Southwest and the Southeast, as well as the Pacific Coast territories, are now being appointed, and will be announced shortly.

According to F. A. LaBaw, general sales manager, the Marvin organization will begin shipping its tubes from the Chicago and Irvington (N. J.) plants in June to the various F. O. B. points throughout the country, from which points the shipments will be made to the trade.

Charles Freshman Co.

Harry A. Beach, vice-president in charge of sales of the Charles Freshman Co., Inc., C. A. Earl Radio Division, announced that J. C. Cushman had been appointed Southeastern District sales manager for the C. A. Earl Radio Division. Mr. Cushman will have complete supervision over all the Southeastern Division, including Maryland, Washington, D. C., Delaware, Virginia, West Virginia, North and South Carolina, Florida, Alabama, Georgia and Tennessee. Mr. Cushman makes his headquarters in the District of Columbia and will have assisting him S. W. Schwobel in Georgia and H. A. Tibbs in Virginia.

General Electric Co.

George F. Mosher, auditor of disbursements, was elected assistant treasurer of the General Electric Company at a recent meeting of the board of directors of the company, it has been announced by R. S. Murray, treasurer. Following his graduation from Union Collge in 1918, Mr. Mosher entered the employ of the General Electric Company in 1919 in the accounting department. In 1925 he became assistant to the treasurer, and in October, 1927, was appointed auditor of disbursements.

Triad Manufacturing Co.

Mr. Ed. Levy, formerly connected with the Sonatron Tube Company, has been appointed district manager of the Triad Manufacturing Co., in charge of the New York office and sales, which territory will include Northern New Jersey.

He will have with him six salesmen who will call upon the retail dealers in connection with the jobbers.

Cable Radio Tube Corp.

The complete Speed tube district organization is the subject of the latest announcement by A. D. Strathy, director of sales of the Cable Radio Tube Corporation of 84-90 North Ninth Street, Brooklyn, N. Y. The appointments follow:

New York City and the merropolitan area: Martwel Sales Co., Inc., 1501 Broadway, New York City.

New York State (exclusive of the metropolitan area) and the State of Connecticut: Walter E. Daw, 122 Fifth Avenue, New York, N. Y.

Eastern Pennsylvania, from the western limits of Williamsport and Harrisburg; Maryland; New Jersey, exclusive of the New York metropolitan territory; Delaware; District of Columbia; Hawley & MacKenzie, Jefferson Building, Philadelphia, Pa.

Western Pennsylvania from the western limits of Williamsport and Harrisburg, and the State of West Virginia. George O. Tanner, 918 Anaheim Street, Pittsburgh, Pa.

State of Ohio: Charles H. Dolfuss, 3957 St. Clair Avenue, Cleveland, Ohio.

Virginia, North and South Carolina, and eastern Tennessee commencing at the eastern limits of Nashville: A. S. Foster, Inc., Columbia, South Carolina.

Georgia, Florida, Alabama, Mississippi, and Western Tennessee commencing at the eastern limits of Nashville, and city of New Orleans: McEwen Cherry Company, 621 Nashville Trust Building, Nashville, Tenn.

Kentucky and Indiana as far north as and including Indianapolis: L. W. Nutt, 821 Dayton Savings & Trust Bldg., Dayton, Ohio.

State of Michigan: S. C. Steinharter, 400 Home State Bank Building, Grand Rapids, Mich.

Southern Wisconsin below the line drawn from the Minnesota-Iowa border to the northern limits of Sheboygan, and northern Illinois above the line drawn from the southern limits of Quincy to the southern limits of Dansville: H. V. Scott & Company, 506 South Canal Street, Chicago, Ill.

North and South Dakota, Minneapolis and upper Wisconsin: J. E. Date, 818 Nicollet Avenue, Minneapolis, Minn.

The State of Iowa: Ralph H. Lesher, Iowa Falls, Iowa.

The State of Missouri and southern Illinois: Gardner Radio & Electric Corporation, 2728 Locust Street, St. Louis, Mo.

Nebraska, Kansas, Oklahoma: F. C. Somers Company, 115 East 66th Street Terrace, Kansas City, Mo.

Texas, Arkansas and Louisiana, exclusive of the city of New Orleans: Roy J. Hobbs, 318 North Windomere Street, Dallas, Texas.

Montana, Wyoming, Utah, Colorado and New Mexico: C. M. McIntosh Company, McClintock Building, Denver, Colorado.

Washington, Oregon, Idaho: Denham Sales Service, 904 E. Pike Street, Seattle, Washington.

Northern California and Nevada: Associated Agencies, 182-Tenth Street, Oakland, California.

Southern California and Arizona: Rosse M. Gilson, 133 W. Washington Street, Los Angeles, California.

The New England States, exclusive of the State of Connecticut, are being covered from the home office at Brooklyn.

Arcturus Radio Tube Co.

Worcester Bouck has resigned from The Equitable Trust Company of New York, where he served as an official for many years, to become a vice-president, treasurer, and a director of the Arcturus Radio Tube Co. of Newark. Mr. Bouck, who resides at Montclair, N. J., will make his headquarters in the general offices of the Arcturus Company at Newark and will have supervision over the company's financial affairs.

Pilot Radio & Tube Corp.

David Grimes, eminent radio inventor, has been appointed chief research engineer of the Pilot Radio & Tube Corporation, it was announced recently by Mr. I. Goldberg, president of the firm. He has taken charge of the main Pilot laboratory at 323 Berry St., Brooklyn, New York, where he will conduct investigations along a number of original lines of thought.

Westinghouse Electric & Mfg. Co.

At a directors' meeting in New York City on May 27, J. S. Tritle, in charge of manufacturing operations of the Westinghouse Electric & Manufacturing Company, was made a vice-president. A native of Nevada and a Yale graduate, Tritle has been an outstanding figure in the electrical industry since 1893.

In his new position, Mr. Tritle's headquarters will be at the Westinghouse Company's main plant in East Pittsburgh, Pa.

A. H. Grebe & Co., Inc.

In continuance of the Sales Department's policy of strengthening the distributing centers of the A. H. Grebe Company, the Richmond Hill, N. Y., manufacturers announce the appointment of Kelley, How, Thomson of Duluth, Minnesota, as distributors for additional territory in the middle west.

This company, one of the oldest Grebe distributors, takes over in addition to Minnesota and northern Wisconsin, the entire North and South Dakota territory with the eastern half of Montana. This expansion is made possible by increased manpower and the establishment of a branch office at Minneapolis.

George W. Wells, Jr., assistant sales manager, is head of the radio department and will concentrate on distribution among the retailers of the middle west.

They also announce the appointment of the Michigan Distributing Company as distributors for Michigan with Detroit as headquarters. This well known distributing outfit will also look after the Grebe interests in northeastern Ohio with Cleveland as the pivot point.

The distributing concern is headed by Harry J. Paul, pioneer radio man, who is familiar with the middle west market and the retail trade.

The Rola Co.

The Rola Company is pleased to announce the appointment of E. J. Kennedy, who will serve in the capacity of Manufacturers' Contact Engineer. Mr. Kennedy has had a very colorful experience in the radio business.

Early training in various prep schools in Canada.

Graduate of Toronto University.

Thorough shop experience, having taken four-year course in the shops of the General Electric Company, three years in the Engineering Department, General Electric Company, Schenectady, N. Y., and Pittsfield, Mass.

Two years, engineer in charge of the design of household and commercial electrical heating appliances for the Simplex Electric Heating Company, Boston, Mass.

Four years, engineering department of the Western Electric Company.

Chief Engineer for the Signal Electric Manufacturing Company at Menominee, Mich., during that company's early effort's in the radio field.

Chief Engineer for the Herbert H. Frost Corp., at Elkhart, Ind., and designer and originator of that organization's product in their early entry into the parts field in radio.

Acted in capacity of consulting engineer for various radio concerns in the Chicago territory.

During recent times, have carried forward important investigations and experiments in television, but not ready to disclose the nature of these developments.

The originator and inventor of new type tubes for future use in television and also synchronizing devices for use in the broad field of television.

Served in France during the World War as a commissioned officer in the chemical warfare branch of the Army, being stationed at Tours, in the inventions section, devoting time to the development and designing of gas shells and other equipment for that branch of the service.

Thomas A. Edison, Inc.

R. R. Karch, who has been associated with Thomas A. Edison, Inc., for the past eleven years, was recently appointed assistant to Mr. A. L. Walsh, vice president of Thomas A. Edison, Inc.

In his new position, Mr. Karch's major duties will be to correlate the Edison Jobbers' activities with those of the Edison factory, duties for which Mr. Karch is well fitted, through his former work as General Supervisor of the Edison Distributing Corporation, wholesale distributors of Edison Radios, Phonographs and Records.

Practically all of the fourteen branches of the Edison Distributing Corporation were established personally by Mr. Karch. From these fourteen branches, located in important trading centers, are now carried on this company's extensive wholesale business in Edison products. While supervising the activities at all fourteen branches of this large distributing organization, Mr. Karch traveled all parts of the country, and acquired through intimate contact, a thorough knowledge of the jobbing problems peculiar to each section.

Eby Manufacturing Co.

Robert C. DaCosta, who for the last twelve years has been in charge of the manufacture of coils and condensers at the Atwater Kent plant, is now the production manager of Atwater Kent's neighbor, in Philadelphia, The H. H. Eby Manufacturing Company, Inc., makers of binding posts, sockets and tip jacks.

Mr. DeCosta has a great many friends in the radio industry with which he has been connected for several years. Before going to Atwater Kent, he had headed the enamelled wire and windings department of John A. Roebling Sons for seven years, and been a member of the firm of the Doyle and DaCosta Manufacturing Co. of Easton, Pa., for two years.

Before that, he had seen service all over the United States as a telephone engineer for the Western Electric Co., the Kellogg Switchboard and Supply Co., and the Stromberg-Carlson Telephone Manufacturing Co.

Aero Products, Inc.

Lieut. Commander F. H. Schnell, U. S. Naval Reserves, for six years traffic manager of the American Radio Relay League and more recently with the Engineering and Research Laboratory of the Burgess Battery Co., has become general manager of Aero Products, Inc., of Chicago, specialists and manufacturers of short-wave radio equipment.

Commander Schnell is now working on some new developments in short-wave, which will shortly be announced from the Aero Products laboratories.

Commander Schnell's experience in short-wave radio development covers a wide range of activities. He arranged a series of trans-Atlantic tests for radio amateurs during which time American signals were first heard in Europe. Heard first English amateur to reach U. S. on 200 meters.

Federal Radio Corp.

Campbell & Penfield have completed arrangements with the Federal Radio Corporation of Buffalo, whereby they have become distributors in the Detroit area for Federal Ortho-sonic receiving sets. Colin Campbell, general manager of this young organization, has been for some time, with one of the largest radio distributing houses in Detroit. His associate, Paul Penfield, is a merchandising and advertising expert, having held managerial positions in these departments for leading automobile manufacturers of Detroit.

Establishment of the Superior Cabinet Corporation as distributor of Federal Ortho-sonic Radio in the Metropolitan area is considered by the Federal Radio Corporation as an important step toward offering to the Federal trade in that area, the best in service.

The Superior Cabinet Corporation has been operating a cabinet manufacturing plant in Brooklyn for a number of years, developing valuable dealer contacts that have resulted in its present enviable position as a radio wholesaler.

SYLVANIA SALES LABORATORY

A unique source of dealer protection has been instituted by the makers of Sylvania Radio Tubes in their new Sales Laboratory, just completed.

The Laboratory will render a twofold service distinctly of interest to distributors and retailers of Sylvania Tubes. It will supervise the conduct of a grent program of field tests as to radio reception and tube characteristics in various types of receivers. And its work within the factory will embrace testing and experimentation entirely independent of the extensive Engineering Department, and will include a wide variety of "breakdown" tests.

Operating in conjunction with the research division of the Sylvania Engineering Department, the new laboratory is expected to sponsor many departures and improvements, especially in the direction of lengthened tube life.

The department will be in charge of Walter R. Jones who, ever since the inception of the radio industry, has been a national figure, highly regarded for his engineering service work. Until recently he supervised research and radio development for the Federal Radio Corporation and has lectured extensively on the tendencies of radio construction.

The new department will have an auxiliary helpfulness for dealers and wholesalers not only with regard to tube characteristics but in the direction of assistance on radio technical problems in which tubes have an especially significant part. Correspondence in this direction by dealers and servicemen will at all times be welcomed by the new division in general and by Mr. Jones in particular.

LEWIS E. DORFMAN BROADENS ACTIVITIES

It is good news to the many friends of Mr. Lew Dorfman that he has been enabled through recent reorganizations of the Gold Seal Electrical Company to broaden his scope of activity.

Mr. Dorfman, who is General Sales Manager of the Electrical Division of the Gold Seal Company will be able to spend a certain portion of his time with the distributors of the well known Gold Seal radio tubes. Mr. Dorfman, former Western Sales Manager of the Chas. Freshman Company was one of the first men in the radio business and is pleasantly known from coast to coast.

RADIO SERVICE MANAGERS ASSOCIATION

LAST March a movement was started for the organization of an association of radio service managers and others in the New York Metropolitan area who are interested in improving radio service to the consumer. A great deal of enthusiasm was shown generally, and the first meeting was held on Monday evening, April 29th, with a very representative attendance of more than forty men. A temporary committee was elected to write by-laws for the conduct of the association—to be submitted at the next regular meeting—and to arrange the necessary details for that meeting. John S. Dunham, president of Q R V Radio Service, Inc., was made temporary chairman; and Howard T. Cervantes, service manager of Haynes-Griffin, Inc.; James E. Shannon, service manager of the Colonial Radio Corporation; C. P. Baldwin, service manager of The Aeolian Company; E. W. Boyce, general sales manager of R. H. McMann, Inc.; E. F. Donnelly, service manager of John Wanamaker, Inc.; D. Van Dyne, service manager of the N. Y. Talking Machine Company, Inc.; Donald Terwilliger, service manager of the Stewart-Warner Corporation; G. P. Marron, chief contact engineer of the Colonial Radio Corporation; J. F. B. Meachan, vice-president of Q R V Radio Service, Inc.; and J. Kahn, service manager of the Kolster Radio Corporation composed the remainder of the temporary committee.

In addition to the business and general discussion at the first meeting, Willis K. Wing, editor of *Radio Broadcast*, gave a very interesting short talk on what has been accomplished in Wisconsin by training, examining and classifying servicemen and service managers.

The second meeting of the Association was held at the offices of the Stewart-Warner Corporation, 37 West 65th Street—where the first meeting was held also—on Monday evening, May 27th. The by-laws worked out by the temporary committee were read, altered somewhat, and then voted on section by section. Permanent officers and directors were elected, general discussion was held, and an instructive talk on noise interference elimination was given by Arthur J. Lyons of the Tobe Deutschmann Co. The officers and directors for the ensuing year are: John S. Dunham, Q R V Radio Service, Inc., president; Howard T. Cervantes, Haynes-Griffin, Inc., vice-president; James E. Shannon, Colonial Radio Corporation, corresponding secretary; C. P. Baldwin, The Aeolian Company, recording secretary, and O. Ramberg, R. H. McMann, Inc., treasurer. The three additional directors provided for and elected are: Wm. W. Heller, Gimbel Brothers; Henry C. Struckmann, American Bosch Magneto Corporation, and J. W. Wiegand, Factory Radio Service.

The principal objects of the Association, as set forth in the by-laws are:

1. To act as a forum for the interchange of ideas and experience relating to service.

2. To secure the co-operation of manufacturers and distributors in furnishing service information for dissemination to its members.

3. To provide a central source of service information for the use of its members.

4. To act as a free employment agency for servicemen and service managers.

5. To establish a system of examination and classification of applicants for service and managerial positions.

6. To co-operate with radio service schools or schools having such courses, for the purpose of improving the training available for men who desire to go into the service business.

The third meeting of the Association, also held at Stewart-Warner, was on Monday evening, June 24th. (Regular monthtly meetings will be held the last Monday of each month.) John F. Rider, Associate Editor of *Radio Engineering* and a well-known writer on service and other radio subjects, gave a talk on the subjects of the requirements of a good serviceman, which he followed by answering numerous questions propounded by many members.

All those who are interested in applying for membership, or who wish to be informed of future meetings, or desire more information, may address the Radio Service Managers Association at Room 406, 1400 Broadway, New York City.

BROWN & CAINE IN NEW PLANT

Brown & Caine, Inc., condenser manufacturers, have moved into their new "daylight" plant, located at 2317 Calumet Ave., Chicago. This modern factory has 50,000 square feet of floor space and has been equipped with a new battery of high vacuum pumps and winding machines.

RIDER STARTS RADIO SCHOOL

A name well known to the readers of this paper is now allied with a radio school established for the purpose of educating men who wish to enter the radio industry.

John F. Rider, who for the past seventeen years has been interested in radio and for the past eight years has been a contributor to radio periodicals, employed as a consulting engineer, Associate Editor and Managing Editor of several radio publications and is the author of several radio text books which have found wide acclaim, has started the Rider-Goll Radio School, 1991 Broadway, New York City, where he will teach radio servicing by attendance and correspondence courses. This phase of the radio industry is well known to this man because he has specialized in that field both in practical form and along educational lines, for several years.

According to advice received from the school, two courses will start on July 15th. The first is a complete service course lasting over a period of 5 months involving elementary radio, advanced radio as applied to servicing and practical servicing of radio receivers. The course has been planned to fulfill the requirements of the Radio Service Managers Association and the requirements set forth by radio manufacturing organizations. The second course is an advanced radio course for men who are now in the service business or who function as servicemen and who are desirous of augmenting their knowledge about a-c. circuits, the most modern receiver design and the most modern servicing. Both courses involve practical and lecture work so that the man who completes the course is familiar with all types of testing apparatus and with the best method of procedure and is in possession of knowledge which is necessary for the routine work in manufacturing plants and radio service organizations. The length of the advanced course is two months.

TO PRODUCE MOLYBDENUM IN UNITED STATES

The American Electro Metal Corporation, with plant in Lewiston, Maine, and executive and sales offices at 65 Madison Ave., New York City, is a recently formed company for the purpose of manufacturing in this country molybdenum products formerly produced by the Deutsche Gluehfaden Fabrik, Berlin, Germany, and imported into this country by J. L. Lohfeld Co., Inc., and marketed under the well-known name of "D. G. F." and "Twinbrand" Molywire.

The same technical staff of the European company has been brought to this country to put the Lewiston plant—recently completed—into operation and thereby assuring the same quality of material as is at present supplied. The sales organization of Lohfeld & Co. has become associated with the American company, so that from all aspects the trade will be served in the same manner as heretofore, with the additional advantage of more adequate assurance of supply and delivery.

Mr. Rudolph Lowit is the general manager of the plant and production at Lewiston and Walter H. Lohfeld, general sales manager in New York City.

COLUMBIUM, A NEW METAL

The introduction of a new elementary metal is always of interest and the first American production, on a commercial basis, of an all-American metal is a feat of which any metallurgist might well be proud.

At the recent Exposition of Chemical Industries in New York, the first metallic columbium made in the United States was exhibited by Dr. C. W. Balke, chemical director of Fansteel Products Company, North Chicago, Illinois.

Columbium, it will be remembered, is a rare metal similar in many ways to tantalum, which also was first produced in America by Dr. Balke. Columbium was noted as an element in 1801 by Hatchett, who gave the metal its name because the mineral in which he found it came from America. Columbium's atomic weight is 93.5, its specific gravity 8.3, and its melting point about 1,950 degrees Centigrade. The metal is silvery in appearance, and may be coated with iridescent colored oxides by electrolysis.

Like tantalum, columbium is inert to practically all chemical action, and is soluble only in a mixture of nitric and hydrofluoric acids. In electrolytes the metal is uni-directional. It readily absorbs gases by occlusion, and has been patented as a "getter" in vacuum tubes. Columbium is very ductile and is easily worked cold. It may be rolled, drawn, hammered, formed or cut with ordinary metal-working tools. It welds readily to itself and other metals by the spot welding process. However, the metal must not be subjected to any great amount of heat in atmosphere, or it will become brittle.

Except for about a half-ounce made by Siemens in 1906, the Fansteel exhibit represents all the metallic columbium in the world. The exhibit consisted of several pounds of the metal in sheets, bars, rods and wire. This represents the first, and perhaps the only occasion when so great a percentage of the world's supply of an elementary metal has been exhibited at one place in the United States.

But columbium is rightfully America's, in name and in fact. There are workable deposits of columbite in the Black Hills of South Dakota, and the ore is also found in several other places on the North American continent.

In value, the metal is about one-seventh the price of platinum, and about half the price of gold. When the comparative lightness in weight is considered, the difference in cost is even more marked. With this advantage, columbium will rapidly find uses where a noble metal, untouched by corrosives, is needed.

"SOUND ADVICE"

An attractive combination booklet and folder covering a wide range of loudspeakers and electrical phonograph equipment has just been issued by the Stevens Manufacturing Corp., 44-48 Spring St., Newark, N. J.

"Sound Advice," as this booklet is called, covers the present extensive line of Stevens Magnetic, Dynetic and Dynamic Speakers in chassis and complete cabinet form, and the unique Sibley electric phonograph motor, die-cast turntable and improved pick-up in convenient portable form for use with any radio set. Brief engineering data on the frequency response of Stevens speakers and how it has been accomplished, is also included. "Sound Advice" will be sent to anyone on request.

ALLIED ENGINEERING INSTITUTE ANNOUNCES NEW SERVICE

The Allied Engineering Institute, which syndicates radio constructional articles bimonthly to four hundred newspapers and magazines, announces the extension of this service direct to fans and custom set builders. Circuits designed and built by this concern have been described in publications from coast-to-coast. The new service makes last-minute developments in radio available to subscribers, prior to publication anywhere. The Allied Engineering Institute has been instrumental in designing a large number of very good circuits, incorporating the latest developments in tubes, parts and accessories. The Allied Engineering Institute was formerly located at 250 West 57th Street, but now has its headquarters at 30 Church Street, Suite 429, New York, N. Y.

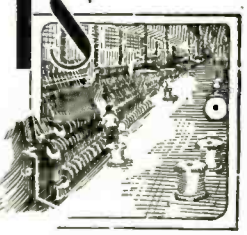
SOVIET TRUST REPRESENTATIVES VISIT U. S.

I. F. Antukhin, Chairman of the Board of Directors, and N. N. Tziklinsky, chief radio engineer of the Soviet Weak Current Trust, which comprises ten factories producing radio, telephone and telegraph equipment and employs 17,000 workers, have just arrived in this country to take part in conferences with engineers of the Radio Corporation of America. Two other engineers of the Soviet trust arrived some time ago and are studying the American radio industry. An agreement providing for an exchange of patents and for technical assistance by the Radio Corporation of America in the Soviet radio industry was concluded last year by the Weak Current Trust. During the past year the trust made purchases from the Radio Corporation and from other American firms to a value of nearly one million dollars.

IGRAD MOVES TO LARGER QUARTERS

The Igrad Condenser & Mfg. Co., Inc., of 26 Avenue D, Rochester, N. Y., announce that due to a large increase in business they have outgrown their present plant and are moving into considerably larger and more modern quarters, with modern equipment, at No. 4322 Lake Ave., Rochester, N. Y.

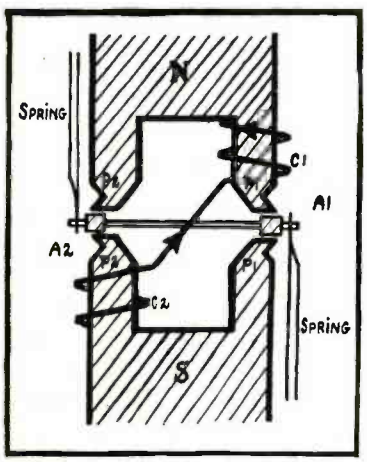
NEW DEVELOPMENTS OF THE MONTH



FARRAND INDUCTOR DYNAMIC SPEAKER

SOME three years ago, C. L. Farrand, who contributed the cone type speaker to the radio art, began his research work and engineering development on a radically new type of loudspeaker which would, in final form, offer a satisfactory compromise between the power and tone of the dynamic and the simplicity and low cost of the magnetic. His efforts have borne fruit in the inductor dynamic type which is now in production.

Upon superficial examination, the inductor dynamic loudspeaker appears to be a somewhat enlarged and refined version of the usual magnetic type speaker. It has two large horseshoe magnets, and the moving mechanism is enclosed in protective covers. However, the cone moves with remarkable freedom, indicating that there is not the stiffly tensioned armature so characteristic of the usual magnetic type speaker. A more critical examination, with protective covers removed, soon discloses its unique principle, with full floating double bar armature capable of driving the diaphragm a full one-eighth inch at low frequencies, for maximum volume on a sufficient input.



Operating details of inductor dynamic unit.

The inductor dynamic derives its name from its resemblance to the induction type a-c. motor in the matter of principle, and from its dynamic power. In principle, it is based on a changing magnetic flux, due to the signal current flowing through a pair of coils, acting on a pair of armature bars connected by tie rods, each bar working between its respective pole faces. The gaps between armature and pole faces remain constant, but the area by which the armature and pole faces overlap is varied as the armature is set in motion by flux changes. The two light bars, with their tie rods, are supported between two sets of pole pieces by means of exceedingly light strip springs, whose function is to hold the gaps constant and not to supply the restorative force which is left entirely to the magnetic force. The springs, in light channel form, are fitted with strips of soft rubber, so as to prevent any possible spring resonance to introduce distortion or extraneous sound.

By referring to the accompanying schematic diagram of the inductor dynamic, the principle may be readily understood. It will be noted that the armature assembly rides freely between the pole faces P-1 and P-2. The coils C-1 and C-2 are connected in series. A current flowing through the windings in the direction indicated will increase the flux through the pole legs P-1, and decrease the flux through the pole legs P-2. The flux, seeking the path of least reluctance, exerts a greater force on the

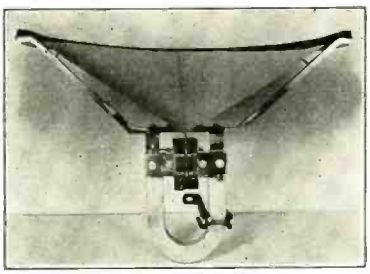


Illustration of Farrand inductor dynamic speaker chassis.

armature bar A-1 than on the armature bar A-2, thus moving the armature in the direction indicated. On the reverse of the cycle, the armature moves in the opposite direction in the same manner. The pole legs are cut to the shape indicated to reduce the leakage flux and to bring the greatest flux density to the desired point. The opposite forces on the two armature bars cause the armature to rest at a middle position which may be termed the "magnetic center." The flow of voice current in the coils causes this magnetic center to shift, and the armature moves along with the magnetic center.

The advantage which is immediately patent to the radio engineer is that this principle permits of very close spacings, without danger of pole slap. In the magnetic type, it is well known that the balanced armature must be placed close to the pole faces if maximum sensitivity and power are to be obtained. However, in order to avoid pole slap or troublesome buzzing, especially on loud signals, it becomes necessary to employ a stiff spring tension. This tension seriously impairs the response of the driving unit, particularly on low frequencies. Also, the spring usually introduces distortion due to its resonance period. Furthermore, the apex of the cone is necessarily driven in an arc motion, rather than a straight line, introducing still more distortion. It is patent, therefore, that the many drawbacks of the magnetic type speaker have caused it to be limited to radio sets of very modest power and tone range, wherein low price is the main consideration.

Strictly speaking, the inductor dynamic is not intended to compare with the magnetic type, save for the features of simplicity of application and low cost. Without calling for a separate field excitation source, the inductor dynamic fits into an assembly quite as simple as the usual magnetic type speaker. The only additional care is to match the impedance of the amplifier output to that of the speaker, since this feature is more important in this type of speaker than with the magnetic or dynamic types. Not only does the matching of impedances make for greater volume, but it also produces better tone quality. As in good magnetic speaker practice, it is necessary to employ an output transformer or a choke and condenser combination, so as to keep d-c. out of the speaker windings. If the speaker is to be applied to a push-pull amplifier, a third lead may be taken from the windings at the point where the two coils are joined together, and used as the mid-point of the windings. This corresponds to the mid-point in the primary of the usual output transformer or the output choke for push-pull amplification, and thus dispenses with either of those devices.

In order to facilitate matching impedances, the inductor dynamic is available in four standard impedance values, distinguished by a disk of one of four colors placed on the chassis, so that any amplifier output may be matched. If the inductor dynamic has too high an impedance for that of the amplifier supplying it, the efficiency will be lowered at the higher frequencies and increased at the lower frequencies. Therefore, the impedance of the speaker should be so selected as to produce the desired balance of high and low frequencies.

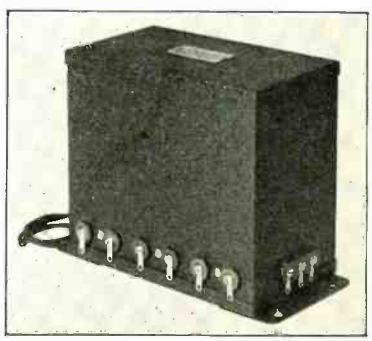
In the matter of low frequencies, where the dynamic has hitherto ruled supreme, it may be pointed out that the inductor dynamic leaves little to be desired. Unlike many of the moving coil dynamics, it requires no mechanical resonance or box boom to reproduce a rich bass effect. The inductor dynamic has a resonance well below 60 cycles. The springs supporting the armature are of very thin stock (.008") and the entire armature assembly, including springs, weighs but 4.5 grams as compared with 8 to 15 grams for a moving coil dynamic. With an input of 15 db. at 30 cycles, the inductor motor moves a 10-inch cone one-eighth inch. In fact, the principle is so much more efficient than the floating coil arrangement that the two permanent magnets will give the same output as a moving coil dynamic using from ten to fifteen watts in the field, it is claimed.

THE REMLER NO. 945 POWER TRANSFORMER

The Remler No. 945 Power Transformer is designed to supply filament, plate and grid-bias voltages for as many as six '27-type or '24-type heater tubes, an '80-type full-wave rectifier and two '45-type power tubes in push-pull. Although compact and small in size, it is of ample dimensions to prevent undue heating.

The popularity of the '45-type power tube is evidenced by the fact that it is standard equipment in a large percentage of the factory-built sets placed on the market. The undistorted power output of a single '45 power tube at the maximum rated plate voltage of 250 volts is 1,600 milliwatts while the undistorted power output of two of these tubes in push-pull is 3,200 milliwatts, the equivalent of the output of a '50-type tube at a plate voltage of 400 volts. Two '45 tubes in push-pull are capable of supplying all of the power required to satisfactorily operate the dynamic speaker and when so used will supply all of the undistorted volume that will ever be needed for the home or a small auditorium.

The No. 945 Transformer is enclosed in a steel case finished in black crystalline enamel. The base of the transformer is



Remler No. 945 Power Transformer.

3¼" wide by 6⅞" long over the mounting lugs. The transformer is 5⅞" high. With the exception of the input leads from the a-c. line, connections are to be made to colored terminals in accordance with a connection diagram packed with the transformer. The primary and secondary windings are electrostatically shielded to prevent the introduction of a-c. hum.

The specifications of the No. 945 Transformer are as follows:

Windings: Two ½ volt, 10 ampere windings to supply filament current for up to six '27 or '24-type heater-tubes.

Two ½ volt, 4 ampere windings to supply filament current for two '45-type tubes in push-pull amplifier.

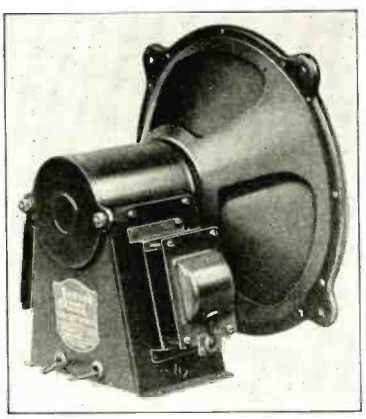
Five volt, 2 ampere winding to supply filament current for an '80-type full-wave rectifier tube.

High voltage winding rated at 125 ma. and 350 volts either side of center to supply plate voltage for two '45-type tubes in a push-pull amplifier, plate current for the tubes in the receiver and field-current for a dynamic speaker. The speaker field is to be connected in series with the filter system and is supplied with 60 ma. under a voltage of 140. The extra voltage supplied by the high-voltage winding, over and above the maximum permissible voltage of 250 for the '45 tube, is to take care of the voltage drop in the rectifier and filter systems and the resistors providing grid-bias.

The list price of the unit is $18.

NEW JENSEN 10-INCH CONE DYNAMIC SPEAKER

The new Jensen Concert Dynamic is to be built in four types for operation from 110 volt a-c. 110 volt d-c., 220 volt d-c. and 6 volt d-c.



Jensen "Concert" Dynamic Speaker.

The top price is $85 for the unit for operation from 110 volt a-c. This unit is equipped with a dry rectifier system and operates without perceptible hum from the alternating current. The models for operation from d-c will carry a list of $27.50.

The new Concert speaker is to be offered also in the Jensen Imperial Cabinet which was announced earlier in the year. Equipped with the Concert Dynamic unit, the list prices have been set at $80 with the a-c. unit, and $72.50 with any one of the three d-c. units.

PILOT "RESISTOGRAD"

A new variable resistor of the compression type, with a resistance range from 40 to about 10,000,000 ohms, has been brought out by the Pilot Electric Mfg. Company, of Brooklyn, N. Y. Its wide resistance range and its ability to handle 20 watts of power make it useful for many purposes in radio receivers. It is absolutely non-inductive and will steadily maintain the resistance value to which it is set by any adjustment of the knob. The change from minimum to maximum resistance is made through four turns of the knob.

The resistance material is a special non-packing compound, contained in a case turned out of a solid piece of brass. The outside of the case is ribbed like the cylinders of an air-cooled airplane engine, to dissipate the heat generated by the instrument during normal operation.

The new resistor, which bears the trade name "Resistograd", will carry 20 watts and will withstand voltages as high as 500 without internal sparking. It is 2-7/16 inches long overall and 1-7/16 inches in diameter, and mounts in a single hole. A black bakelite adjusting knob is provided.

The Resistograd may be used for control of the output voltages of "B" power packs; as an oscillation control in several different positions in r-f. circuits; as a

The Pilot "Resistograd".

volume control across the antenna circuit or in the audio amplifier; and as a regeneration control across the tickler or in series with the "B" lead to the detector tube. It is also valuable as a means of controlling the local exciting current through a neon-gas television lamp.

The retail price of the Resistograd is $1.00.

DURHAM MIDGET RESISTORS

Space saving to a great many set manufacturers today is almost as essential as money saving, and in order to meet both of these necessities, the International Resistance Company have designed what they term their "Midget" resistor.

Durham Midget Resistor.

This resistance unit is known as their Durham Type MF4–½ Midget—a very compact and substantially made unit, and well adapted to use with the UX-222 type tube.

These Durham Midget units are supplied by the International Resistance Company in all ranges of from approximately 250 ohms to 5 megohms.

SUPER-POWER CLAROSTAT

The Super-Power Clarostat is a heavy-duty adjustable resistor intended for all manner of applications calling for a precise resistance value. This device is based on the well-known Clarostat compression principle of obtaining stepless and noiseless resistance that remains set at any value desired. Thus the Super-Power Clarostat is at once a variable resistance when it is necessary to try different values, and a fixed resistance when the proper value has been found by actual test.

For the various applications in radio as well as in electrical work, the Super-Power Clarostat is furnished in three resistance ranges, namely:

Filament Range.....	¼—10 ohms
Low Range	25—50 ohms
Universal Range ...	100—100,000 ohms

This device is built for heavy-duty service. It is capable of withstanding high temperatures when dissipating up to its

Super-Power Clarostat.

maximum capacity of 250 watts. It is provided with a long shaft and special bracket, so as to be mounted clear of the panel for proper air circulation, or again for mounting on thick slate panel. Ideal as a heavy-duty line control, variable speed motor control, plate voltage control for transmitters, field control for shunt type generator, and so on. Finished in nickel. Mica and asbestos insulation. Handy bakelite knob. Sturdy and wearproof.

TOBE FILTERETTES

The Tobe Deutschmann Corp., of Canton, Mass., are marketing a series of Filterettes to meet all special filtering requirements in the radio field. A group of these units are shown in the accompanying illustration.

The Filterette Junior, which lists at $3.50, is suitable for use in connection

Complete group of Tobe Filterettes, for light and heavy duty electrical appliances.

with most household electrical appliances; such as vacuum cleaners, electric fans, etc., and is so designed that it can be plugged in series with the terminals on the appliance, without the necessity of any wiring changes. When used in this manner, the unit filters out line surges, etc., that would ordinarily create interference in the radio receiver.

The other models shown in the illustration are designed for use in connection with heavy duty electrical equipment and the majority of them are more elaborate in construction than the Filterette Junior. The prices on these units range from $10 to $20.

LINE BALLAST CLAROSTAT

In order to meet the demand for a simple, efficient, inexpensive yet durable device to compensate for fluctuating line voltage in the operation of socket-power radio sets, the Line Ballast Clarostat is now introduced by the Clarostat Mfg. Co., of Brooklyn, N. Y.

This device maintains a constant voltage on the primary of the power transformer, even though the line voltage may

Line Ballast Clarostat.

fluctuate as much as 30 per cent. It is usually designed to function between the limits of 100 and 135 volts. The unit can also be made to suit other expected ranges of line voltage. During such wide voltage fluctuation, the actual primary voltage and resultant secondary voltages vary less than the plus or minus 5 per cent specified by vacuum tube makers. The response, while not instantaneous, does not lag more than that of the average voltmeter.

The Line Ballast Clarostat is in handy cartridge form and provided with flat or round prongs for ready insertion or replacement in any assembly. The casing is of heavy perforated metal for rapid heat displacement. The ballast wire is mounted on notched mica spacing strips held by a rigid metal framework, avoiding all danger of breakage, sagging, or short-circuited wires. The wire employed is non-oxidizing and has no plating or coating to peel off or crack.

In order to provide for the core saturation voltage and the input current, the Line Ballast Clarostat must be designed to balance with the particular transformer with which it will be employed. Therefore, interested radio set manufacturers are asked to submit a sample of the intended transformer, wound for 80 or 85 volts, in order that the Clarostat engineering staff may design and submit a suitable line ballast.

OPERADIO DYNAMIC CHASSIS

The new Operadio Dynamic Speaker is unusual in design. It is very sensitive because the moving system is suspended at one point only and uses a pliable material for the flexing member.

The rectifier for a-c. models is of the tube type which reduces hum to a minimum.

The chassis is unusually simple to mount owing to its compact design, and may be mounted directly on the baffle. It occupies a minimum of space. The rectifying unit is on a separate base and can be placed where desired. If placed directly under the speaker, it takes no more additional space than that occupied by the speaker alone.

Cone, ten inch, one piece, free edge "Accoustex".

The Operadio Dynamic, not only responds faithfully to low input energy, but will also stand up under tremendous power, it is claimed. The chassis is extremely rugged and owing to its design, makes possible many new treatments.

It is adaptable to practically any condition of installation.

NEW SONATRON TUBE DESIGN

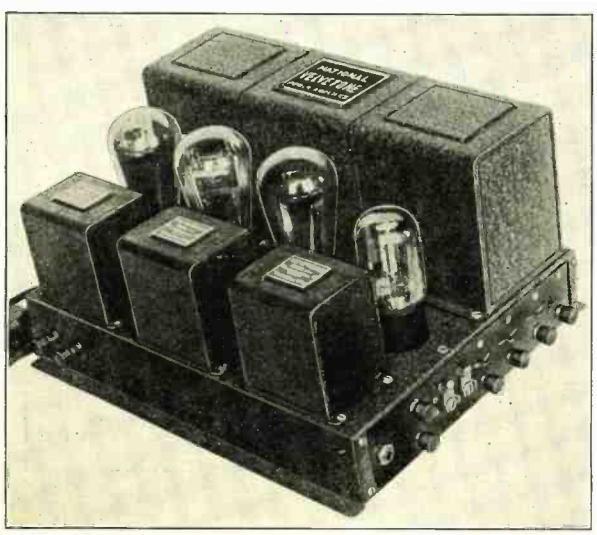
The Sonatron Tube Company has developed a new type of power tube, it has been announced by Harry Chirelstein, president of the company.

This tube is to be known as the 245 power tube. In addition to the development of this new tube, Mr. Chirelstein announced that type 281, 210 and 250 are now manufactured with a screen plate and a new filament, which results in a practically gas-free tube. Type 226, 280, 171 and 171-AC have undergone changes which promise greater efficiency and longer life, according to Mr. Chirelstein.

NATIONAL VELVETONE AMPLIFIER

The National Company, of Malden, Mass., are manufacturing a new power amplifier of modern design, that will be of considerable interest to the trade. This new amplifier employs a 227 tube in the first stage, which feeds into a push-pull output stage employing two 245 power tubes. The B-and C-voltages are supplied through an improved filter circuit utilizing a 280 rectifier tube.

The audio transformers are of the standard National high permeability nickle steel core type.



The new National Velvetone Amplifier. A 227 is employed in the first stage and two 245 tubes, in push-pull, in the output stage. B and C voltages are supplied by a 280 rectifier tube.

The amplifier unit also supplies a-c. heater voltage and B voltage for an r-f. tuner. A jack is provided for use with a phonograph pick-up.

This combination amplifier and power supply is exceedingly compact, measuring only 12¼ x 10¼ x 7 inches. It lists for $97.50 and is licensed under R.C.A. patents.

NEW SYLVANIA TUBES

The Sylvania Products Company, of Emporium, Pa., announce two new tubes which are available to the trade. These tubes are the SX-245 and SY-224. Both tubes are of the 2.5 volt filament type, and hence when employed with SY-227 will require only a single transformer winding.

Sylvania SX-245 and SY-224 tubes.

The SX-245 is a power output tube designed to fall between the SX-171A and SX-250 tubes. Under normal operating conditions of 250 volts plate and 50-volt grid bias, the undistorted power capacity is 1.6 watts. It is supplied with a large standard X-type base and has a maximum diameter of 2⅜ inches and a maximum height of 5⅛ inches. The average rating of this tube is as follows:

Filament Volts	2.5
Filament Amperes	1.5
Plate Volts (Maximum)	250
Grid Bias Volts	50
Amplification Factor	3.5
Plate Impedance (approximate ohms at 250 Plate Volts)	1900
Maximum Undistorted Power Output	1.6 Watts

The SY-224 is a screen-grid tube having a heater and cathode similar to the SY-227 tube. The control grid is brought to a cap on the top of the tube as in the d-c. screen-grid tube. This tube gives considerably better performance than the d-c. screen-grid tube because it has a lower plate impedance and a higher mutual conductance. The normal voltages for operation are 180 volts on the plate, 75 volts on the screen-grid and 1.5 volts negative bias on the control grid. In addition to being employed as a radio-frequency amplifier, this tube may be employed as a bias detector permitting the elimination of the first audio-frequency stage with its distortion. Average ratings of the SY-224 tube are as follows:

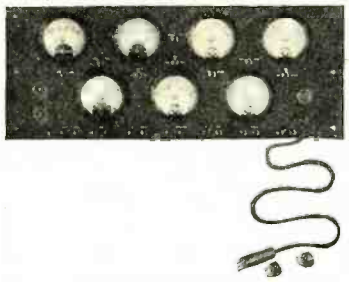
Heater Volts	2.5
Heater Amperes	1.75
Plate Volts (Max)	180
Control Grid Volts	−1.5
Screen-Grid Volts	75
Mutual Conductance	1040 Micromhos
Plate Impedance	400,000 ohms
Amplification Constant	420
Effective Grid to Plate Capacity	.01 mmf.

These tubes have not been offered to the trade until exhaustive tests have proven them to be satisfactory from every standpoint.

JEWELL RADIO TEST PANEL

A new test panel, No. 581, that provides rapid checking of both old and new radio sets is announced by the Jewell Electrical Instrument Company, 1650 Walnut Street, Chicago. Mounted on a panel of black enameled steel are seven instruments approximately 5" in diameter with long finely divided scales. Every accessory for testing receivers and tubes in the laboratory is included. The arrangement permits the panel to be easily mounted on a wall or service table at eye height.

The seven instruments provide for the following ranges: 0-7.5 volts d-c., 1-75 volts d-c., 0-150-300-750 volts d-c., 1000



Jewell Radio Test Panel.

ohms per volt; 0-15-150 d-c., milliamperes, 0-4-8-16 volts a-c., 0-150-750 volts a-c., and 0-1.5-15 microfarads. Binding posts are supplied so that all instruments can be used individually and with switches to cover all ranges.

A plug and cord are supplied so that all circuits in the radio set can be tested with a tube, a socket for which is provided in the panel. A pair of outlets is arranged for connection to the 110 volt, 60 cycle a-c. line, so that the line voltage may be read. There is also an outlet for connecting the set on the tester. The panel is so wired that the line voltage may be read at will.

The 750 volt a-c. range enables testing power pack secondaries for open circuits and the capacity meter which gives direct readings at 115 volts, 60 cycles, provides a method for determining condenser values and checking condensers for short circuits.

A 4-INSTRUMENT SET ANALYZER FOR EXPERT SERVICEMEN

The Jewell Electrical Instrument Company, Chicago, announces a 4-Instrument Set Analyzer, designed especially for expert servicemen. Four Jewell Instruments mounted on its panel provide simultaneous readings of plate voltage, plate current, filament and grid voltages.

The 3½ inch face bakelite case instruments supplied in the Pattern 409, as this new set analyzer is called, are as follows: A d-c. instrument for reading plate voltages, with ranges of 0-120-300-600; a milliameter with ranges of 0-12-60-300 for reading plate current; a d-c. voltmeter for grid, filament, and cathode voltages, with scales 0-10-100; and an a-c. voltmeter with 0-4-8-16-160-800 volts, the last reading be-

Jewell 4-Instrument Set Analyzer.

ing particularly suitable for checking a-c. high voltage transformer output.

In service the tube is removed from the receiver and inserted in socket provided in the set analyzer. The plug of analyzer is inserted in the tube socket. Since plate voltage and current are always indicated, it is only necessary to press the a-c. and grid voltmeter buttons to get all four values at once. The simplicity with which the whole group of values are simultaneously obtained makes for quicker set analysis.

All instruments are equipped with individual binding posts so that every desirable test is available. Push buttons are provided for selecting scales.

DUBILIER DRY "A" CONDENSER

For applications requiring high capacity at low voltage, the Dubilier Condenser Corporation of New York City has developed a dry "A" condenser which is proving highly popular. This unit is in the form of a polarized condenser, utilizing a novel bone-dry electro-chemical dielectric.

The Dubilier dry "A" condenser is intended for use on unidirectional or direct current up to 15 volts, where high capacity is essential. Its main applications are for "A" battery eliminators, for low-voltage rectifier circuits supplying radio or signal systems, and for hum-proof operation of dynamic speakers on rectified field current. Its capacity of 2,000 mf., in relation to size, is claimed to be unapproached by any other "A" condenser, while its leakage current is less than 1 milliampere, as against 6 to 10 milliamperes or more for the usual types.

DUBILIER 2000-VOLT FILTER CONDENSER

In order to meet the growing demand for filter condensers of higher working voltage, particularly in conjunction with the UX-866 mercury vapor rectifying tube, the Dubilier Condenser Corporation, of New York City, now announces the Type 688 condenser in the 1 and 2 mf. capacities. The Type 688 Dubilier condenser is rated at 2000 volts d-c., and 1500 volts a-c., as the working voltage in each case. Twelve papers are used for the dielectric, or twice the number heretofore employed for the 1000-volt Dubilier condensers. Each condenser is housed in a heavy metal case, with porcelain insulated terminals at top.

The Type 688 Dubilier condensers may be employed in any filter circuit where voltages up to 2000 are encountered, such as in amateur transmitters and broadcast transmitters using ¼ kilowatt tubes.

DUBILIER GENERAL PURPOSE CONDENSERS

Standard condensers for general purposes, ranging from 1 mf. capacity at 200 volts d-c., to 6 mf. at 600 volts d-c., and 2 mf. at 1000 volts d-c., are now offered by the Dubilier Condenser Corporation of New York City. In fact, this line of general purpose condensers covers a broad range of capacities and voltage ratings to meet all radio applications, as well as other applications in scientific apparatus, telegraph and telephone work, signalling, and so on. A convenient use of these standard condensers is in the use of one or more of them to substitute for one or more exhausted sections in condenser banks of radio receiving sets, without removing or scrapping the entire bank. Another use is in the grouping of a number of these condensers, selected as to capacity and voltage rating, to replace entirely exhausted condenser banks that may have passed out of current manufacture.

These Dubilier general purpose condensers have a high safety factor to insure long life. They are designed to give at least 10,000 hours of normal service—about ten years in usual radio broadcast reception—when operated at or below rated voltages. Each condenser is sealed in a compact metal case, with soldering terminals at the top.

ROLLER-SMITH CONTINUITY TESTER

The Roller-Smith Co., 233 Broadway, New York City, announces the new Type HTD Radio Continuity Tester.

This Tester is offered for making continuity and resistance tests on radio receiving and transmitting sets and on other radio devices and circuits.

This instrument possesses many new and novel features. The following features stand out as characteristic:

The device is entirely self-contained and requires no external battery, the small standard flashlight cell being built-in.

All circuits, and parts may be tested instantly for continuity.

Grounds, crosses and short circuits can be located quickly.

The approximate resistance of the circuit or part is indicated by the position of the pointer.

The range of the device is from zero to 100,000 ohms.

The instrument is small (pocket size), compact, light and, although very rugged, is highly sensitive.

The list price of $25.00 is subject to liberal discounts.

DEFOREST A-C. SCREEN-GRID AUDION

The DeForest Radio Company, of Jersey City, N. J., announces a new a-c. screen-grid audion of unique mechanical design, known as the 424 Audion. This tube has an amplification factor of 420, as compared with an average of 300 for the d-c. screen-grid tube. It operates on a 2½-volt a-c. heater current, or again on storage battery current with a drain of 1¾ amperes as an ideal radio-frequency amplifier in short-wave sets. While the other electrical characteristics are identical with the standard -24 type a-c. screen-grid tube, the 424 Audion differs in mechanical details. Instead of the familiar glass cross-bar insulator, and the elements positioned solely by support wires, the 424 Audion makes use of mica spacers for positive, accurate and permanent positioning of the elements. Also, this Audion incorporates the humless and noiseless heater or cathode recently developed by DeForest engineers and already introduced in the 427 A-C. Audion.

DeForest 424 and 445 Audions.

DEFOREST 445 POWER AMPLIFIER AUDION

The DeForest Radio Company of Jersey City, N. J., announces a new power audion known as the 445 type, which has the same electrical characteristics as the -45 power tube, but differs in the matter of mechanical construction and filament efficiency. Mechanically, this tube is sturdier, it is claimed, with more positive, accurate and permanent positioning of the elements, due to the use of mica spacers instead of just the support and anchor wires. The filament is of special type developed in the DeForest filament laboratory. This tube is certain to prove highly popular in this season's sets, as a successor to the -71-A as well as the -10 type.

SCREEN PLATES FOR VACUUM TUBES

One of the outstanding exhibits at the recent Chemical Show in New York City was an improvement in radio screen plates manufactured by the Newark Wire Cloth Co., 351-365 Verona Avenue, Newark, N. J. Their new product is called "Sealed Edge Grid Screen."

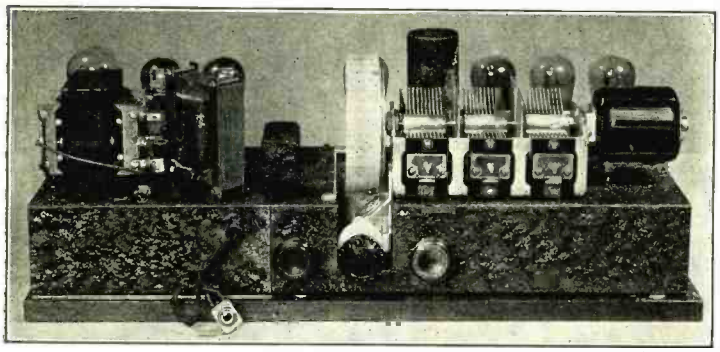
The principal difficulty heretofore has been the unevenness of the edges of these plates and their tendency to unravel. As made by the Newark Wire Cloth Company unraveling is impossible. Their plates have a remarkably smooth and even finish all over. All wire ends are individually bent over, hence the name, "Sealed Edge." All cutting is perfectly straight.

The use of this material in tubes prevents wires dropping out from the cloth, thus overcoming a great many rejects of the finished tube due to short circuits.

The uniformity of the cloth is a great advantage to the tube manufacturer who saves considerable time in forming the plates as the accuracy in width, straightness, and all around perfection eliminates jamming in the guides.

We are informed by the Newark Wire Cloth Company that they are already making this wire cloth in a number of widths and are equipped to make it in any width desired.

Receiver Designs For The Coming Season



The Eveready Series 30 A-C. Chassis.

EVEREADY SERIES 30 A-C. SETS

All Eveready Radio Receivers in the 30 series are identical as respects the chassis. The differences between the various models in this series are differences in furniture only. The following description of the Model 30 Chassis therefore applies to all Eveready Radio Receivers having model numbers between 30 and 40.

The receiver is a 7 tube, single dial, antenna operated, all electric a-c. set, having three stages of radio-frequency amplification, detector and two audio stages, the last of which consists of two power output tubes, UX-171A or CX-371A, in a push-pull circuit.

Every tube in the receiver, with the exception of the two power output tubes, is the indirectly heated, UY-227 or CY-327, type.

The R. F. L. Circuit is retained for the Model 30 chassis. Refinements and improvements as applied to the Eveready Receiver make this set even more sensitive and stable than heretofore. A total of four tuned circuits is used in this set.

The conventional method of designing a radio tuning system is to employ a fixed inductance coil tuned by a variable condenser. Such a system has the advantage of low cost, but it has the disadvantage of becoming less sensitive as the circuit is tuned to the higher wavelengths. To overcome this disadvantage one of the four tuned circuits in the Eveready Receiver consists of a condenser tuned by a variable inductance coil. This variable inductance coil, in the form of a variometer, is mounted on the shaft which rotates the variable condensers in the remaining three tuned circuits, and revolves with them. Thus, instead of the tuning "gang" having four condensers on one shaft, as has been customary heretofore, the Eveready "gang" consists of three condensers and a variometer. Careful design and accurate manufacturing methods insure the variometer "tracking" consistently with the condensers throughout the entire range of wavelengths covered by the receiver.

The response characteristic of a circuit which is tuned by a variometer is exactly the reverse of one which is tuned by a condenser; that is, the circuit becomes more sensitive as it is tuned to the higher wavelengths. By using a combination of both methods, the sensitivity of the Eveready Receiver becomes much more uniform throughout the entire broadcast range, and is many times as sensitive at all wavelengths than other four-circuit receivers employing conventional methods.

Volume is controlled by a rugged, wire wound, variable resistance unit. Being low in resistance and made of wire instead of impregnated paper, the Eveready volume control is much less subject to derangement than other types, and consequently is much more dependable and trouble-free. Its volume control will completely shut out the strongest local station.

A phonograph pick-up connection has been provided in the Eveready Model 30 Chassis which enables the user to plug in the leads from a phonograph pick-up and thus play his records through the amplifier in the set, without having to remove a tube or otherwise disturbing the receiver.

The power supply unit of the Eveready Model 30 chassis has been designed to furnish ample power for the field excitation of a dynamic speaker. Two terminals in the form of pin jacks located on the rear face of the power plant provide that outlet for the field exciting current. Directly below the field terminal jacks on the table model, is a snap switch, which is thrown one way for dynamic speaker, and the other way for magnetic speaker operation.

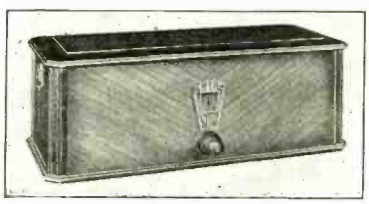
The receiver is constructed in two separate units, one comprising the radio-frequency amplifier, detector and first audio stage, the other, the second audio stage, rectifier and power supply unit. Because of the relatively heavy current required in the filaments of the heater type tubes, the electrical connections between the two units are made with securely bolted terminal strips, rather than with a flexible cable and plug and socket arrangement. These tightly bolted contacts insure the current from the power plant reaching the radio chassis without loss, and without the likelihood of loose connections developing in use.

Breaking the receiver into separate units greatly facilitates servicing the set. In case of damage to one of the units, the trouble can quickly be located and the damaged unit replaced without the necessity of tearing down the whole receiver to effect repairs.

RADIOLAS 44 AND 46

Two new Radiolas employing the new a-c. screen-grid tubes and a new power amplifier in a specially designed circuit, have been announced by E. A. Nicholas, vice-president of the Radio-Victor Corporation of America.

One of these sets, Radiola 44, is a table model, and the other, Radiola 46, is a console with a built-in electro-dynamic loudspeaker. Both receivers are encased in cabinets of two toned walnut veneer.



The Radiola 44 screen-grid receiver.

Radiola 44 utflizes three UY-224 screen-grid tubes, two of which serve as radio-frequency amplifiers, and the third as a power detector. The new UX-245 power amplifier tube is used in the single stage of audio amplification. The receiver has three tuned radio-frequency circuits, but because of the characteristics of the screen-grid tubes, has as much selectivity as a set having four tuned circuits and using the standard three-element tubes. The two UY-224 tubes which are used as radio-frequency amplifiers give as much amplification as four of the ordinary three-element tubes.

The screen-grid power detector tube gives such a strong signal that it makes possible the elimination of one stage of audio-frequency amplification, thus reducing to a minimum the possibility of distortion, which is sometimes present where successive stages of audio amplification are used. The output energy from the plate of this power detector tube is transferred by means of a choke and filter system to the UX-245 power amplifier tube instead of through a transformer. The elimination of the transformer and the use of the impedance coupling circuit between the power detector and the audio amplifier results in an exceedingly high quality of musical reproduction and brings out particularly well the full, rich tones of the bass register. As an additional precaution to insure undistorted reproduction, the UY-224 power detector tube has a radio-frequency filter which prevents any radio-frequency disturbance from being carried over into the audio amplifier.

An unusual type of selector dial is employed in Radiola 44. In addition to the usual scale markings of zero to one hundred, the selector dial has approximate kilocycle markings to facilitate tuning. When the set is in operation, the scale markings and numbers, clearly and greatly magnified, are projected upon a small translucent, composition screen in the center of the escutcheon plate.

Another unusual feature of this set is a two-in-one tuning and volume control, arranged concentrically so that they appear to be one control. This adds materially to the external appearance of the receiver, and it enables the user to operate both controls simultaneously with one hand.

A local-distance switch has been provided to maintain the quality of reproduction for both strong local and weak distance stations.

Radiola 46 is enclosed in an attractive, walnut veneer, console cabinet having burled maple overlays. Instead of the conventional loudspeaker grille and operating control board, this receiver has an embroidered silk panel which conceals the loudspeaker opening and is so skillfully designed that the single tuning volume control and escutcheon plate appear to form a part of the embroidered pattern of the cloth.

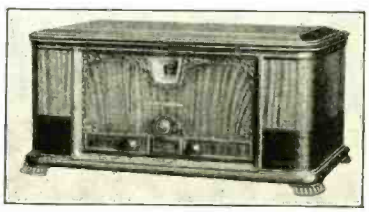
The same radio circuit and Radiotrons as used in Radiola 44 are incorporated in Radiola 46, together with a built-in electro-dynamic loudspeaker of the Model 106 type.

STROMBERG-CARLSON NO. 641 RECEIVER

Refinements in the detection and the audio systems are among the improvements included in the new Stromberg-Carlson No. 641 receiver. These refinements are especially adapted to reception from the modern high-modulation broadcast stations. This table model, American walnut Treasure-Chest uses the new a-c. screen-grid tubes in its radio-frequency stages. According to engineers, more than thirty times the signal is supplied to the detector grid by these tubes than with an equal number of radio-frequency stages, using the most common UY-227 tubes. Because of this increased amplification, each r-f. transformer is enclosed in a seamless copper can with a tight cover to prevent coupling and to give best transformer characteristics. Each unit of the gang tuning capacitors and each radio-frequency tube is enclosed in metal compartments.

A UY-227 tube is used as a linear power detector with automatic bias. This type of detector circuit operates at high radio-frequency voltages and gives less distortion than the ordinary detector circuit on signals from the new broadcast stations with high modulation.

Many owners of radio receivers have, no doubt, noticed with the coming of the new transmitting methods that they have not obtained the improvement in tone quality that they had anticipated. This is due to the fact that highly modulated carriers set up harmonics within the detector circuit which seriously detract from the quality of reproduction. The linear detection method avoids the production of these har-



Stromberg-Carlson No. 641 screen-grid receiver.

Solving the "X" in Line Voltage Problems WITH LINE BALLAST CLAROSTAT

IT'S no use playing blind man's buff in the engineering of radio set or power amplifier. You might as well face the facts as they are, and design your products accordingly.

Thus 110-volt A.C. supply usually means nothing of the kind. Rather, it is X-volts A.C. In a typical power area, for instance, here is what we found with our voltmeter:

DAYTIME: In business section, with heavy industrial load, line voltage varied between 90 and 100. In suburbs, line voltage read around 100, rarely as high as 110. In rural districts, line voltage dropped to 85, and seldom rose above 92.

EVENING: Voltage in business section rose to 105 or 110. In the suburbs, it went to 110 and held fairly steady. In the rural districts, it rose to 100 or 105, but never much higher.

NIGHT: As the load went off the line, the voltages rose to higher levels. In the business section, the line voltage went as high as 125, and in one instance to 130. In the suburbs it went to 120. In the rural districts it rose to 108.

These are actual readings, taken in a typical metropolitan area and its surrounding rural districts. Of course these readings do not check with the claims made by electric power companies, who maintain that their line voltages are accurately maintained at all times. From an engineering standpoint, however, we know that it is physically impossible to maintain steady voltage in the face of fluctuating load, and also that all sections of a power distribution system cannot have the same line voltage.

What does this mean? Simply this: Your dealers, who must eventually make good on the sets you are designing, simply cannot give a satisfactory demonstration on low line voltages. Volume, tone, and general performance suffer, and many a sale is lost. On higher voltages, the performance may be brilliant, but so will be the tubes, which will burn out in short order, resulting in frequent servicing, excessive tube replacements, and a serious loss of good will for your product.

Why take a chance on the "X" in line voltage? Solve the problem now by means of the—LINE BALLAST CLAROSTAT.

A metal cartridge with plug-in terminals. Compact. Weighs only 3 ounces. Special resistance wire cannot oxidize, crack or break. Novel mica and metal support prevents sagging wires and short-circuiting. Holds secondary voltages to within plus or minus 5 per cent as specified by tube manufacturers, even though line voltages may fluctuate as much as 30 per cent. Response as rapid as average voltmeter. Will outlast usual radio assembly.

The LINE BALLAST CLAROSTAT is standard equipment in many of the leading radio sets and power amplifiers. It is being widely featured. Radio buyers are coming to appreciate the necessity for automatic line voltage control, and are looking for this device in their next set. You can decrease your sales resistance in no better, more positive, and less expensive manner than by incorporating the LINE BALLAST CLAROSTAT.

Manufacturers and Designers of A.C. Sets

WRITE for engineering data on the LINE BALLAST CLAROSTAT. Better still, if you are engaged in manufacturing radio sets, amplifiers, talking movie equipment and allied products, send a sample of your power transformer wound with 80 or 85 volt primary and we shall make up sample ballasts for your inspection and tests.

CLAROSTAT MANUFACTURING COMPANY, INC.

Mem. R.M.A.

Specialists in Genuine Wire Wound and Fixed Resistances

282 North Sixth Street, :: Brooklyn, N. Y.

Remember—there's a* CLAROSTAT *for Every Purpose

monics and gives powerful undistorted reproduction.

The audio system of this new receiver consists of but one stage, employing the new UX-245 power tube, fed directly from the detector. This tube makes available plenty of reserve output power for peak demands, and improved quality and fidelity are obtained by feeding directly from the detector.

Provision is made for using this audio system for the reproduction of phonograph records in conjunction with a pick-up outfit. A jack is placed in the rear of the chassis for plugging in the pick-up and a switch is so arranged that by turning the volume control completely to the "off" position, the pick-up is connected into the grid circuit of the detector tube and vice versa. In this way the pick-up may be left permanently plugged in the jack in the rear of the chassis and connected for operation by the mere turning of a control knob.

The new receiver possesses but three controls—the single station selector, operating an illuminated tuning dial, the volume control, and the "ON-OFF" switch. The volume control is dual in action and operates by varying the amplification of the first and second r-f. tubes as well as the voltage supplied to the r-f. amplifier from the antenna. This gives complete control of the strongest signals without introducing audio distortion or altering the selectivity of the receiver.

NEW KOLSTER AND BRANDES RECEIVERS

Complete remote control of a radio receiver from any part of the home, the use of the new screen-grid tube in radio amplification, push-pull audio amplification, dynamic speakers of a new design and selector tuning are the outstanding innovations among the new Kolster and Brandes sets.

The Kolster model K-45 is a distinct advance in radio for several reasons. One is remote control. There are no knobs or dials on the front of the set. In a corner of the top, the dial can be seen through a small glass window, and on the side are automatic tuning buttons in addition to the usual knob for manual tuning.

A cable is attached to the set which can be led around the home behind the picture moulding or under the carpet, or even built into the wall, to any desired points of remote control. A small box, about four inches by six inches, at the end of the cable, can rest on the arm of the listener's chair or on a bedside table. On the small box are six buttons, marked for six selected stations, a volume control, an on-and-off switch and two colored lights.

When the set is turned on at the remote control point, a red light glows on the small box. When a station button is pressed, the red light disappears and a green light comes on to show that the set is not ready to play until a small motor automatically completes the tuning of the set, when the red light again appears to show the set is tuned to the desired station. The colored lights show the set is working perfectly, and, if no program is heard after the tuning is completed, it indicates that the station is not broadcasting.

New Brandes set, with selector tuning, using 327 type tubes and 245's in push-pull.

While the automatic tuner is turning the dial, the reproducer is short-circuited automatically so that no intervening stations are heard.

This Kolster model is placed in the room just as any other set is installed, with the cable for remote control either stretched along the wall or built into the walls with taps in each room beside the favorite chair or at the bedside.

The audio amplifier makes use of three stages, the first employing one 327 tube, the second two 327 tubes in push-pull arrangement and the third two 350 tubes in push-pull. The second stage of two 327 tubes is necessary to supply sufficient power to the last stage for efficient operation and represents a development of the Kolster laboratories. Very low ratio transformers are used in the audio-frequency system to avoid any distortion, and an exceptionally large speaker has been installed.

Two other Kolster models, both consoles, the K-43 and K-44, are equipped with the Kolster master dynamic speaker and 345 tubes in push-pull arrangement. The K-44 has eight tubes, including the rectifier, with two 345 tubes in the audio amplifier and three screen-grid tubes in the radio amplifier. It uses four tuned circuits for advanced selectivity, another Kolster feature. The K-43, also with eight tubes, has two 345 tubes in push-pull audio amplification and screen-grid tubes.

The Brandes sets in the low-priced field are outstanding in that they have selector tuning similar to the Kolster sets, in addition to being four-condenser receivers with eight tubes, including five 327 tubes and two 345 tubes in push-pull arrangement. With a slight change in wiring, the 371A type of tube can be used in place of the 345 in case it is desired. Both the B-15 and B-16, console models have dynamic speakers. The B-10, a table model, is designed for either a dynamic speaker or magnetic speaker, with a special power unit. The dynamic speaker or a floor lamp can be operated by the same switch which turns on the set.

NEW FEDERAL RECEIVERS

The Federal Radio Corporation, Buffalo, N. Y., is introducing to the trade its new 'M' line of receivers. The receiver is exceptionally sensitive in picking up long distance stations. The chassis is triple-shielded, having separate shielding for the r.-f. stages, over-all shielding and tube shielding. It has two 245 tubes in the push-pull audio stage, housed in the power pack. One 280 rectifier tube also is housed in the power pack. The five 227 tubes are in the chassis. The sets have the standard Federal volume control. Arrangements are made in the chassis for pin jacks and a switch for phonograph pick-up.

The dial is calibrated in kilocycles. The vernier is arranged so that there will be greater knob movement for a given antenna condenser displacement thus making the vernier broader and easier to tune.

A Jensen dynamic speaker, d-c. type, is used in each of the three console models, the M 36, M 41 and M 46.

Cabinets of the 'M' receivers are in keeping with the refinements of their engineering, coming in four models, one table type and three consoles. The cabinets are of the finest mahogany and walnut enhanced with hand carving and contrasting overlays, substantially constructed by furniture artisans.

Prices on the new Federal 'M' line range from $245 to $295, without tubes.

FEDERAL 32-VOLT RECEIVER

The Federal Radio Corporation, Buffalo, N. Y., is now offering receivers adaptable to 32-volt farm lighting plants, meeting an increasing demand in the community and rural sections for sets of this type.

According to the engineering department of the Federal Corporation, these receivers are identical in circuit with their E and F series-filament receivers operating from the a-c. 110-volt lines in conjunction with the power supply unit. For use on 32-volt d-c. systems, only the receiver itself is required, in conjunction with a special coupler and minor changes in the cable. A 32-volt pilot lamp is required. Only eight watts power is drawn from the 32-volt source for filament excitation while ordinary dry B and C batteries are used in the installation.

These new farm light plant receivers are available in six or seven tube types, with dynamic speakers. The prices range from $100 to $325.

BOSCH SCREEN-GRID RECEIVERS

The American Bosch Magneto Corporation announces three new Bosch Radio models, all engineered to the new screen-grid, four-element tubes. The new line is composed of a table model, a combined set and speaker console and a DeLuxe Highboy model. All will use the same seven tube chassis. All three models have sliding doors, including the table model and present rather unusual furniture attractiveness.

Bosch Highboy model screen-grid set.

On examining the Model 48, it was seen that there were three type 224 screen-grid tubes in the radio-frequency circuit; one type 227 tube in the detector circuit; two type 245 tubes arranged in push-pull for high quality amplification and one type 280 for power rectification.

This new model uses to advantage all the latest developments in tube engineering as well as good radio practice. The shielding is unusual and very well worked out. There is total shielding for the condensers, coils and tubes. Another interesting feature is the powered detector for which is claimed the new and better detector results.

The Model 48 is built up on a steel chassis and the condenser assembly is mounted at but three points, eliminating strains and stresses. The entire chassis has every evidence of being well engineered and its various features are highly pleasing in the way they have been handled. The table model is unusual in size and appearance and with the two sliding doors, it becomes an interesting piece of furniture instead of just a radio box. The table model is reported to list at $119.50; the combined set and speaker console at $168.50 and the De Luxe Highboy at $240.00. All prices less tubes. All models are for dynamic type speaker operation. The consoles will have the new Bosch dynamic-type speaker which is also furnished as a table type K.

NEW KELLOGG RECEIVERS

The new receivers offered by the Kellogg Switchboard & Supply Co. incorporate a number of distinctive improvements. The new a-c. heater screen-grid tubes are employed with marvelous results in a new circuit design requiring no neutralizing to prevent oscillation and securing tremendous gain per stage, of which there are three.

In order to handle the tremendous input into the detector circuit from these three screen-grid tubes, power detection has been found necessary. The detector tube uses high voltage on the plate and a high grid bias. It is thus able to handle the enormous input from the amplifier stages without any distortion or overloading.

The first audio tube, of the K-27 heater type, is operated at maximum plate voltage and grid bias. The output of the first audio is fed into a push-pull stage, utilizing two K-50 tubes in one chassis and two of the new 245 tubes in another.

In order to make this power available to the operator of the receiver with a mini-

mum of effort, there are only three controls on the front panel. The center knob controls the single illuminated dial for tuning. The right hand knob is an input energy control. This device controls the signal input to the receiver in order that the sensitivity can be regulated to suit the taste of the operator.

The left hand control knob is the manual setting for an automatic volume regulator. This controls the amount of amplification of a signal after it has been passed by the input control.

The tremendous power from the amplifier stages is put through a dynamic speaker design and construction with matched impedances.

Model 523 utilizes the following tubes: Three K-24 a-c. heater screen-grid tubes; two UX 245 a-c power tubes; three K-27 heater a-c. tubes and one 280 rectifier tube.

The model 524 and the combination Radio Phonograph, Model 525 employs in each: Three K-24 a-c. heater screen-grid tubes: two K-50 power tubes; three K-27 a-c tubes and two UX 281 rectifiers. Both models 523 and 524 will be equipped for phonograph pick-up, enabling the excellent audio amplifier to be used for reproduction of phonograph music.

NEW U. R. C. CIRCUIT

An entirely new radio circuit has been adopted by United Reproducers Corporation for incorporation into its line of receivers which will make their first appearance at the trade show. The circuit is designated as the "uniform high gain radio-frequency circuit", and as used by United Reproducers is the result of scientific development of the Hazeltine corporation and the company's own Newcombe-Hawley laboratory at St. Charles, Illinois.

Coupled with the new circuit and for all practical purposes a part of it, is an automatic volume control, which will eliminate all blasting when the set is tuned.

"SILVER RADIO" RECEIVERS

Silver-Marshall, Inc., of Chicago, have announced their new receivers which make liberal use of the lately announced a-c screen-grid tube (224)—employing this tube in all three radio-frequency stages with band selector tuning, and even using another as the latest type of power detector. The receiver is said to be so sensitive that no aerial is required, even for distant stations, an invisible built-in "screen-collector" being entirely sufficient. The audio end employs 245 tubes in push-pull connection, and a dynamic speaker also of Silver-Marshall manufacture, is included.

Two sets are offered, under the name of "Silver Radio," to distinguish them from the previous "S-M" line of radio parts. The Model 95 Highboy, in striped and diamond-grain walnut, of Sheraton design, with noiseless sliding doors, lists at $195 east of the Rockies and $210 west. The Model 60 Lowboy is identical electrically with the Highboy; even the cabinet is very similar in shape and appearance, though it is without doors. The Lowboy lists at $160 east of the Rockies and $170 west.

The "Silver" model 95 screen-grid receiver with 245 push-pull output and dynamic speaker.

THE NEW 1930 PIERCE-AIRO RECEIVER

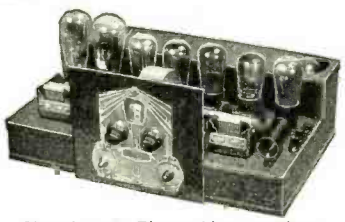
The 1930 Pierce-Airo employs the new 245 tubes. An added feature this year is the automatic phonograph attachment for the use of phonograph pick-up if desired. Another feature which the manufacturers claim is exclusive, is the construction of the chassis, which enables one to use either an a-c. or d-c. dynamic speaker. The chassis is rigidly constructed of heavy gauge drawn and welded steel and houses all component parts, including the power supply, which is of liberal design and construction to withstand heavy overloads.

The tuning drum is illuminated from the rear and large type makes station reading easy. The dial light also functions as a pilot light. A compensating control assists materially in tuning distant stations.

In the new 1930 Pierce-Airo, provision has also been made for the regulation of line voltage, assuring proper delivery of power regardless of line voltage fluctuations in various localities.

The tube requirements of the new Pierce-Airo are as follows: Two 245 tubes in the push-pull power amplifier circuit, two 227 tubes for the detector and first audio, the usual 226 tubes in the radio-frequency circuits, and one 280 tube as a rectifier.

The new 1930 Pierce-Airo is available as a chassis, Model A.C. 245, in a metal cabinet of black rubberoid finish, Model A.C. 246.



Chassis of Pierce-Airo receiver, designed for use with either an a-c. or d-c. dynamic speaker.

The Pierce-Airo Electric Receivers are manufactured by Pierce-Airo, Inc., 119 Fourth Ave., New York City.

NEW WARE RECEIVERS

Ware Manufacturing Corporation, Trenton, New Jersey, announces a new radio receiver which is the first to embody the Band-Selector system of tuning evolved by Dr. Frederick Vreeland. Alternating-current, screen-grid tubes and the new 245 type super power output tube are also used.

In designing this set Paul Ware, pioneer radio manufacturer, has included band-selector tuning to obtain sharp selectivity without sacrifice of tonal range. Sensitivity is accomplished by using the new a-c. screen-grid tubes which gives a voltage amplification far greater than the conventional type of amplifier tube. The 245 type super-power output tube is employed so that the fullest advantage can be taken of the selectivity and sensitivity of which this receiver is capable.

The new Ware line includes a table model, priced at $195 (without tubes or speaker), and a completely self-contained, artistic console with a special electrodynamic reproducer, retailing at $425 (without tubes).

VICTOR RADIO-PHONOGRAPH COMBINATIONS

The Victor radio is a power operated, completely shielded, tuned radio-frequency set. It has four stages of tuned and neutralized radio-frequency amplification and a fifth or antenna coupling stage; two stages of audio-frequency amplification and detector. Ten Radiotrons are required as follows: Five UX-226's in the radio-frequency stages, a UX-226 in the first audio and two UX-245's in the second audio; UY-227 detector and UX-280 rectifier.

Another feature is a new method of stabilizing the circuit, reducing internal noises and disturbances to a minimum.

Victor Radio-Phonograph Combination, using 226's, a 227, two 245's and a 280. The set is equipped with a tone control.

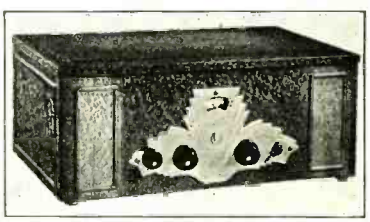
Tuning is accomplished with a new single lever control, an improvement over the customary single dial control. The tuning lever operates over a full-vision illuminated scale, accurately calibrated in kilocycles, with space at the top for marking the station positions. Accurate vernier adjustment can be obtained by turning the knob of the lever. There are three additional controls—the volume control, the radio-record transfer switch, and the small snap switch below the tuning scale to control all power.

The power amplifier unit has many new and distinctive features, including use of the UX-245. Two UX-245's are used in an accurately balanced push-pull circuit, giving distortionless reproduction.

There is a Harmonic Modulator which enables the dealer to regulate emphasis on the bass when the customer's preferences or the acoustic qualities of a room seem to demand the alteration. This Harmonic Modulator is set at the factory for the best reproduction over the entire musical scale, and by means of a simple adjustment the high notes can be reduced and the bass increased, or vice-versa. The amplifier unit is small and compact, constructed on a metal base. A multi-plug socket provides all connections from the unit to the radio set and to the electrodynamic speaker.

The combination instrument is equipped with the Electrola model 91 induction disc motor, and 12-inch turntable covered with green fabrikoid. A new electric pick-up is mounted on the end of a straight pick-up arm which replaces the tone arm.

Serviceability is one of the foremost features of the design. There is an arrangement of individual units with parts easily accessible, and a new and simplified color code system of internal wiring. Any one of the four units in the combination instrument—the radio receiver, the power amplifier, the electrodynamic speaker and the Electrola playing equipment—may be instantly dismounted and replaced or substituted.



New Buckingham receiver, which has a tuned antenna circuit. It employs four 226's, one 227, two 171-A's in push-pull and a 280 rectifier. There is an adjustable hum control.

Buyers Directory of Materials and Apparatus

Readers interested in products not listed in these columns are invited to tell us of their wants, and we will inform the proper manufacturers. Address Readers' Information Bureau.

Addresses of companies listed below, can be found in their advertisement—see index on page 78.

ADAPTERS:
Insuline Corp. of Amer.
Lynch, Arthur H., Inc.

ALUMINUM:
Aluminum Co. of America

ALUMINUM FOIL:
Aluminum Co. of America
Reynolds Metals Co., Inc.

AMMETERS:
General Electric Co.
General Radio Co.
Jewell Elec. Inst. Co.
Weston Elec. Instrument Corp.

AMPLIFIERS, POWER:
G. M. Laboratories, Inc.
General Amplifier Co.
General Radio Co.
National Co., Inc.
Samson Elec. Co.

ANTENNAE, LAMP SOCKET:
Dubilier Condenser Mfg. Co.
Electrad, Inc.

ARRESTERS, LIGHTNING:
Jewell Elec. Inst. Co.
Westinghouse Elec. & Mfg. Co.

BASES, VACUUM TUBE:
Formica Insulation Co.
General Electric Co.
General Plastics Co.
National Vulcanized Fibre Co.
Synthane Corp.

BAFFLES:
Wright-DeCoster, Inc.

BENCHES, STEEL WORK:
Standard Pressed Steel Co.

BINDING POSTS:
Eby, H. H., Co.
General Radio Co.

BRACKETS, ANGLE:
Electrad, Inc.
Insuline Corp. of Amer.
Scovill Mfg. Co.

BRASS:
Baltimore Brass Co.
Scovill Mfg. Co.

BROADCAST STATION EQUIP'T:
Cardwell, Allen D., Mfg. Co.
General Radio Co.
Jenkins & Adair, Inc.
Nelson, I. R., Co.

BULBS, PANEL:
Palatine Industrial Co., Inc.

BUTTS:
Scovill Mfg. Co.

CABINETS, METAL:
Aluminum Co. of America.
Copper and Brass Research Assn.

CELLS, PHOTOELECTRIC:
Burt, Robert C.
G. M. Laboratories, Inc.
Raytheon Mfg. Co.

CHARGERS:
Benwood-Linze Co.
Elkon Co.

CHASSES
Aluminum Co. of America.
United Scientific Laboratories, Inc.

CHOKES, AUDIO FREQUENCY:
American Transformer Co.
General Radio Co.
Jefferson Electric Co.
Silver-Marshall, Inc.
Thordarson Elec. Mfg. Co.
Transformer Co. of Amer.

CHOKES, RADIO FREQUENCY:
Cardwell, Allen D., Mfg. Co.
General Radio Co.
Silver-Marshall, Inc.

CHOKES, B ELIMINATOR:
American Transformer Co.
Dongan Elec. Mfg. Co.
General Radio Co.
Jefferson Electric Co.
Nelson, I. R., Co.
Polymet Mfg. Corp.
Silver-Marshall, Inc.
Transformer Co. of Amer.
Valley Appliances, Inc.

CLAMPS, GROUND:
Insuline Corp. of Amer.
Fahnestock Elec. Co.
Scovill Mfg. Co.

CLIPS, SPRING:
Electrad, Inc.
Fahnestock Elec. Co.
Scovill Mfg. Co.

COIL FORMS:
General Radio Co.
Silver-Marshall, Inc.

COIL WINDING:
Acme Wire Co.
Dudlo Mfg. Co.
Polymet Mfg. Corp.
Rome Wire Co.

COILS, CHOKE:
Acme Wire Co.
Dudlo Mfg. Co.
Jefferson Electric Co.
Nelson, I. R., Co.
Polymet Mfg. Corp.
Rome Wire Co.

COILS, IMPEDANCE:
Acme Wire Co.
Dudlo Mfg. Co
Nelson, I. R., Co.
Polymet Mfg. Corp.
Rome Wire Co.

COILS, INDUCTANCE:
Acme Wire Co.
Aero Products Corp.
Cardwell, Allen, D., Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co.
National Co., Inc.
Nelson, I. R., Co.
Rome Wire Co.
Silver-Marshall, Inc.

COILS, MAGNET:
Acme Wire Co.
Dudlo Mfg. Co
Nelson, I. R., Co.
Polymet Mfg. Corp.
Rome Wire Co.

COILS, RETARD:
Hammarlund Mfg. Co.

COILS, SHORT WAVE:
Aero Products Corp.
General Radio Co.
Hammarlund Mfg. Co.
Silver-Marshall, Inc.

COILS, TRANSFORMER:
Acme Wire Co.
Dudlo Mfg. Co
Nelson, I. R., Co.
Polymet Mfg. Corp.
Rome Wire Co.
Valley Appliances, Inc.

CONDENSER PARTS:
Aluminum Co. of America
Scovill Mfg. Co.

CONDENSERS, BY-PASS:
Acme Wire Co.
Aerovox Wireless Corpn.
Allen-Bradley Co.
Amrad Co.
Condenser Corp. of America.
Concourse Elec. Co.
Dongan Electric Mfg. Co.
Dubilier Condenser Mfg. Co.
Electrad, Inc.
Fast, John E. & Co.
Flechtheim Co.
Gerd Electric Co., Inc.
Polymet Mfg. Corp.
Sangamo Elec. Co.
Wireless Specialty Apparatus Co.

CONDENSERS, FILTER:
Acme Wire Co.
Aerovox Wireless Corpn.
Allen-Bradley Co.
Amrad Co.
Concourse Elec. Co.
Condenser Corp. of America.
Dongan Electric Mfg. Co.
Dubilier Condenser Mfg. Co.
Fast, John E. & Co.
Flechtheim Co.
Gerd Electric Co., Inc.
Polymet Mfg. Corp.
Sangamo Elec. Co.
Wireless Specialty Apparatus Co.

CONDENSERS, FIXED:
Acme Wire Co.
Aerovox Wireless Corpn.
Allen-Bradley Co.
Amrad Co.
Concourse Elec. Co.
Condenser Corp. of America.
Dongan Electric Mfg. Co.
Dubilier Condenser Mfg. Co.
Electrad, Inc.
Electro-Motive Eng. Co.
Fast, John E., & Co.
Flechtheim Co.
Gerd Electric Co., Inc.
Polymet Mfg. Corp.
Sangamo Elec. Co.
Wireless Specialty Apparatus Co.

CONDENSERS, MIDGET:
Cardwell, Allen D. Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co.
National Co., Inc.
Scovill Mfg. Co.
Silver-Marshall, Inc.
United Scientific Laboratories

CONDENSERS, MULTIPLE:
Cardwell, Allen D. Mfg. Co.
Hammarlund Mfg. Co.
National Co., Inc.
Scovill Mfg. Co.
United Scientific Laboratories.

CONDENSERS, NEUTRALIZING:
Polymet Mfg. Corp.

CONDENSERS TRANSMITTING:
Dubilier Condenser Mfg. Co.

CONDENSERS, VARIABLE TRANSMITTING:
Cardwell, Allen D. Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co.
National Co., Inc.

CONDENSERS, VARIABLE:
Cardwell, Allen D. Mfg. Co.
DeJur-Amsco Co.
Frost, Herbert H., Inc.
General Radio Co.
Hammarlund Mfg. Co.
National Co., Inc.
Scovill Mfg. Co.
Silver-Marshall, Inc.
United Scientific Laboratories

CONNECTORS:
Cornish Wire Co.
Scovill Mfg. Co.

CONTROLS, CURRENT:
Central Radio Laboratories
DeJur-Amsco Corp.
Insuline Corp. of Amer.
Polymet Mfg. Corp.
Ward Leonard Elec. Co.

CONTROLS, ILLUMINATED:
Hammarlund Mfg. Co.
Silver-Marshall, Inc.

CONTROLS, VOLUME:
Central Radio Laboratories
Clarostat Co.
Electrad, Inc.
Polymet Mfg. Corp.

CONVERTERS:
Cardwell, Allen D., Co.
Electric Specialty Co.

CONVERTERS, ROTARY:
Electric Specialty Co.

COPPER:
Baltimore Brass Co.
Scovill Mfg. Co.

CORDS, EXTENSION:
Acme Wire Co.
Cornish Wire Co.

CURRENT CONTROLS, AUTOMATIC:
Radiall Co.

DIALS:
Crowe Nameplate & Mfg. Co.
Hammarlund Mfg. Co.
National Co., Inc.
Scovill Mfg. Co.
Silver-Marshall, Inc.
United Scientific Laboratories

DIALS, DRUM:
Hammarlund Mfg. Co.
National Co., Inc.
Silver-Marshall, Inc.
United Scientific Laboratories

DIES:
Luna Metal Craft Co.
Willor Mfg. Corp.

DYNAMOTORS:
Electric Specialty Co.

ENGINEERS, CONSULTING:
Allied Engineering Institute

ESCUTCHEONS:
Crowe Nameplate & Mfg. Co.
Scovill Mfg. Co.

EXPORT:
Ad. Auriema, Inc.

FILAMENTS:
Cohn, Sigmund
Callite Products Co., Inc.
Fansteel Products Co., Inc.
Gilby Wire Co.
Vacuum Tube Products Co.

FILAMENT CONTROLS, AUTOMATIC:
Lynch, Arthur H., Inc.
Polymet Mfg. Corp.
Radiall Co.

FOIL:
Aluminum Co. of America
Lehmaier, Schwartz & Co.
Reynolds Metals Co., Inc.

GALVANOMETERS:
General Electric Co.
General Radio Co.
Jewell Elec. Inst. Co.

GASES, RARE:
Palatine Industrial Co., Inc.

GEARS:
Chicago Stock Gear Wks.

GENERATORS:
Electric Specialty Co.

GETTER MATERIAL:
Cohn, Sigmund.
Gilby Wire Co.

GRID LEAKS:
Aerovox Wireless Corpn.
Allen-Bradley Co.
DeJur-Amsco Co.
Electrad, Inc.
Electro Motive Eng. Co.
Hardwick, Hindle, Inc.
International Resistance Co.
Lautz Mfg. Co.
Lynch, Arthur H., Inc.
Polymet Mfg. Corp.
Ward Leonard Elec. Co.

HARNESSES, A-C.:
Cornish Wire Co.
Eby, H. H. Co.

HEADPHONES:
Amplion Co. of Amer.

HINGES:
Scovill Mfg. Co.

HORNS:
Amplion Co. of Amer.
Best Mfg. Co.
Magnavox Co.
Miles Mfg. Corp.
Oxford Radio Corp.

INDUCTANCES, TRANSMITTING:
Aero Products, Inc.
General Radio Co.
Silver-Marshall, Inc.

INSTRUMENTS, ELECTRICAL:
General Electric Co.
Jewell Elec. Inst. Co.

INSULATION LAMINATED
Formica Insulation Co.
General Electric Co.
National Vulcanized Fibre Co.
Synthane Corp.

INSULATION, MOULDED:
Bakelite Corp.
Formica Insulation Co.
General Electric Co.
General Plastics Co.
National Vulcanized Fibre Co.
Synthane Corp.

INSULATION, VARNISHED:
Acme Wire Co.

IRON, MAGNETIC:
Reid, David, Jr.

JACKS:
Carter Radio Co.
Eby, H. H., Co.
Electrad, Inc.
General Radio Co.
Yaxley Co.

JACKS, TIP:
Carter Radio Co.
Eby, H. H., Co.
Yaxley Co.

KITS, SHORT WAVE:
Aero Products, Inc.
Lynch, Arthur H., Inc.
Silver-Marshall, Inc.

KITS, TELEVISION:
Insuline Co.
Lynch, Arthur H., Inc.

KITS, TESTING:
General Radio Co.
Jewell Elec. Inst. Co.

KITS, TRANSMITTING:
Aero Products, Inc.

LACQUERS:
Zapon Co., The

LABORATORIES, TESTING:
Electrical Testing Labs.

LABORATORIES, ENGINEERING:
Allied Engineering Institute

LAMINATIONS:
Lamination Stamping Co.
Valley Appliances, Inc.
Willor Mfg. Co.

LAMPS, SOUND RECORDING:
G. M. Laboratories, Inc.

LEAD-INS:
Electrad, Inc.
Insuline Corp. of Amer.

LOCK WASHERS:
Shakeproof Lock Washer Co.

LUGS:
Scovill Mfg. Co.
Shakeproof Lock Washer Co.

MACHINERY, TUBE:
Eisler Eng. Co.

MACHINES, SPECIAL
Willor Mfg. Corp.

MAGNESIUM:
Aluminum Co. of America.

MAGNETS:
Indiana Steel Products Co.
Reid, David, Jr.
Thomas & Skinner Co.

METALS, RARE:
Fansteel Products Co., Inc.

MERCURY SWITCHES:
(See Switches)

METERS:
General Electric Co.
Jewell Elec. Inst. Co.
Weston Elec. Instr. Co.

MICROPHONES:
Amplion Co. of America
Jenkins & Adair, Inc.
Universal Microphone Co.

MOLDING MATERIALS
Bakelite Corp.
Formica Insulation Co.
General Electric Co.
General Plastics Co.
National Vulcanized Fibre Co.
Synthane Corp.

MOTORS:
Electric Specialty Co.

MOTOR-GENERATORS:
Electric Specialty Co.

MOUNTINGS, RESISTANCE:
DeJur-Amsco Co.
Electrad, Inc.
Lynch, Arthur H., Inc.
Polymet Mfg. Corp.

NAMEPLATES:
Crowe Nameplate & Mfg. Co.
Scovill Mfg. Co.

NICKEL:
Cohn, Sigmund

NUTS:
Shakeproof Lock Washer Co.

OHMMETERS:
General Radio Co.
Western Elec. Instru. Co.

OSCILLOGRAPH:
Burt, Dr. Rob't C.
General Radio Co.

OSCILLOSCOPE:
Burt, Dr. Rob't C.

PANELS, COMPOSITION:
Formica Insulation Co.
Insuline Corp. of Amer.
Synthane Corp.

PANELS, METAL:
Aluminum Co. of America
Scovill Mfg. Co.

PAPER, CONDENSER:
Dexter, C. H. & Sons, Inc.
Old Masters Paper & Pulp Co.
Schweitzer, Peter J., Inc.

PAPER, CONE SPEAKER:
Seymour Co.

PARTS, SCREW MACHINE:
Standard Pressed Steel Co.

PHONOGRAPH MOTORS:
(See Motors)

PHOSPHOR BRONZE:
Baltimore Brass Co.

PHOTOELECTRIC CELLS:
(See Cells)

PICK-UPS, PHONOGRAPH:
Amplion Co. of Amer.
Jensen Co.
Magnavox Co.
Wright DeCoster

PLATES, OUTLET:
Carter Radio Co.
Yaxley Co.

PLATING:
Valley Appliances, Inc.

PLUGS:
Carter Radio Co.
General Radio Co.
Polymet Mfg. Corp.
Yaxley Co.

POTENTIOMETERS:
Allen-Bradley Co.
Central Radio Laboratories
DeJur-Amsco Co.
Electrad, Inc.
General Radio Co.
Polymet Mfg. Corp.
United Scientific Laboratories

POWER UNITS, A-:
Elkon, Inc.
Jefferson Electric Co.
Kodel Radio Corp.

POWER UNITS, B-:
Dongan Elec. Mfg. Co.
General Radio Co.
Jefferson Electric Co.
National Co., Inc.
Silver-Marshall, Inc.
Thordarson Electric Mfg. Co.
Webster Co.

POWER UNITS, A-B-C:
Dongan Elec. Mfg. Co.
General Radio Co.
Jefferson Electric Co.
Kodel Radio Corp.
National Co., Inc.
Silver-Marshall, Inc.
Thordarson Electric Mfg. Co.

POWER UNITS, PARTS FOR:
Acme Wire Co.
American Transformer Co.
Dongan Elec. Mfg. Co.
General Radio Co.
Jefferson Electric Co.
Kodel Radio Corp.
Lynch, Arthur H., Inc.
National Co., Inc.
Nelson, I. R., Co.
Polymet Mfg. Corp.
Thordarson Electric Mfg. Co.
Transformer Co. of Amer.

PRESSINGS:
Scovill Mfg. Co.

PUNCHINGS:
Aluminum Co. of America
Luna Metal Craft Co.
Scovill Mfg. Co.

RECEPTACLES, WALL:
Carter Radio Co.
Yaxley Co.

RECTIFIERS, DRY:
Benwood-Linze, Inc.
Elkon, Inc.
Kodel Elec. & Mfg. Co.

REGULATORS, VOLTAGE:
Central Radio Laboratories
Clarostat Co.
DeJur-Amsco Co.
Polymet Mfg. Corp.
Radiall Co.
Ward Leonard Elec. Co.
Yaxley Co.

RELAYS:
Cardwell. Allen D., Mfg. Co.
Leach Relay Co.

RESISTANCES, FIXED:
Aerovox Wireless Corp.
Allen-Bradley Co.
Central Radio Laboratories.
DeJur-Amsco Co.
Electrad, Inc.
Electro-Motive Co.
Frost, Herbert H.
Hardwick, Hindle Inc.
International Resistance Co.
Lautz Mfg. Co.
Lynch, Arthur H., Inc.
Polymet Mfg. Corp.
Ward Leonard Elec. Co.

RESISTANCES, VARIABLE:
Allen-Bradley Co.
American Mechanical Labs.
Central Radio Laboratories.
Electrad, Inc.
Electro-Motive Co.
Frost, Herbert H.
Hardwick, Hindle, Inc.
International Resistance Co.
Lynch, Arthur H., Inc.
Polymet Mfg. Corp.
Ward Leonard Elec. Co.

RHEOSTATS:
Allen-Bradley Co.
Central Radio Laboratories.
DeJur-Amsco Co.
Electrad, Inc.
Electro-Motive Co.
Frost, Herbert H.
General Radio Co.
Polymet Mfg. Corp.
United Scientific Laboratories.

SCREW MACHINE PRODUCTS:
Aluminum Co. of America
National Vulcanized Fibre Co.
Scovill Mfg. Co.
Standard Pressed Steel Co.
Synthane Corp.

SEALING COMPOUNDS:
Candy & Co.

SHIELDING, METAL:
Aluminum Co. of America.
Copper and Brass Research Assn.
Luna Metal Craft Co.

SHIELDS, TUBE:
Carter Radio Co.

SHORT WAVE APPARATUS:
Cardwell, Allen D., Co.
General Radio Co.
Lynch, Arthur H., Inc.
Silver-Marshall, Inc.

SOCKETS, TUBE:
Eby, H. H., Co.
Frost, Herbert H.
General Radio Co.
Lynch, Arthur H., Inc.
Silver-Marshall, Inc.
Yaxley Co.

SOLDER:
Chicago Solder Co.

SOUND CHAMBERS:
Amplion Corp. of Amer.
Jensen Radio Mfg. Co.
Miles Mfg. Corp.
Oxford Radio Corp.
Rola Co., The

SOUND RECORDING LAMPS
(See Lamps)

SPAGHETTI:
(See Wire, Spaghetti).

SPEAKERS:
Amplion Corp. of Amer.
Best Mfg. Co.
Jensen Radio Mfg. Co.
Magnavox Co.
Miles Mfg. Corp.
Oxford Radio Corp.
Rola Co., The
Silver-Marshall, Inc.
Transformer Co. of Amer.
Wright-DeCoster, Inc.

STAMPINGS, METAL:
Aluminum Co. of America
Luna Metal Craft Co.
Scovill Mfg. Co.
Valley Appliances, Inc.

STEEL, MAGNETIC:
See *(Iron Magnetic.)*

SPRAYING:
Valley Appliances, inc.

SUBPANELS:
Formica Ins. Co.
Insuline Corp. of Amer.
General Radio Co.
National Vulcanized Fibre Co.
Westinghouse Elec. & Mfg. Co.

SWITCHES:
Electrad, Inc.
Insuline Corp. of Amer.

SWITCHES, MERCURY:
G. M. Laboratories, inc.

TABLES, STEEL WORK:
Standard Pressed Steel Co.

TANTALUM:
Fansteel Products Co., Inc.

TAPPERS
Eastern Tube and Tool Co.

TELEVISION PARTS:
Allen-Bradley Co.
Clarostat Co., Inc.
Insuline Corp. of Amer.
Lynch, Arthur H., Inc.

TESTERS, B-ELIMINATOR:
General Radio Co.
Jewell Electrical Inst. Co.

TESTERS, TUBE:
General Radio Co.
Jewell Elec. Inst. Co.

TESTING INSTRUMENTS:
General Electric Co.
General Radio Co.
Jewell Elec. Inst. Co.
Weston Elec. Instrument Corp.

TESTING KITS:
Jewell Elec. Inst. Co.

TESTING LABORATORIES:
Electrical Testing Labs.

TIN COATED METAL:
Baltimore Brass Co.

TINFOIL:
Lehmaier, Schwartz & Co.
Reynolds Metals Co., Inc.

TOOL STANDS:
Standard Pressed Steel Co.

TOOLS:
Eastern Tube and Tool Co.
Willor Mfg. Corp.

TRANSFORMERS, AUDIO:
Dongan Elec. Mfg. Co.
Ferranti, Ltd.
General Radio Co.
Jefferson Electric Co.
National Co., Inc.
Samson Elec. Co.
Sangamo Elec. Co.
Silver-Marshall, Inc.
Thordarson Electric Mfg. Co.
Transformer Co. of America.
Webster Co.

TRANSFORMERS, B-POWER UNIT:
Dongan Elec. Mfg. Co.
Ferranti, Ltd.
General Radio Co.
Jefferson Electric Co.
National Co., Inc.
Nelson, I. R., Co.
Samson Elec. Co.
Sangamo Elec. Co.
Silver-Marshall, Inc.
Thordarson Electric Mfg. Co.
Transformer Co. of America.
Webster Co.

TRANSFORMERS, FILAMENT HEATING:
Dongan Elec. Mfg. Co.
General Radio Co.
Jefferson Electric Co.
Nelson, I. R., Co.
Silver-Marshall, Inc.
Thordarson Electric Mfg. Co.
Transformer Corp. of America.

TRANSFORMERS, OUTPUT:
Dongan Elec. Mfg. Co.
Ferranti, Ltd.
General Radio Co.
Jefferson Electric Co.
Nelson, I. R., Co.
Samson Elec. Co.
Sangamo Elec. Co.
Silver-Marshall, Inc.
Thordarson Electric Mfg. Co.
Transformer Corp. of America.

TRANSFORMERS, POWER:
Dongan Elec. Mfg. Co.
Ferranti, Ltd.
General Radio Co.
Jefferson Electric Co.
National Co., Inc.
Nelson, I. R., Co.
Polymet Mfg. Co.
Samson Elec. Co.
Silver-Marshall, Inc.
Thordarson Electric Mfg. Co.
Transformer Co. of America.
Webster Co.

TRANSFORMERS, R. F., TUNED:
Cardwell, Allen D. Mfg. Co.
Silver-Marshall, Inc.

TRANSFORMERS, STEP-DOWN:
Amplion Corp. of Amer.

TUBE MACHINERY:
Eisler Eng. Co.

TUBES, A.C.:
Allan Mfg. Co.
Arcturus Radio Co.
Armstrong Elec. Co.
Cable Radio Tube Co.
Ceco Mfg. Co.
De Forest Radio Co.
Duval Tube Co.
Hyvac Radio Tube Co.
National Carbon Co., Inc.
Perryman Electric Co.
Sylvania Products Co.
Triad Mfg. Co.

TUBES, RECTIFIER:
Allan Mfg. Co.
Arcturus Radio Co.
Armstrong Elec. Co.
Cable Radio Tube Co.
Ceco Mfg. Co.
Duval Tube Co.
Hyvac Radio Tube Co.
National Carbon Co., Inc.
Perryman Electric Co.
Sylvania Products Co.
Triad Mfg. Co.

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Armstrong Elec. Co.
Cable Radio Tube Co.
Ceco Mfg. Co.
Duval Tube Co.
Hyvac Radio Tube Co.
De Forest Radio Co.
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Sylvania Products Co.
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TUBES, TELEVISION
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De Forest Radio Co.
National Carbon Co., Inc.
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Sylvania Products Co.
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Temple, Inc.
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General Radio Co.
Jewell Elec. Inst. Co.
Weston Elec. Instrument Corp.

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General Radio Co.
Jewell Elec. Inst. Co.
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WASHERS:
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Scovill Mfg. Co.
Shakeproof Lock Washer Co.
Synthane Corp.

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Candy and Co.

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Roebling, J. A., Sons, Co.
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Dudlo Mfg. Corp.
Roebling, J. A., Sons, Co.
Rome Wire Co.

WIRE, COTTON COVERED:
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Cornish Wire Co.
Dudlo Mfg. Corp.
Roebling, J. A., Sons Co.
Rome Wire Co.

WIRE, ENAMELED COPPER:
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Cornish Wire Co.
Dudlo Mfg. Corp.
Polymet Mfg. Corp.
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Rome Wire Co.

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Cohn, Sigmund
Fansteel Products Co., Inc.
Gilby Wire Co.
Vacuum Tube Products Co.

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Cornish Wire Co.
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Roebling, J. A., Sons, Co.
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Dudlo Mfg. Corp.
Roebling, J. A., Sons Co.
Rome Wire Co.

WIRE, MOLYBDENUM:
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Fansteel Products Co., Inc.
Palatine Industrial Co., Inc.

WIRE, PIGTAIL:
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Roebling, J. A., Sons Co.
Rome Wire Co.

WIRE, RESISTANCE
Gilby Wire Co.

WIRE, SILK COVERED:
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Cornish Wire Co.
Dudlo Mfg. Corp.
Roebling, J. A., Sons Co.
Rome Wire Co.

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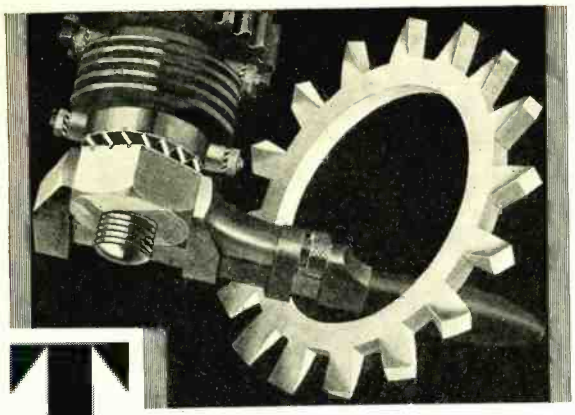

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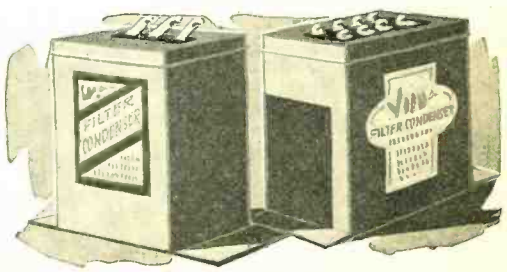

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