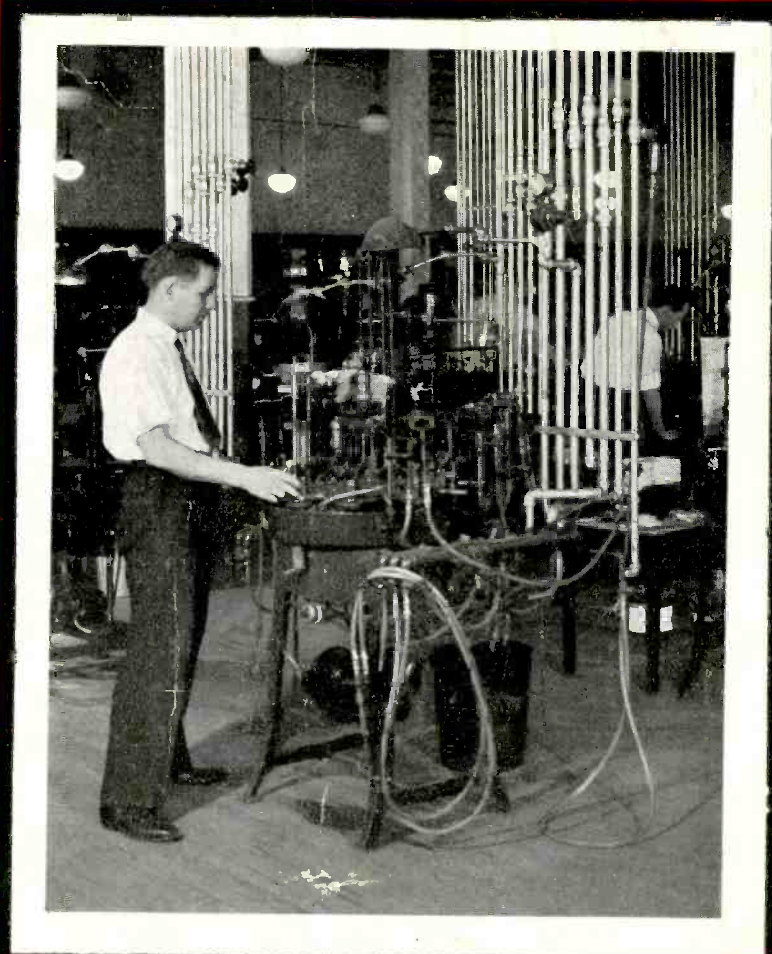
Radio Engineering

OCTOBER, 1936

VOL. XVI NO. 10

DESIGN • PRODUCTION • ENGINEERING

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



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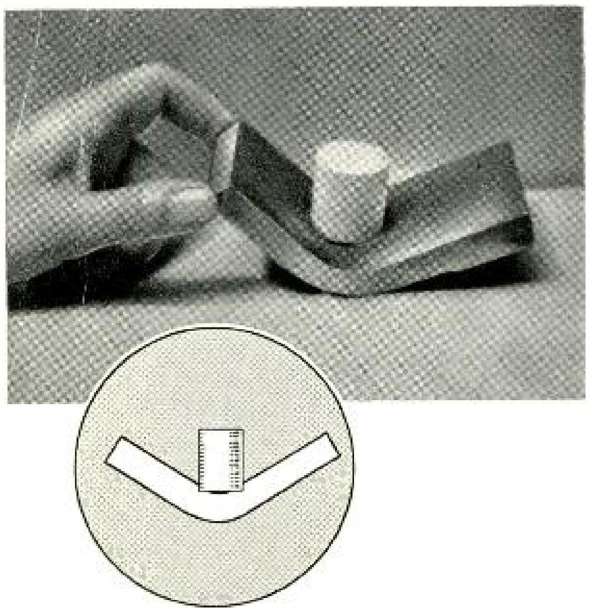

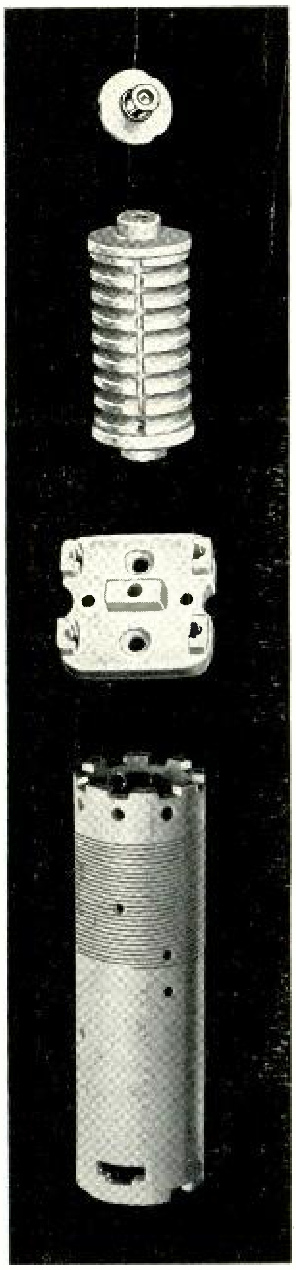

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The illustration shows a test block of Alsimag 196 which has been compressed on the Riehle universal testing machine at the maximum load of the machine:—35,000 lbs.

The underlying block of cold rolled steel, ½″ thick × 2½″ wide and supported on edges 4″ apart, bent but the ceramic test piece imbedded itself in the steel without breaking or cracking.

Ceramic was Alsimag 196 extruded rod 1⅛″ O. D. x 1⅛″ long.

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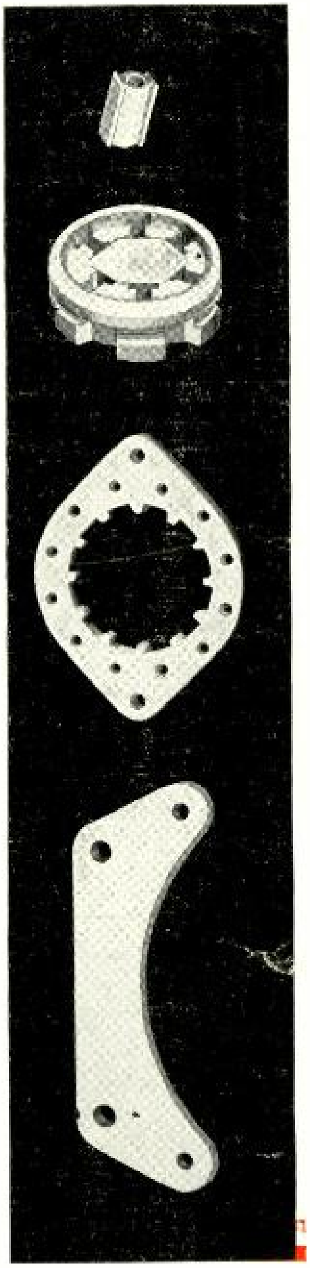
ELECTRICAL CHARACTERISTICS

Dielectric Constant at 3000 K.C.	6.		
Power Factor at 1000 KCS—50 MCS	.08	-.04%	(.0008-.0004)
Loss Factor at 1000 KCS—50 MCS	.48	-.24%	(.0048-.0024)
Volume Resistivity ohms per CC: 20°C	10^{14}	-10^{15}	
300°C	10^{10}		
600°C	4.10^{7}		
Porosity	Nil		

These desirable

MECHANICAL PROPERTIES

Tensile Strength: lbs. per sq. in.	8,000
Compressive Strength: lbs. per sq. in.	120,000
Modulus of Rupture: lbs. per sq. in.	18,000
Impact bending strength: ft. lbs. sq. in.	1.6-2.1
Thermal expansion between 20°—650°C	$6.3 - 7.6 \times 10^{-6}$



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RADIO ENGINEERING

REG. U. S. PATENT OFFICE

W. W. WALTZ • Editor

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DEPARTMENTS

VOL. XVI — *Member Audit Bureau of Circulations* — NO. 10

COVER ILLUSTRATION

ROTARY GLASS-BLOWING MACHINE IN THE VACUUM TUBE LABORATORY OF THE BELL TELEPHONE LABORATORIES, INC.

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Editorial

THIS MONTH

THE COMPLETE PROGRAM of the joint meeting of the IRE and the Engineering Division of the RMA, which is to be held in Rochester on November 16, 17, and 18, will be found on page 5. As is generally the case, the papers scheduled are of the greatest interest to the engineers of the industry. A later issue will contain a full report of the meeting.

We seem to have a decided acoustic trend this month. The paper on the RCA "Magic Voice" leads the procession; further on are details of ERPI's new theatre sound system, in which there are a number of innovations, especially at the stage end of the system where a radically new type of speaker is employed. The Stromberg-Carlson Acoustic Labyrinth is shown, along with a few remarks for which we are indebted to Messrs. Manson and Olney. Mr. Olney has given papers before several engineering societies on the subject of the Labyrinth, and we, among others, are keenly anticipating his talk scheduled for the Rochester IRE meeting.

Regarding inverse feedback, which we discussed last month, the chart on page 21 shows, we believe, what may be expected from the use of this system. Actually, on the chart mentioned, the comparison is between speakers driven by triodes and pentodes, but the final results—which so completely favor triode drive—are essentially the same with feedback to "hold down" the peaks due to the high impedance of pentodes. The chart is a portion of the concluding article of the series on loudspeaker analysis.

Our engineering chart this month—for which we wish to express our thanks to the Aerovox Corporation—should be of value to those, who like ourselves, are more or less constantly "balled up" trying to keep a lot of mathematical expressions filed in their proper mental locations. And it is just about ideal for the rapid determination of the maximum voltage which may be impressed across a resistance of a given watts rating.

TUBES AND TUBE NUMBERS

OUR EDITORIAL ON this subject (RADIO ENGINEERING, July, 1936) has met with several different reactions—radically different!

Among other things, it has been suggested to us that if we know of—or think we know of—a better numbering system, we ought to drag it out for inspection. Just at the present moment, our pet system is none other than the oldest of the lot, two or three digit numbers. There are 990 of these available and, although we will admit that such a numbering system tells nothing whatever of the type of the tube, it isn't beyond the realm of possibility that once a particular number has been identified with a tube, it will more or less unconsciously be associated with that tube. Who among us has any doubt of the tubes associated with such numbers as 01, 45, 10, etc.?

However, such a system doesn't represent progress, so we aren't too much inclined to harp on its advantages. Probably some modification of the present number-letter-number system can be worked out which will be more descriptive of the tube. We are assembling a lot of comments on this matter and will, before long we hope, have something more constructive to suggest.

While on the subject of tubes, we wonder how much, if any, consideration has been given to the idea of permanently discontinuing some of the old tube types. The market for these tubes certainly can't be very great, and the price at which these tubes must be sold surely represents a loss to the tube manufacturer.

The argument will arise that there are many receivers in use today which require these out-dated tubes, and the sad part of that argument lies in the absolute truth of it. But, can't the owners of these 1926 model antiques be sold on the advantages of a new set?

We know, personally, of one store-keeper who raises particular Hell in his neighborhood with one of these something-or-anothers from 'way back when. We asked him what he would do if he could no longer obtain tubes for his "set." His answer, delivered with an eloquent shrug was, "Then, I buy a new set."

That man may not be typical of the owners of these millions (actually!) of ancient receivers, but again, he may be highly representative. No doubt, many people have held on to their old sets simply because they didn't have the money to buy a new one, and perhaps they have become so accustomed to the sound of the thing that it really doesn't annoy them.

Such people, however, ought to be ideal prospects for the sale of new receivers and, if the incentive to go out and buy a couple of new tubes—for 37 cents each—was removed by the simple procedure of the tube manufacturer refusing further to supply them, there ought to be a decided up-turn in set business.

There is an opportunity here for some cooperation between the tube and receiver people.

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RADIO ENGINEERING

FOR OCTOBER, 1936

I R E

Rochester Fall Meeting

November 16, 17, 18

THE INSTITUTE OF RADIO ENGINEERS and the Engineering Division of the Radio Manufacturers Association will hold a combined three-day meeting at the Sagamore Hotel, Rochester, N. Y., on November 16, 17 and 18. An unusually interesting program has been prepared; the complete schedule follows:

MONDAY, NOVEMBER 16

9:00 A.M.
Registration
Inspection of Exhibits

10:00 A.M.
Technical Session

Equipment and Methods Used in Routine Measurements of Loudspeaker Response, by S. V. Perry, RCA Mfg. Co., Victor Division.

Current Measurements at Ultra-High Frequencies, by John H. Miller, Weston Electrical Instrument Corp.

Acoustic Networks in Radio Receiver Cabinets, by Hugh S. Knowles, Jensen Radio Manufacturing Co.

12:30 P.M.
Group Luncheon

2:00 P.M.
Technical Session

Shot Effect in Space-Charge-Limited Vacuum Tubes, by B. J. Thompson and D. O. North, RCA Mfg. Co., Radiotron Division.

Automatic Control of Selectivity by Feedback, by H. F. Mayer, General Electric Company.

4:00 P.M.
Inspection of Exhibits
RMA Committee on Broadcast Receivers

6:30 P.M.
Group Dinner

7:30 P.M.-8:30 P.M.
Inspection of Cyclotron at University of Rochester

9:00 P.M.
"Open House" at Rochester Club, courtesy of Delco Appliance Corporation

TUESDAY, NOVEMBER 17

9:00 A.M.
Exhibits Open

9:30 A.M.
Technical Session

The Federal Communications Commission and the Engineering Division of RMA, by T. A. M. Craven, Federal Communications Commission.

Radio Tubes Today, by R. M. Wise, Hygrade Sylvania Corporation.

Survey of Receiver Characteristics, by A. F. Van Dyck and D. E. Foster, RCA License Laboratory.

12:30 P.M.
Group Luncheon

2:00 P.M.
Technical Session

Commercial Television—and Its Needs, by Alfred N. Goldsmith, consulting engineer.

Latest Television Standards as Proposed by the Engineering Division of RMA, by Albert F. Murray, Philco Radio & Television Corp.

4:00 P.M.
Inspection of Exhibits
RMA Committee on Sound Equipment

6:30 P.M.
Stag Banquet
Toastmaster, J. S. Wellwood.
Speaker, Henry W. Parker.
Subject, Radio Observations.

WEDNESDAY, NOVEMBER 18

9:00 A.M.
Exhibits Open

9:30 A.M.
Technical Session

Application of Nickel to Radio, by E. M. Wise, International Nickel Company.

Partial Suppression of One Sideband in Television Reception, by W. J. Poch and D. W. Epstein, RCA Mfg. Co., Victor Division.

Improvements in the Performance of Cabinet Type Loudspeakers at Low Frequencies, by Benjamin Olney, Stromberg-Carlson Tel. Mfg. Company.

12:30 P.M.
Group Luncheon

2:00 P.M.
Technical Session

Notes on Feedback Amplifiers, by R. B. Dome, General Electric Company.

Improvements in High Frequency Receivers, by J. J. Lamb, American Radio Relay League.

4:00 P.M.
Exhibits Close
RMA Committee on Vacuum Tubes.

Chassis assembly, Noblitt-Sparks.

MODERN

PROBABLY NOT ONE out of twenty of the old-time home construction enthusiasts knows or cares what lies within the present factory-built receiver in his home or automobile, so long as its performance meets modern standards. Shown the complex circuit or the parts that make it up, he frankly recognizes the fact that radio assembly today is a highly developed industrial operation, requiring specialized production facilities to provide precision, economy and favorable working conditions.

Among the production facilities, lighting which meets the exceptional requirements of compact receiver assembly has shown progress paralleling that of the receivers themselves. Today, at every step in parts manufacture and assembly in a number of modern plants, workers and inspectors not only "see what they are doing," but have the benefits of a sight-saving illumination that makes for continued accuracy and favorable morale.

As an example of progress in meeting the specialized lighting problems encountered in parts manufacture, the coil-winding department of the Philco Radio and Television Corporation, Philadelphia, is a significant example. Although the winding operation itself is largely automatic, continuous inspection by trained operators is necessary during the process to assure flawless coils and to make certain that each is wound with watch-like precision. Unlike watch-making, however, the work can not be localized beneath a bench lamp, as the moving strands must be checked at several points spread over a working area of considerable extent. Moreover, drop lamps at too low a level would seriously interfere with the production operations. Except for a limited area directly adjacent to the windows, daylight illumination is inadequate for critical work of this kind during a large part of the working day.

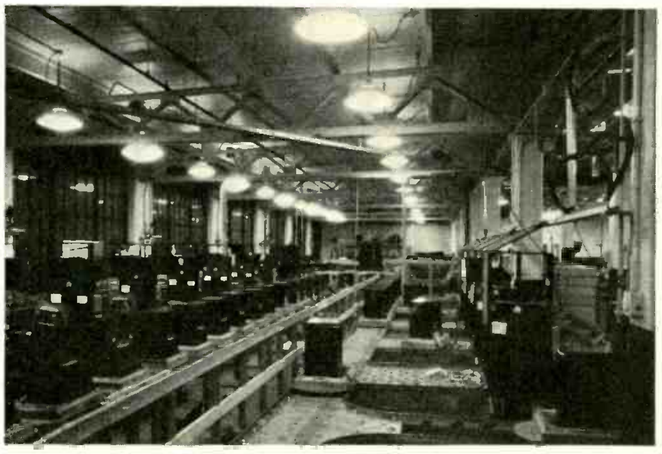
For a number of years, this coil-winding department was equipped with a lighting system of incandescent lamps in typical direct reflectors located so as to provide about the highest illumination level then considered practical without the use of bench lamps or others so close to the work as to interfere with the operations. This system involved the use of 300-watt lamps spaced on 8 by 8 foot centers, and mounted 9 feet from the floor. An illumination of about 20 foot candles was obtained at the working level, using approximately 4.6 watts per square foot. Although this illumination level is ordinarily regarded as adequate for plant operations, no possibility was overlooked in assuring the accuracy of the coils and the productive efficiency and health of the operators.

Within the past year, engineers of the General Electric Vapor Lamp Company suggested that higher illumination levels might economically be obtained with the new 400-watt "high-intensity" mercury-vapor lamp. These lamps have an output of approximately 40 lumens per watt, or approximately twice that of incandescent lamps.

A group of fifty of the units were installed in Philco's coil-winding department on an experimental basis. The installation was rather unusual, in that they did not replace all of the former units with the new type, but only *every other unit* throughout the coil-winding department. By supplanting half of the 300-watt incandescent lamps with 400-watt high-intensity lamps in reflectors designed for such use, current consumption increased from approximately 4.6 to 5.4 watts per square foot, or about 17%. The illumination at the working level, however, rose to above 50 *foot candles* with the change, a figure about three times that formerly secured! In addition, the blend of light from the alternate incandescent and mercury vapor lamps produced a whiter light of high visual effectiveness, which involved no annoying contrast to daylight from the windows.

The lighting system has now been in operation for more than six months, and is said to have resulted in tangible dollars-and-cents results in its effects upon the precision of operations and the effectiveness of inspection. Less tangible factors which condone the effect of good lighting upon the moral and continued visual health of operators are difficult to determine, but if the opinion of the operators themselves is any criterion, the new type of lighting has justified itself from this standpoint as well.

Another modern example of the use of the 400-watt bulb-type mercury lamp is in operation at the plant of the General Electric Company at Bridgeport, Conn. Here 198 of the lamps are used throughout the manufacturing assembly and inspection operations, again in



Part of the General Electric assembly line.

LIGHTING

Philco coil-winding department.

combination with alternate units containing 300-watt incandescent lamps.

Reflectors of a design that provides excellent diffusion and elimination of harsh shadows are regularly spaced on 9 by 12 foot centers 12 feet from the floor. At the working plane, the light from the alternate mercury and incandescent sources blends uniformly to supply an illumination level in excess of 30 foot candles. Energy consumption is approximately 3.2 watts per square foot.

From the installations mentioned, however, it should not be assumed that mercury lamps and incandescent lamps installed alternately in diffusing reflectors necessarily offer the most satisfactory type of lighting for all radio assembly work. Indeed, engineered lighting is receiving new attention today because of the wide flexibility with which modern light sources can meet specific visual tasks which every plant presents.

An analysis of the lighting requirements for radio chassis assembly at the plant of Noblitt-Sparks Industries, Columbus, Indiana, makers of Arvin radios, is a case in point. In the past four years, this organization has come to occupy an important place in the manufacture of automobile radios, where the necessity for combining sturdy construction with the highest receiver efficiency per cubic inch of chassis space is particularly acute.

Aside from compactness, a desirable end in itself, the "shock-resistance" which must be built into an auto-radio chassis requires that parts be assembled into a practically solid, vibration-free unit. Shielding must be complete, and all resistors, capacitors and wiring must be firmly supported and fixed in place. Construction in which the chassis is integral with the all-metal mounting case is a further move toward compactness and sturdiness in Arvin car radios.

A radio of this kind, including such complex features as automatic volume control and designed so that parts which may require service attention are easily accessible, necessarily places great demands on the assembly operations. The maze of parts and connections on the under side of the chassis base must be put in place within a well formed by the metal sides where space is at a premium, and coils and other units form other restricted pockets.

Another view of the General Electric plant.

In both assembly and inspection, these conditions require not only a high level of illumination, but a light high in its power to illuminate deep recessions, and in those qualities that make for the sharpness of vision. There must be a minimum of shadows from the case sides or projecting parts. In addition, every effort must be made to eliminate reflected glare from the bright metal parts.

When these requirements are taken together, along with the fact that ceilings in the assembly department of the Arvin plant are relatively low, the most logical solution to the problem is the use of Cooper-Hewitt mercury lamps of the straight tube type.

As a part of an expansion program which now provides capacity for about 100 car and home radios per hour at the Noblitt-Sparks plant, 64 of the 50-in. (450 watt) Cooper-Hewitt lamps were recently installed on the basis of this analysis. For chassis assembly, these lamps are mounted longitudinally above the assembly lines, 10 feet center-to-center along the axes of the lamps, 5 feet above the benches where the work is carried out. A uniform illumination level of 70 foot candles is obtained at bench level.

Due to the fact that the Cooper-Hewitt tube is a "large area" light source of relatively low intrinsic brightness, this high illumination level is obtained without appreciable reflected glare on the bright metal parts. Unlike conventional lighting at this level, there is none of the annoying contrast between surfaces too bright for comfort and dark shadows in the recessions. Theories which ascribe added clearness of vision to monochromatic light at the low light levels such as are obtained in deep pockets between the parts appear to be confirmed in practice by the ease of seeing tiny screw threads, coil windings and the like.

An objection originally raised to the use of Cooper-Hewitt lighting was the color distortion resulting from the lack of red in the mercury-vapor spectrum. This was regarded as important because of the wide use of color coding on resistors, capacitors, wires and other small parts. A test on this point, however, revealed that although the colors were somewhat unnatural, color differentiation of the coded parts was unimpaired.

THE MAGIC VOICE

by C. O. Caulton, E. T. Dickey and S. V. Perry *

EVER SINCE THE discovery in 1875 by Alexander Graham Bell of the microphone, which has made possible radio and wire telephonic communications, hundreds of scientific workers have dedicated their lives to better and more faithful reproduction of the human voice. The advances of this line of scientific endeavor have been marked by distinct and definite steps, each of which in turn has added immeasurably to the wealth of information already available.

Confining our attention to the development in radio reception, since probably as much concentrated attention has been given this problem in that field as in any other in recent years, we find considerable work being done in the early days of radio broadcasting on the audio amplifier systems. It was soon apparent, however, that after a certain point had been reached in improving this part of the system, further improvement in fidelity could only be obtained by additional development of the acoustical system. We find the old horn loudspeaker with which broadcast reception started rapidly giving place to the moving cone type of loudspeaker; first, the magnetic drive and later the dynamic type. Early in these developments it was realized that in order to reproduce the lower frequencies, some means were required to prevent neutralization of the front and back waves from the speaker cone. A large flat baffle was the obvious solution but did not lend itself easily to the limitations of conventional cabinet design. Even if a flat baffle were used, it was necessary to make it of undesirable area (the theoretically perfect loudspeaker would have a baffle of infinite extent). When the loudspeaker was housed in a console cabinet two difficulties were encountered: First, the effective baffle area was not sufficiently great to provide faithful reproduction of the very low frequencies of music; and, second, the barrel resonance effect of the partly closed cabinet space back of the loudspeaker resulted in an undue accentuation of certain parts of the low-frequency register. While this did not so seriously disturb the reproduction of musical selections (in fact to the ears of many the result was to give the impression of good low-frequency response) its effect on the reproduction of speech—particularly certain male voices whose fundamental pitch was in the region of cabinet resonance—was to exaggerate the voice fundamental with a resultant "boomy" type of reproduction which was admittedly undesirable. In many cases this made certain male voices almost unintelligible. This effect was further intensified by the practice of broadcasting studios whereby the amplifiers are operated at such levels that the musical part of the program is reproduced by the receiver at a level below normal whereas the announcer's and other voices are reproduced at a level above normal.

*Engineering Department. RCA Manufacturing Company, Inc., Camden, New Jersey.

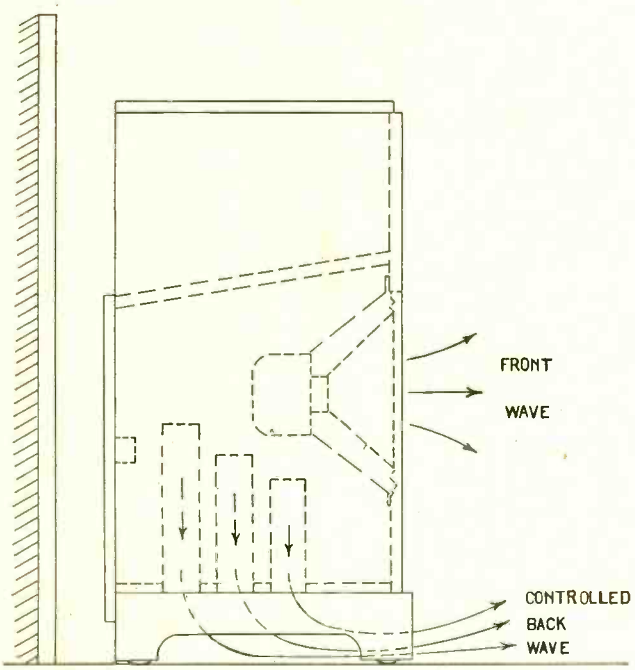


FIG. 1

The receiver designer has therefore been faced with the necessity for compromising between the requirements of good musical reproduction and those of good speech reproduction. If he elected to build into the chassis sufficient low-frequency amplification to reproduce the lowest musical notes (those below the range of male voices) at their proper loudness, then the "boom" accompanying male speech would be so loud as to render the speech disagreeably unnatural or even in some cases almost unintelligible. If, on the other hand, he elected to reduce the low-frequency amplification to the point where speech began to sound natural, then the lower musical notes were reduced in unnatural proportion and often to the point of inaudibility. To meet the requirements of both these conditions has been quite impractical, if not impossible. The result has been a compromise leaning considerably toward the "boomy" side, so that the lower register musical instruments have lacked distinctness and have seemed to be jumbled together as though removed to another room and heard through a thick curtain or screen, or a closed door. Voices, particularly male voices, have been distorted by an unnatural "boom" giving the definite impression that the speakers were talking into a rain-barrel.

Various means have been devised and proposed for the purpose of remedying this trouble. Certain of these had some remedial effect while others were little more than "sales talking points." Recently there has been some effort directed towards suppressing the back wave from the loudspeaker since this is the wave giving trouble from cabinet resonance effects.

Another possible solution, which appears quite obvious after given a little thought, is not to try to suppress the back wave but to control it and make it work with rather than against the front wave by reversing it in phase so that it may combine with and reinforce the sound from the front of the loudspeaker. The only reason for the requirement of the large baffle was the necessity for preventing neutralization of the 180° out of phase front and back wave components. The necessity for the large baffle would, therefore, be eliminated if this phase reversal of the back wave could be accomplished. If, at the same time, the resonant tendency of the rear of the cabinet could be reduced or avoided, the tendency toward "boomy" speech reproduction would also be decreased. Working with this general idea in mind it has been possible to develop an acoustic system, which without the use of a large baffle, permits the reproduction of low notes with a high degree of fidelity and with remarkable freedom from cabinet resonance effects. The device which accomplishes this result has been given the commercial name of the "Magic Voice." The constructional features of this device, as well as a brief discussion of its theory, are given below.

In order to control the back wave it was necessary to rigidly enclose the cavity behind the loudspeaker. This involved the use of a well-constructed cabinet employing thick end panels, well glued and braced to heavy corner posts and base rails, together with as heavy a back panel as was practical, rigidly secured and braced to prevent undue vibrations with the consequent transmission of any large portion of the sound through the walls of the cavity. In passing it may be mentioned that this provides the incidental additional advantage of making the acoustics of the cabinet independent of its position with respect to the room walls in its immediate vicinity.

The effect of this rigidly sealed cavity enclosing the back of the loudspeaker was to completely prevent all interference between the back and front waves so that low notes, previously below the cut-off of the system, and, therefore, not reproduced, might then be reproduced efficiently. Such an arrangement, however, was inefficient in that it did not utilize the back wave from the loudspeaker. In order to utilize this back wave it was first necessary to provide means whereby its phase might be reversed so that it would be in proper phase relation to reinforce the sound from the front of the loudspeaker. This phase reversal was accomplished by means of five metal tubes or pipes which were situated in the bottom of the cabinet with their tops and bottoms open. They thus formed an array of parallel paths through which the sound energy from inside the cabinet might radiate to the outside. Speaking more technically, they acted in conjunction with the enclosed cavity as an acoustic low-pass filter on the sound emerging through them and were so proportioned mechanically as to cause a reversal of the phase of this sound. Reinforcement of the sound from the front of the loudspeaker was thus obtained with resulting increased efficiency. Fig. 1 shows a sketch of the cabinet construction using the "Magic Voice" arrangement and Fig. 2 shows a photograph of a radio receiver employing this device, but with the back removed to provide a view of the interior. The theory involved may be better understood by reference to an analogous circuit condition.

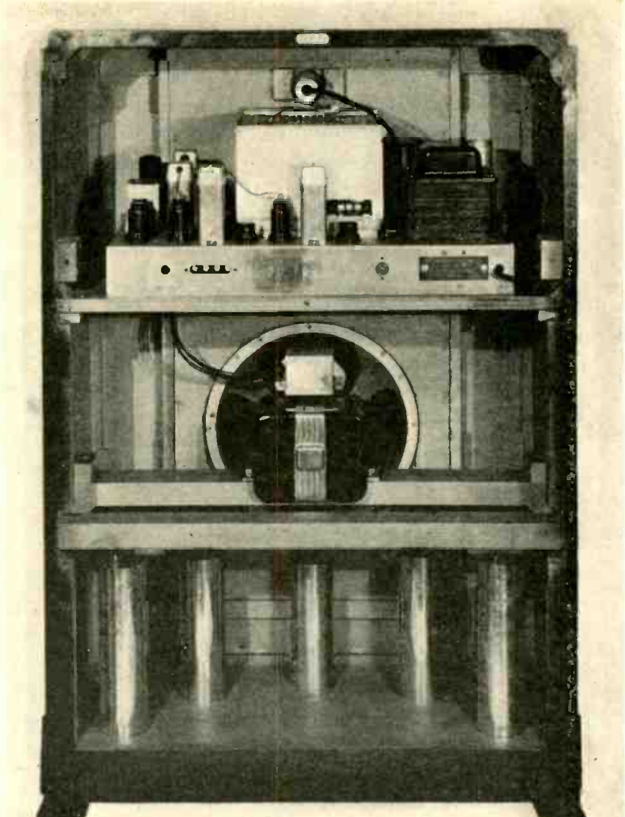


Fig. 2

The operation is similar to the addition of a tuned circuit containing resistance and inductance to another tuned circuit with the same or somewhat different constants. Let us consider first a circuit corresponding to the loudspeaker and the ordinary cabinet as the acoustic system. In electrical terms this circuit may be represented as shown in Fig. 3.

Where F is the acoustical force in the system
- Z_e the electrical impedance reflected into the mechanical circuit
- C_c the centering and edge acoustic capacitance of the cone
- M_c the acoustic inertance of the cone and adjacent air
- R_c the acoustic radiation resistance from the front of the cone
- C the acoustic capacitance of the enclosed air in the cabinet
- M_b the acoustic inertance of the openings between the cabinet and wall, floor, etc.
- R_b the acoustic radiation resistance at the above-mentioned openings

Here we have the terms R_b and M_b due to the radiation from the rear of the cabinet, both being uncontrolled and dependent in value on the location of the cabinet with respect to the wall, floor (when cabinet has no bottom) and other surrounding conditions. The problem is further modified by the phase relations and interactions between R_c and R_b.

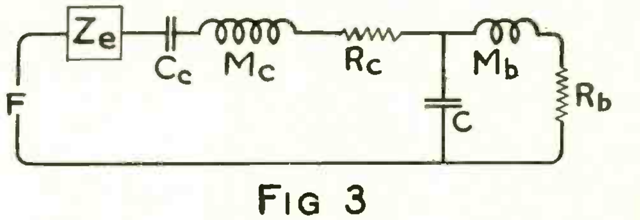


FIG 3

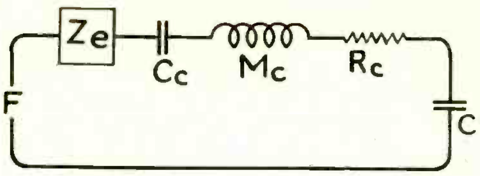


FIG. 4

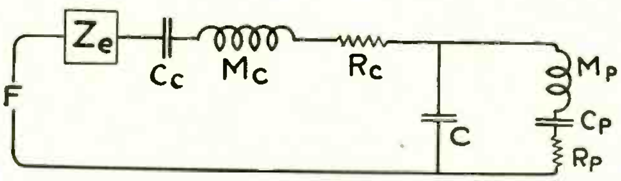


FIG. 5

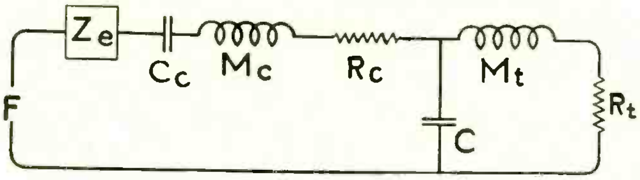


FIG. 6

Next let us consider the cabinet enclosed on all sides, back, top and bottom, and made of sufficiently sturdy material so that none of the panels are resonant or liable to vibrate in the audible range. This condition is similar to that expressed by the circuit of Fig. 4 where the factors representing radiation from the rear of the cabinet have disappeared. In case one of the panels was not rigid and was capable of vibrating to an appreciable extent as a result of the internal sound pressure in the cabinet, we would get the condition shown in Fig. 5 in which a tuned circuit shunts C and M_p; C_p and R_p are the acoustic inertance, capacitance and acoustic radiation resistance of the vibrating panel. Such a condition is obviously undesirable since a vibrating panel practically always causes a second peak in the loudspeaker impedance curve and an undesirable peak in the response curve. For the proper operation of the "Magic Voice" it is extremely important to avoid such vibrating panels.

Let us now consider the case where the sound from the rear of the loudspeaker is permitted to emerge in a controlled fashion from the enclosed cabinet of Fig. 4. We then get a circuit condition (Fig. 6) similar to that of Fig. 3 but in which the values of R_t and M_t are controllable and relatively independent of surrounding conditions. M_t is the acoustic inertance of the pipes in the bottom of the cabinet through which the sound is permitted to radiate from the closed rear of the cabinet and R_t the acoustic radiation resistance at the outer end of the pipes.

Since these values are now controllable we can now make M_t much larger than M_b of Fig. 3. We can also arrange the circuit so that it is balanced on each side of C since this is found to be the most desirable condition. The reason for this may be explained as follows: In an electrical circuit of the type of Fig. 6, by making $M_c = M_t$ and $R_c = R_t$ it is possible to cause the current in the two series arms to be practically 180° out of phase with each other. Similarly in the acoustic case, by making the corresponding quantities equal, it is possible to obtain a condition where the particle velocity of the sound from the cavity at the rear of the cone is inverted in phase. Since the back wave is normally 180° out of phase with the front wave, this puts the back wave in phase with that from the front of the cone as the back wave emerges from the cabinet. The latter will then add to the sound radiated from the front of the loudspeaker and thus increase the efficiency of the system.

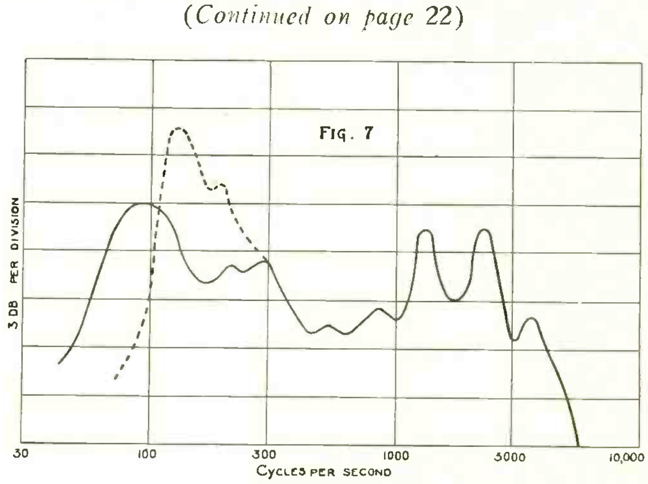
The acoustical system, as regards power output, differs somewhat from the electrical system in that the acoustic radiation resistance and air mass of the diaphragm and the corresponding radiation resistance and air mass of the diaphragm and the corresponding radiation resistance and air mass of the pipes have a mutual reaction on each other and furthermore their acoustical impedances vary with frequency. A complete solution of the problem is rather difficult, but starting from the assumption that the enclosed cavity should be as nearly as possible a pure acoustic capacitance (a rigid cavity without vibrating sides) and the mass of air in the pipes equal in mass to that of the cone with the same radiating surface as the cone, a final practical design may be developed.

The results obtainable by use of the "Magic Voice" are illustrated by the curves of Fig. 7. The dotted curve was taken with no back, bottom or acoustic pipes in the cabinet, i.e., a typical console of the conventional construction. The solid curve shows the same cabinet in which a back, bottom and pipes were added. All panels were, of course, sufficiently rigid for the purpose. The increased low-frequency range, reduction in amplitude of the low-frequency peak, together with the lowering of its peak frequency are quite noticeable. These last two effects greatly reduce the tendency of the cabinet to cause male voices (which often resonate around 120 cycles) to sound "boomy." By eliminating the necessity for a large baffle area around the cone, this acoustic device increases the low-frequency range of the cabinet over that which it would have when acting only as baffle for the loudspeaker. Of practical importance also is the fact that the construction used is simple and does not add unduly to the cabinet cost.

Practical demonstration of the effectiveness of the "Magic Voice" device on the points mentioned above may be provided by comparative listening tests of a radio cabinet of the conventional design and one provided with the "Magic Voice" construction but with other factors remaining the same. Such a test should be made of course, using speech and music containing the frequency ranges in which the "Magic Voice" differs effectively from the conventional cabinet as shown in the curves of Fig. 7.

A further practical and interesting demonstration may be obtained as follows:

(*Continued on page* 22)



REGULATING CONDENSERS

It is a well-known fact that damage to electrolytic condensers generally occurs during that period, immediately after the receiver or amplifier is turned on, before tube heaters have reached the temperature at which full electron emission is given off by the cathode. Plate currents are low, and power supply regulation being what it is, something generally lets go.

The following material, which was prepared by the engineering staff of the Aerovox Corp., shows in detail how these destructive surges may be reduced.

THE LEAKAGE CURRENT of electrolytic condensers has been put to work. It has been a common experience in the evolution of radio that a new development was found to have some undesired feature which eventually was turned into a useful asset. Examples of this are easy to enumerate; regeneration is one of them. Even motorboating has been put to good use in the multi-vibrator. Similarly, the leakage current of an electrolytic condenser was thought to be undesirable by many. It has been shown several times that it is not the leakage which causes any harm and that the increased power factor is not due to the leakage. The power factor is due to an apparent series resistance which seems to be in the film, formed on the anode. Let us now confine our attention to leakage.

A new type of wet electrolytic condenser has been made available. This type of condenser has such leakage properties that it can be used to prevent undesired rises in voltage when a radio receiver is first turned on. Yet, it operates as a normal condenser with a power factor of 10 percent and a very low leakage during the normal operation of the receiver.

The Normal "Wet" Electrolytic Condenser

Few users are familiar with the leakage characteristics of the ordinary variety of wet electrolytic condensers. Under normal operation at its rated voltage the leakage is very low, but what happens when the voltage is increased? The curve of Fig. 1 shows the relation between leakage and applied voltage. When the voltage is increased beyond the normal peak voltage, the current rises, first slowly then faster until a point is reached where the condenser "scintillates." Scintillation consists in the repeated breakdown of the insulating film, which is formed on the positive foil. After the breakdown the film is formed again, it breaks down again, forms again, etc.

This scintillation does not ruin the condenser; when the voltage is lowered again and the normal operating voltage re-applied the condenser will work the same as before. These self-healing properties are confined to the wet electrolytic condenser. The dry type exhibits no phenomenon of scintillation and it is ruined if the film ever breaks down.

Referring to Fig. 1 again, note that the characteristic of the wet electrolytic condenser is not a straight line and that the device does not follow Ohm's law. It is a non-linear impedance, similar to a vacuum tube or a rectifier. Indeed, the wet type could be used as a rectifier. Still referring to Fig. 1, note that the increase of leakage current with the increase in applied voltage is rather slow. When the voltage rises fifty volts or more above its normal value the leakage will not increase enough to check this rise. In order to do this, the leakage would have to rise rather suddenly at some critical value of voltage.

The shape of the leakage characteristic can be changed by varying the composition of the solution inside the wet condenser. After considerable research a condenser with the desired characteristic has been developed.

Regulating Type Wet Electrolytic Condensers

Fig. 2 shows the relation between the applied voltage and the leakage current for the new regulating type wet electrolytic condenser. Note the steep rise of the curve at a point 50 volts above the normal rating. This condenser does not exhibit any scintillation. At the operating voltage of 300 volts, the leakage is very low and the power factor is 10 percent. This corresponds to a series resistance of 7 ohms at 120 cycles. When the voltage is increased above 300 volts, the leakage first rises slowly but at 350 volts there is a steep rise. In fact, the increase in current is so fast when the voltage keeps increasing, that it is practically impossible to impress any potentials higher than 350 volts across the condenser.

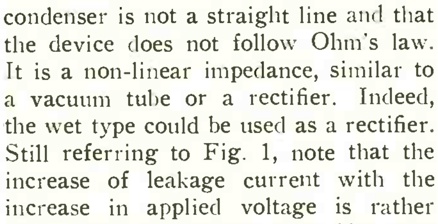


Fig. 1.

When one tries to impress higher voltages the result will be that the current rises until the voltage drop in the circuit is large enough to reduce the potential across the condenser to 350 volts.

The curve shows the characteristic of a 300-volt condenser. There are condensers of different voltage ratings but they all have their sudden rise in leakage current at 50 volts above the rated voltage.

When using the regulating type of condenser it should be remembered that the unit was not designed to carry this increased leakage current for a considerable time. They are intended to be operated at their rated voltage except during short periods such as the heating up of the tubes in a radio receiver or amplifier.

Applications

When a radio set is turned on, the rectifier heats considerably faster than the rest of the tubes. During this period the tubes are not drawing any current and there may not be any drain on the power supply except that of the filaments and the voltage divider. Many of the newer sets, if they have a voltage divider at all have one of the low drain type because it has been found that the receiver can be made to operate even when the voltages vary widely. The omission of the voltage divider is purely a matter of economy.

What happens during these few seconds when the B-supply has no drain? The result is that the large condensers in the power pack will be charged to the peak voltage of the transformer secondary, and since there is no current, there is no voltage drop in the filter and

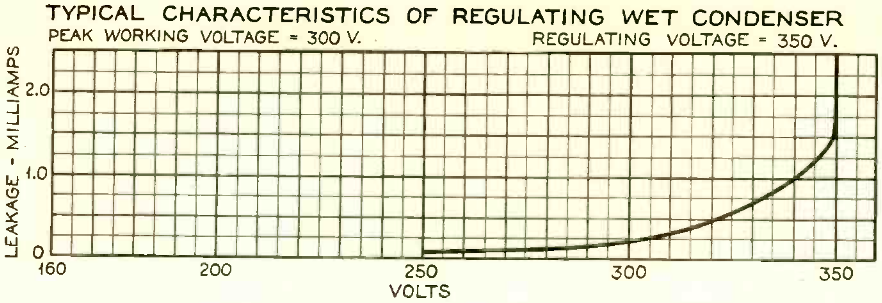


Fig. 2.

the speaker field so the same peak voltage is applied to all of the smaller tubular condensers and all the other equipment in the receiver.

Usually the large electrolytic condensers in the power pack withstand this voltage surge well enough. It is the tubular condenser that suffers the most. When the rating of the transformer secondary is 350 volts, the peak voltage would be 490 volts, approximately. Under normal operating conditions there is enough drop in the filter to reduce the B-supply to approximately 300 volts by the time it reaches the tubes and the smaller bypass condensers. A tubular condenser of 400 volts rating seems ample for the purpose. But, as was shown above, the voltage actually rises to 490 during the heating up period and it depends on the quality of the condenser whether it will withstand this overload.

This danger can be completely eliminated by the use of the regulating type electrolytic condenser. In whichever circuit it is placed, the voltage cannot rise above the regulation voltage.

A special demonstration set-up was made in order to show the amount of regulation obtainable. The essential circuit is shown in Fig. 3. A power pack was built up with a variable high voltage supply to the rectifier while the rectifier filament voltage was kept constant. The secondary of the high-voltage transformer could supply as much as 1,400 volts. Its primary was connected to the line through a variable auto transformer so that any voltage up to 1,400 could be applied to the plates of the rectifier. When the voltage across the primary of the high-voltage transformer was 30 volts, the voltmeter across the output of the filter showed 350 volts. The applied voltage was then increased fourfold, making the primary voltage 120 and the secondary somewhere near 1,400. Under this condition the voltmeter across the output of the filter showed 353 volts. This is certainly a remarkable experiment, since no practical circuit would subject a condenser to such extreme overloads.

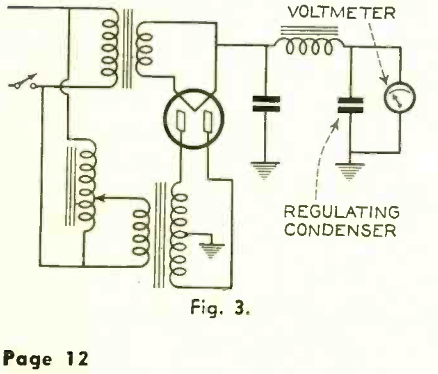


Fig. 3.

It is very important that the regulating condenser be connected across the output of the filter and not immediately after the rectifier. If the regulating condenser were placed at the input of the filter it would result in an enormous peak current which has to pass through the rectifier. Very probably the rectifier will be ruined in that way. The regulating type of condenser can be placed after the first choke or after the second one, if there are that many.

Another important point to watch is the correct rating of the condenser. Under no circumstances should the voltage be allowed to rise so that the condenser is operated in the regulating range when the apparatus is in normal operation. Care should be taken that the regulating feature is utilized only during the heating up period, since a prolonged heavy current through the condenser will result in too large a temperature rise.

Use in Multi-Section Filters

Some readers may wonder which is the preferred location for the regulating type condenser in a multi-section filter. Shall it be the second condenser or the third one and why? Fig. 4 shows a circuit of a power pack employing a two-section filter and the values of currents and voltages under normal operations are indicated. Being a typical 6-tube superheterodyne with a single output tube, the total current is approximately 80 milliamperes. The voltage at the output of the filter is 270 volts. Across C_2 the potential is 415 volts and there is 440 volts across C_1. The rating of the transformer is 350 volts each side of centertap. These values were measured from an actual receiver.

This set did not have a voltage divider and the condensers were dry electrolytics. When the set is turned on, the voltmeter reads 500 volts for about 10 seconds regardless of whether it is placed across the condensers C_1, C_2, or C_3, or across any of the tubular bypass condensers, even those which bypass the screens! When C_3 is replaced by a regulating type condenser it can be one which is rated at 300 volts because the voltage will not normally rise, or even approach 350 volts where the regulating action starts.

If such a condenser is used there, the voltage across C_3 will be 350 during the heating up period (instead of 500) and this is well within the rating of the other condensers. It is true that the potential across C_1 and C_2 will be somewhat higher than normal, but these are generally designed to stand this sort of thing.

If the regulating condenser is placed at C_2 it will have to be one which can normally operate at 415 volts without entering the regulating range. Its regulation should certainly not start lower than 450 volts. The result would be that during the heating up period the voltage will be 450 everywhere instead of 350 with the regulating condenser at C_3. It is very obvious that the output of the filter is the preferred location.

The above is true even if the filter does not have such large differences in voltages across its condensers. Assume for a moment that the same receiver used a dynamic speaker which had an independent field supply. The field could then be replaced by a choke of rather low resistance and to get the same output voltage, the transformer secondary rating need be only 300 volts.

Employing a regulating condenser with a 300-volt rating and placing it at C_3 would result in limiting the voltage to 350 at the output of the filter. Also, when placing it at the location C_2, the output voltage will be 350 volts. In the first case, the voltage drop before the regulating condenser is divided across two chokes, while in the second case, the same voltage drop will be across the first choke only. It is easy to see that in the second case the regulating condenser has to draw a much heavier leakage current in order to get the same voltage drop across the one choke. This results in more wear and tear on the condenser as well as on the choke. So, also, in this case the output of the filter is the preferred place of the regulating type wet electrolytic condenser.

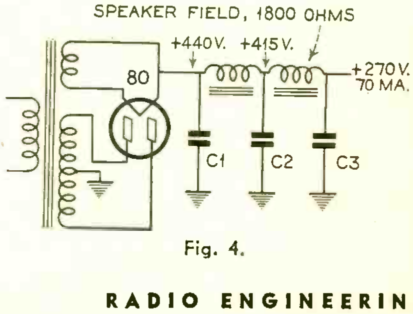


Fig. 4.

PHASE INVERSION

by H. W. Paro*

With the advent of power tubes which give tremendous output with relatively small driving voltages, interest in low-cost coupling systems has increased. Phase inversion permits push-pull operation without the more conventional transformer coupling. Here is a resume of some of the methods which may be used to obtain two signals 180° out of phase.

FEW SOUND SOURCES now commercially available offer push-pull output. In amplifiers operating from a single-ended sound source (microphones, photocells, pickups, etc.) inclusion of the well-known advantages of push-pull requires phase inversion of some kind. A wide variety of circuits have been developed for this purpose. Except, however, as they vary to meet requirements of detailed application, all such circuits stem back to a few fundamental arrangements. Neglecting minor variations and obsolete fruitless attempts, the general trend of development is traced below to Fig. 6, which represents present-day standard practice.

One of the earliest phase inversion circuits is shown in Fig. 1, in which a center-tapped inductance, essentially an auto-transformer, provides a push-pull signal. This circuit, however, should be regarded as a pioneer stage in development, rather than an arrangement of practical use of importance today.

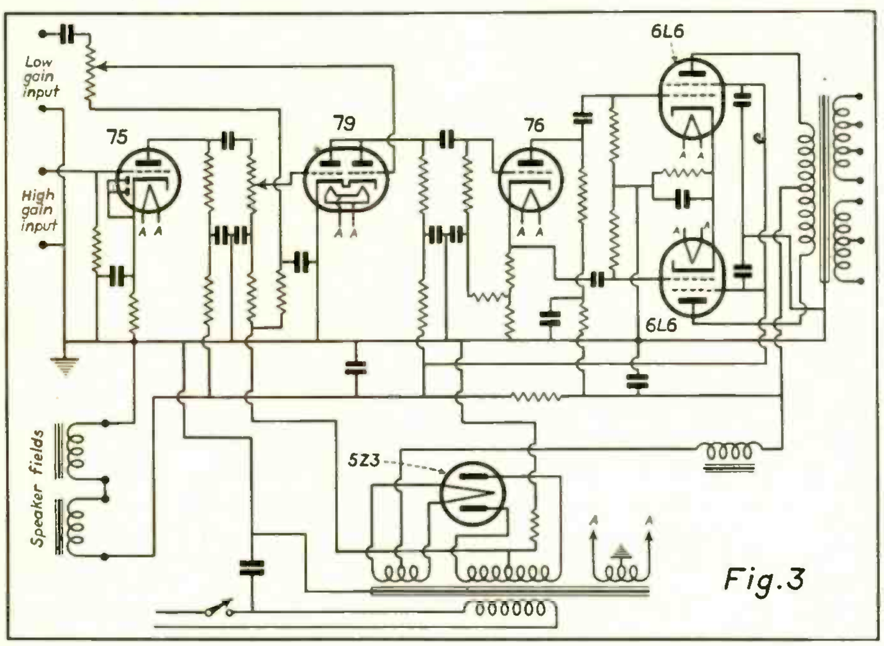


Fig. 3

Fig. 2 diagrams a more modern system, R_1 and R_2 constitute a voltage divider. The ratio of resistances is so chosen as to secure equal though opposite voltage changes on the grids of the two push-pull tubes. Figs. 3 and 4 are slightly modified forms of the same system, which have enjoyed somewhat extensive publicity.

Referring to Fig. 2, it will be obvious that the gain provided by the left-hand tube is cancelled in the voltage divider, and in an amplifier the circuit as diagrammed represents a stage of phase inversion, but not a stage of amplification. In fact the gain is slightly less than unity.

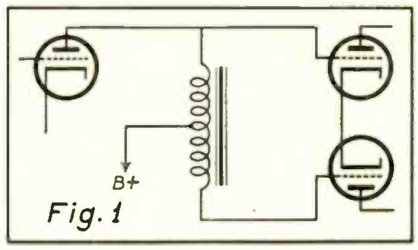


Fig. 1

The availability of twin amplifier tubes particularly favors the method outlined in Fig. 5 and shown, as incorporated in a modern commercial amplifier, in Fig. 6, and this arrangement is in wide-spread use at the present day.

Referring to Fig. 5, the upper left-hand tube represents a standard stage of amplification, the lower left-hand tube being the phase inverter. (In Fig. 6, the function of both tubes is performed by the 6A6.) The two right-hand tubes of Fig. 5 constitute the push-pull stage. R_1 and R_2 are the voltage divider, but R_1 also serves as the grid leak for the upper right-hand tube. The grid leak for the lower right-hand tube is R_3, of the same value as R_1. The essential design feature of this circuit is that R_2 must be so chosen that its resistance ratio to R_1 will maintain equal but opposite voltages on the push-pull grids, the voltage gain of the

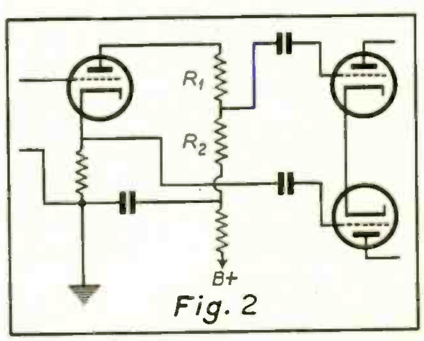


Fig. 2

*Wholesale Radio Service Company.

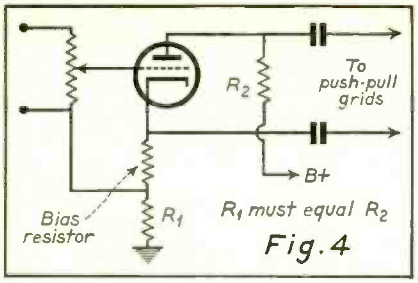


Fig. 4

phase inverter tube being taken into consideration.

The upper end of R_1 connects directly to the grid of the upper push-pull tube. From the lower end of that resistor a return is taken to the grid of the phase inverter tube, and the plate of the phase inverter is condenser coupled to the lower push-pull grid.

The full voltage gain provided by the upper left-hand tube is impressed, through the coupling condenser, on the grid of the upper push-pull tube. The loss in the voltage divider is made good by the phase inverter. Thus, in this circuit, two tubes are used to secure a single stage of amplification, in contrast to Fig. 2, in which only one tube is used, and the effective amplification is less than unity. In Fig. 6 the single 6A6 tube provides both voltage amplification of normal value, and phase inversion for the final stage.

The ratio of R_1 to R_2 constitutes a simple method of measuring the amplification obtained from the upper left-hand tube or (in Fig. 6) from the left-hand half of the 6A6. If a potentiometer is substituted for the two resistors, the circuit affords a convenient method of checking tube amplification. The potentiometer is adjusted until a cathode-ray oscilloscope shows equal output from both sides of the push-pull stage. When such output is obtained the amplification ratio of the upper left hand tube and the resistance ratio of R_1-R_2 are one and the same.

In Fig. 6 the two 6B5s correspond to the two right-hand tubes of Fig. 5. R_1 of Fig. 5 is the 0.5 meg grid leak that connects to the left-hand grid of the upper 6B5. R_3 of Fig. 5 is the 0.5 meg grid leak that connects to the left-hand grid of the lower 6B5. R_2 of Fig. 5 is the 20,000 ohm resistor that joins the two grid leaks, and the voltage gain of the left-hand portion of the 6A6 is therefore equal to 500,000/20,000, or 25.

The frequency response obtained from this amplifier is within 1 decibel from 50 to 10,000 cycles.

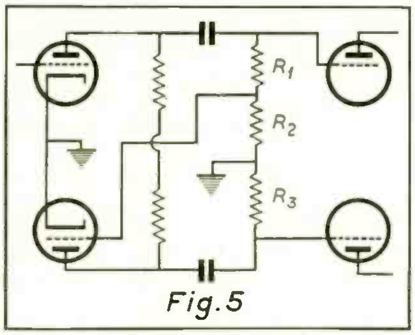


Fig. 5

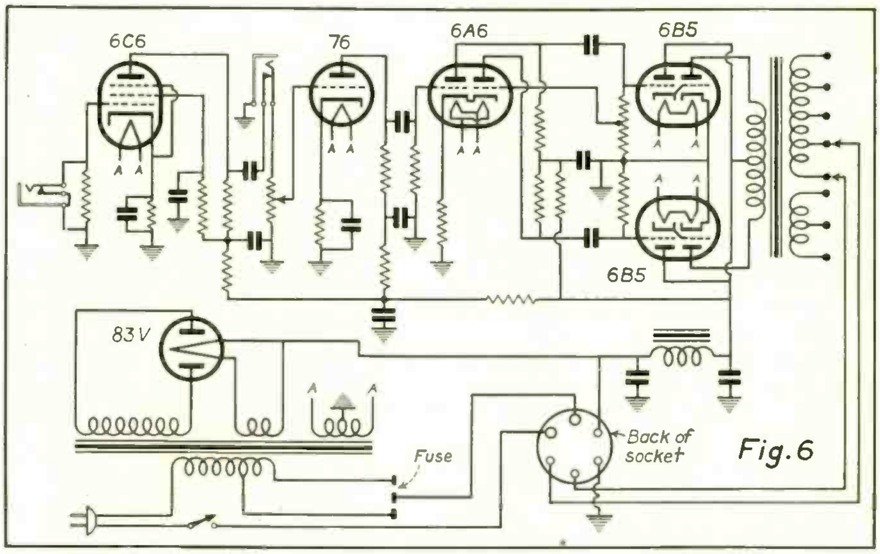


Fig. 6

BOOK REVIEWS

THERMIONIC EMISSION, by T. J. Jones. 108 pages, pocket size. Published by the Chemical Publishing Co. of N. Y., Inc. Price $1.25.

This is a concise little volume purporting to give the latest information on the principles of thermionic emission. It is addressed particularly to those engaged in experimental work in this field, and as such it may be regarded as an excellent pocket companion. The inclusion of a fairly comprehensive bibliography further enhances the book's value.

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ELECTRON DIFFRACTION, by R. Beeching. 106 pages, pocket size. Published by the Chemical Publishing Co. of N. Y., Inc. Price $1.25.

This book on a subject which is comparatively new in the scientific field is, by its author's admission, an attempt to interest more research workers in the study and investigation of electron diffraction.

Starting out with a discussion of the wave properties of electrons, the book then progresses through a description of the early experimental work to discussions of research technique and the practical applications of the study of electron diffraction.

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TELEVISION WITH CATHODE RAYS, by Arthur H. Halloran. Pocket size, loose leaf. Published by the Pacific Radio Publishing Co., San Francisco, Cal. Price $2.75.

This handbook should provide the answers to many of the questions which will soon be asked about television. Without going into any serious engineering discussions, Mr. Halloran has managed to tell concisely and clearly how the different systems of television function.

The engineer will not be especially interested in this book unless he happens to be one of these mortals who likes to keep abreast of what the other fellow is doing, but the book is by no means a thorough technical treatise on television. Such a book is still to be written.

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TELEVISION, a collection of papers of RCA origin. Published by the RCA Institutes Technical Press, New York, N. Y. Price $2.00.

This book, evidently the first volume of a series, is a compilation of addresses and technical papers from RCA. All of these have appeared elsewhere—addresses by RCA officials at different times and places, reports to the FCC, and technical papers in the Proceedings of the IRE. The subject of television is covered in great detail, although just how recent the material may be we are unable to say due to the omission of all dates in connection with those papers reprinted from the IRE Proceedings.

HIGH-FREQUENCY MAGNETIC MATERIAL

by Henry L. Crowley*

IN REVIEWING THE history of insulated ferro-magnetic particles as a core material for coils, references are found dating back to 1870. Several United States Patents were issued between 1886 and 1900 pertaining to this type of material. The introduction of loading coils for telephone and telegraph systems about 1900 gave impetus to the development. However, it was not until some years later that a suitable core material was developed using finely-divided iron powder, insulated and compressed into the desired forms. The adaptation of this material to the then existing telephone and telegraph circuits gave amazing results; later this material was replaced by a nickel-iron alloy called permalloy.

While up to this time the contributions were concerned primarily with telephone and telegraph circuits at comparatively low frequencies, they were soon carried over into the radio field, and thus is found, at an early date, suggestions and a few working examples of insulated ferro-magnetic particle cores for radio circuits.

The problem of providing a thin insulating film around each particle, and at the same time one strong enough to withstand the pressures encountered in the molding or extruding of the core without causing a breakdown of the film, proved to be too difficult from a manufacturing viewpoint. Various resins were tried and their limitations and disadvantages as insulators were soon found. For one thing, the losses are ten to one hundred times the losses of a good ceramic material. Therefore, it was considered desirable that a suitable ceramic insulator and binder for core material be developed. By a long process of research and elimination among new materials and methods, the choice finally narrowed to a magnesium-ferrous alloy, insulated and bound with a Crolite ceramic, which has proved to be an ideal high-frequency core material. This material has been named "Magicore."

The fundamental magnetic and dielectric properties and the modification of various losses due to interaction of these fundamentals result in a very complicated and involved relationship, the actual analysis of which is mainly of academic interest, and is beyond the scope of this paper.

In the application of this core material, the radio engineer is primarily interested in the inductance and effective resistance of the various units. However, to obtain the maximum of open core efficiency requires correct relationship between coil and core losses, and coil designs which take advantage of the magnetic field adjacent to the core. These designs may not conform to ideal aircore dimensions. The coil shown in Fig. 2 is a typical design for 456 kc and is wound with 7/41 Litz wire to an inductance of 1.5 millihenries.

One advantage of these inductance coils is the excellent Q which can be obtained in a very small space. One of these units and an air-core unit, in shield cans, are illustrated in Fig. 3; the units have equivalent performance characteristics. The curve in Fig. 4 shows the gain of such a coil with larger shield can.

It is important in receiver design to use a high-gain antenna unit, thereby obtaining satisfactory signal-to-noise ratio with better sensitivity and selectivity. This high gain is of paramount

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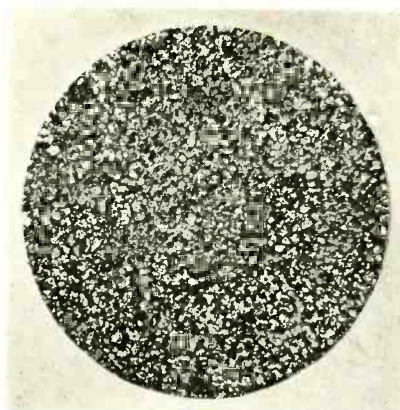
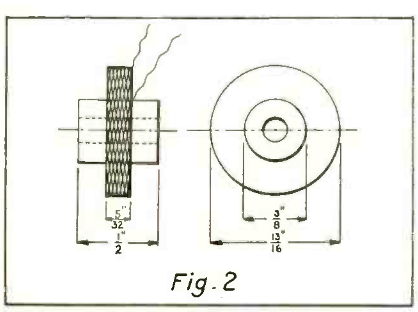


Fig. 1. Microphotograph of "Magicore" (x250).



Typical i-f coil.

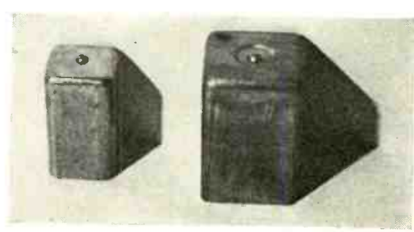
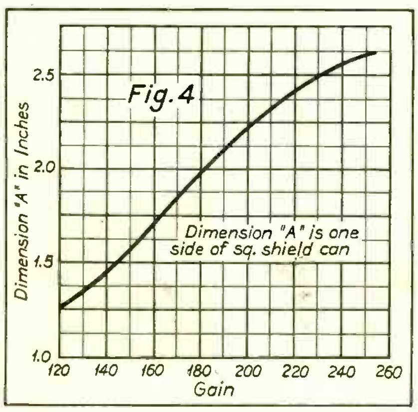


Fig. 3. Iron-core (left) and air-core coils, in shield cans.

importance in receiver designs where space factor is given first consideration; as a result, small universal-wound air-core transformers have been used for this purpose. However, this design in a limited space may have an inherently low Q. The gain in the antenna unit is dependent on the Q—the higher the Q, the higher the gain.

The use of higher intermediate frequencies to decrease image response in present-day superheterodyne circuits requires intermediate-frequency transformers having higher values of Q to produce satisfactory results. To secure the same performance at 456 kc as is obtained at 175 kc, coils having more than twice as high a Q are required. The high values of Q that can be obtained with iron-core coils enable the set designer to take full advantage of increased gain and selectivity. In the application of these units, one can increase selectivity many times and at the same time retain gain equivalent to air-core units, or one can retain the same selectivity while increasing the gain. Usually, a compromise between gain and selectivity is made in order to secure the best overall performance.

Coupling between primary and secondary windings of an intermediate-frequency transformer is due either to capacitative or inductive coupling or a combination of both, inductive coupling as a rule being preferred. Stray coupling may cause irregularities in the selectivity curve, or the circuit may be too selective because of regeneration. Changing the position of either primary or secondary with respect to the other will vary the degree of coupling. When the unit is adjusted below critical coupling, extremely sharp selectivity is obtained; while with an over-coupled unit, broad band-pass characteristics are secured. Replacing the usual two circuit intermediate-frequency transformer with a three-tuned circuit unit will result in a selectivity curve having a blunter nose and a steeper slope. If a device is provided for adjusting the coupling of the unit from the front panel, a means of varying the fidelity of the receiver is obtained.



Gain as a function of shield size.

Fig. 5. Samples of the cores.

The full advantages to be gained with iron cores are nullified if high losses are embodied in associated circuits, or if the associated components are unstable with respect to such variables as temperature, humidity and time. It would be inconsistent and wasteful to employ low-loss materials in one portion of the circuit without regard to maintaining the same standard of quality in the rest of the circuit. The performance chain, like any chain, can be no stronger than its weakest link.

It has been found possible in some cases to eliminate a radio-frequency tube and still retain satisfactory performance of the radio receiver by using these units. If, for sales reasons, no reduction in the total number of tubes is allowable, an additional tube can be placed in the audio system to very good advantage.

Changing the position of a "Magicore" with respect to its associated coil will vary the inductance of the coil. A direct-current winding placed adjacent to these coils will, to a limited extent, vary the inductance, or the inductance may be increased or decreased by using a combination core of copper and the material described. The many means of varying the inductance lead to a multiplicity of applications in present-day radio receivers. Those illustrated in Fig. 5 are but a few that are being employed in high-frequency circuits.

The latest developments in wave filters, high-frequency equipment and transmission circuits have imposed rigorous requirements on performance. Low dissipation in high-frequency circuits is obtained with high-Q components. Many of these developments necessitate the use of inductances having Q values from 150 to 250. Such values are readily attained with greatly reduced size.

NOTES ON POLICE-CAR RECEIVERS

RADIO has come to be one of the most important and effective law-enforcement agencies available to police. It can no longer be considered as an expensive experiment of doubtful value. The development of apparatus for police use has been rapid and specialized. At the present time, thoroughly dependable equipment, completely suited to police service, is available. Development of a radio receiver suitable for installation in an automobile and capable of operating continuously and dependably under the severe conditions of police service has been a considerable engineering problem.

Not only are the operating conditions severe, but they are extremely varied. It has been difficult to produce receivers which are entirely suitable for any given set of operating conditions without making undesirable compromises in performance which detract seriously from the effectiveness of the receivers.

The factors which are most important in considering the adaptability of a particular receiver to certain operating conditions are the following: sensitivity, selectivity, freedom from frequency drift, ease of installation, simplicity of operation, and reliability of operation.

The great number of police transmitters has forced the assignment of police frequencies with a channel separation of 8 kilocycles. Frequently, transmitters in adjacent territories operate on adjacent channels. In such cases, there are always locations where the strength of an undesired signal is as great as, or many times greater than, the strength of the desired signal. It is then necessary to employ a receiver which discriminates against the undesired signal. Although extreme selectivity results in sideband cutting with a consequent impairment in the fidelity of voice reproduction, the intelligibility of voice transmissions is not greatly affected. However, any frequency drift of the receiver immediately results in decreased sensitivity, since the received signal is transmitted through the i-f amplifier system at some frequency other than the resonant frequency with a consequent reduction in the amount of amplification. Recognizing the fact that it is impossible to construct a receiver which is completely free from frequency drift without resorting to impractical measures, the degree of selectivity is necessarily a compromise between the permissible amount of adjacent-channel interference and the extent to which a reduction in sensitivity can be tolerated.

Abstract of an article, by Stanley E. Benson, which appeared in COMMUNICATION & BROADCAST ENGINEERING, *September*, 1936.

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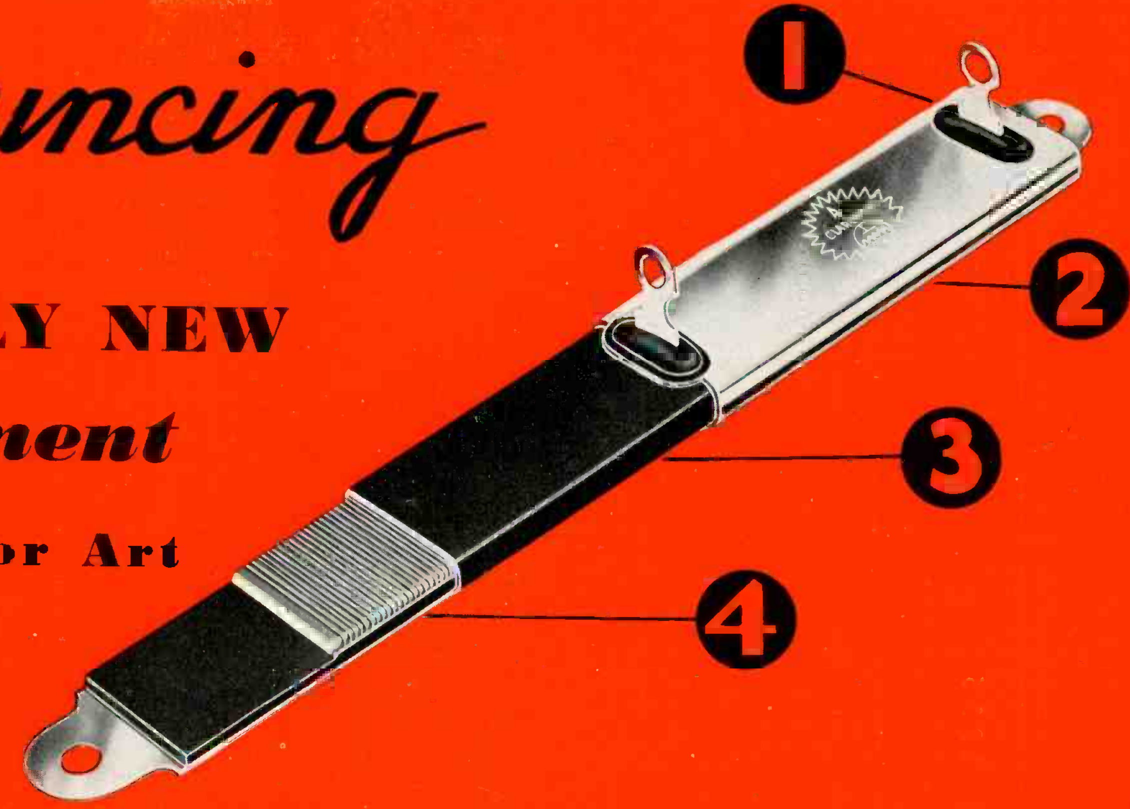

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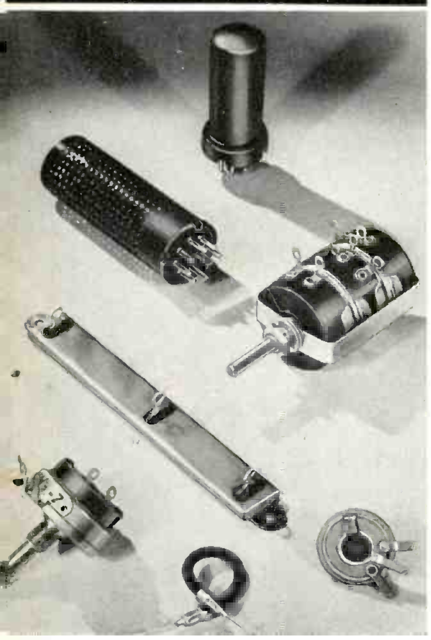

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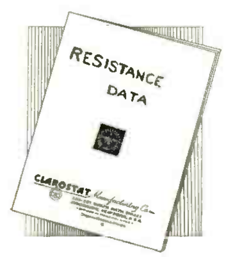

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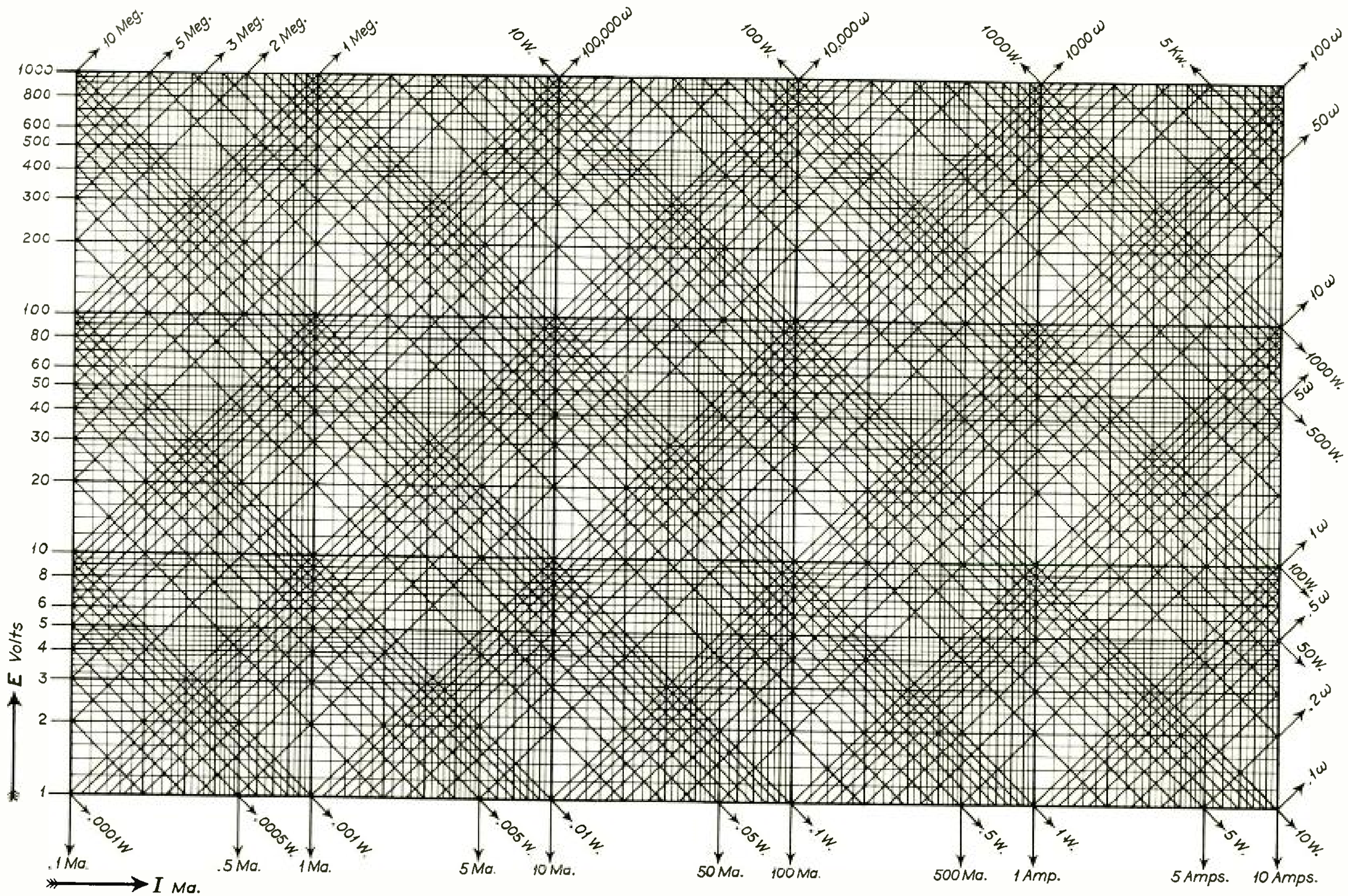

USE OF THE CHART

Suppose the emf in a circuit is 100 volts and the current 100 ma; what is the resistance of the circuit, and what power is being dissipated? Starting with the 100-ma point on the abscissa, follow the vertical line to its intersection with the horizontal 100-volt line. This is also an intersection of two sloping lines. Following the line sloping to the left, the power, 10 watts, is read on the top of the chart. The line to the right gives the resistance, 1000 ohms, at the upper margin.

If a 5000-ohm resistance has a rating of 20 watts, what is the maximum permissible current, and at what voltage? Follow the 5000-ohm line to its intersection with the 20-watt line. Follow the vertical line from this point downward to the abscissa and obtain, by interpolation, 63 ma. Follow the horizontal line to the left of the intersection to the margin and read 316 volts.

THEORY OF THE LOUDSPEAKER AND OF MECHANICAL OSCILLATORY SYSTEMS

Part IV—Conclusion

by Hans Roder*

IT WAS SAID IN the beginning of Part III that the validity of the theory developed therein is limited to a certain frequency range.

The *lower limit* is, for most practical purposes, the frequency of mechanical resonance of the cone. Even at low operating voltages, the cone is driven with such large excursions at the resonant frequency that the region of linear operation of the edge and spider compliance is exceeded thereby introducing effects which are not taken into account in the theory.

Another factor which limits the validity of theory at the lower frequency is the fact that under most practical conditions, it is impossible even to approximate the condition of an infinite baffle. With a finite baffle the acoustical radiation resistance is small and acoustical output and efficiency greatly reduced.

The *upper limit* of validity is given by the frequency at which the cone ceases to operate as a stiff piston. Because the cone has distributed mass and compliance, it "breaks up" into nodes and anti-nodes. This phenomenon can possibly best be explained by referring to a more familiar phenomenon which can be observed with a vibrating rod or needle (Fig. 12). Assume that this needle be securely fastened to a heavy driving rod at right angle with the rod. If the latter is driven by an oscillatory force acting in the direction of its axis, we will note the following types of oscillation for the thin rod. At very low frequency the whole rod moves as one unit, parallel to its position at standstill (Fig. 13a). As the frequency increases, the motion of the ends will become larger than the motion in the middle (Fig. 13b). At still higher frequency, the motion at the ends will decrease again, while the excursions of portions located between the middle and ends is still large. In other words, there will be a standing wave on the rod (Fig. 13c). At frequencies yet higher, more nodes and anti-nodes will appear on the vibrating rod (Fig. 13d).

A very similar effect takes place on the diaphragm, complicated, however, by the fact that the diaphragm has a conical shape and that its motion on the edge is restricted by the flexible surround. In other words, at frequencies above approximately 400 cycles there is a series of more or less standing waves on the diaphragm. The standing waves may be both of the radial and of the circumferential type. Under these conditions, different portions of the diaphragm will move with different amplitudes and phases. It is evident that the theory previously derived can not be valid any more under these conditions. While with the perfect piston there is always a maximum of radiation along the cone axis, this is not true any longer if the cone vibrates in one of its higher modes. It may occur at certain frequencies that there is little or no radiation on the axis while there is still appreciable radiation under certain angles. However, the general tendency remains to concentrate radiation in a beam along the axis.

When taking sound pressure curves with a cone type loudspeaker it is usually noted that a high peak occurs in the region from 2,000 to 3,000 cycles. This rise in response is quite desirable for a loudspeaker designed to be operated from a radio receiver. In this manner a very effective equalization of the loss of higher frequencies due to selective circuits is obtained. We are not completely sure what the reason is for this phenomenon which is typical of all straight cone loudspeakers, but the following explanation is possibly one of the most probable ones. At the point where the voice-coil collar is fastened to the cone, there is a rapid transition of shape. This region will probably display some compliance effects at higher frequencies. With this assumption, we arrive at a cone structure like that shown in Fig. 14a. The mechanical system represented by this

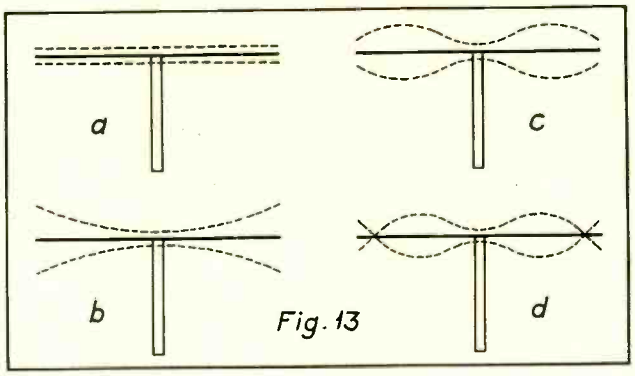

Fig. 13

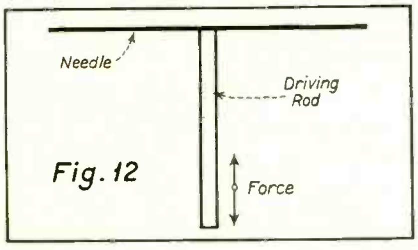

Fig. 12

*Radio Receiver Engineering Section, General Electric Co., Bridgeport, Conn.

figure can be redrawn into that of Fig. 14b, the electrical equivalent network of which is pictured in Fig. 14c. It is seen from this last figure that the mechanical system will possess the characteristic of a non-terminated low-pass filter. A filter of this type shows a rise in its transmission curve before it cuts off. A very similar effect probably takes place in the cone structure at frequencies around 2,000 to 4,000 cycles.

We found earlier that the mass of the voice coil is, in most cases, not very important for the sensitivity of the loudspeaker, because the voice-coil mass usually is considerably smaller than the cone mass and the air mass combined. While this is true for the low-frequency range, the voice-coil mass has great importance at the higher frequencies, say, at frequencies above 2,000 cycles. Fig. 15 shows the effect which an increase in voice-coil mass has upon the sensitivity at higher frequencies. A large voice-coil mass tends to decrease the sensitivity very considerably in this region. It is therefore advisable to hold the voice-coil mass small if the loudspeaker is to have high-frequency response. It may be of advantage to use a voice coil made of aluminum wire in case it is desired to extend the loudspeaker response out into the range of the highest usable frequencies (7,000 cycles and above). The conductivity of aluminum is only approximately half that of copper. Thus, with an aluminum voice coil, it must be taken into account that the loudspeaker efficiency at low frequencies will be greatly reduced in comparison with that obtainable with a copper voice coil.

Transients in a Loudspeaker System

In this section, we will make a brief study of the effect which a transient voltage has upon the mechanical system.

If we consider the equivalent network of Fig. 10 (Part III) we notice a system of two coupled circuits. For an electrical system of this type, it is known, that a damped oscillation will be started in the secondary if a voltage is suddenly applied to the primary input terminals. The frequency of the damped oscillations is equal to the resonant frequency of the secondary. The duration of the secondary transient—i.e., its number of full oscillations—is inversely proportional to the resistance in the secondary circuit and to coupling between secondary and primary circuit.

For the analytical investigation we have to use the

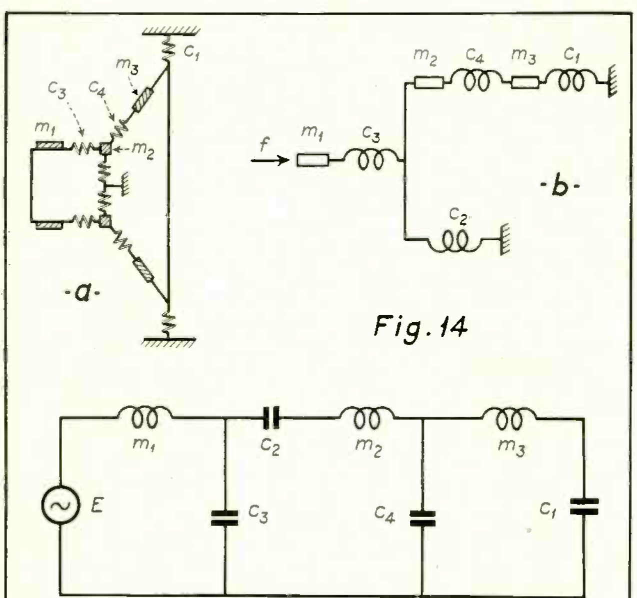

Fig. 14

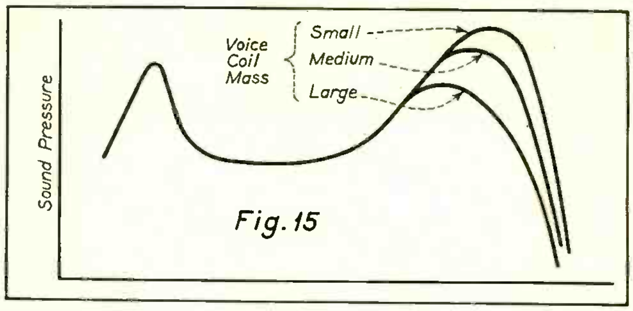

Fig. 15

differential equations (20) and (21) (See Part III) which constitute the conditions for the equilibrium of forces and voltages in secondary and primary circuits, respectively. Differentiating equation (20) with respect to t and substituting into (21) under elimination of all i-terms—yields the expression:

$$L\left(m\frac{d^3x}{dt^3} + r\frac{d^2x}{dt^2} + \frac{1}{c}\frac{dx}{dt}\right) + R\left(m\frac{d^2x}{dt^2} + r\frac{dx}{dt} + \frac{1}{c}x\right) + B^2l^2\frac{dx}{dt} = eBl \quad \ldots\ldots (36)$$

In this expression, the term containing l can be neglected, because we are interested only in the frequency range close to the mechanical resonant frequency; in this range the effect of l is very small. With this simplification, we have

$$\frac{d^2x}{dt^2} + \frac{1}{m}\left(r + \frac{B^2l^2}{R}\right)\frac{dx}{dt} + \frac{1}{mc}x = \frac{Bl}{mR}e \quad \ldots\ldots (37)$$

For abbreviation we introduce the following terms:

$$\frac{1}{mc} = \omega_0^2$$

$$\frac{1}{\omega_0 m}\left(r + \frac{B^2l^2}{R'}\right) = 2\rho,$$

$$t_1 = \omega_0 t.$$

The term R′ used in the equation defining ρ will be explained below. By substitution into (37):

$$\frac{d^2x}{dt_1^2} + 2\rho\frac{dx}{dt_1} + x = \frac{Bl}{\omega_0 mR}e \quad \ldots\ldots (38)$$

The solution of this differential equation has the form:

x = transient + forced oscillation .... (39)

The term "forced oscillation" we have already determined for a sinusoidal driving voltage; this term is represented by equation (24). The transient will be obtained, when solving (38) with the right-hand term put equal to zero. Doing so, we have as "transient" solution for (38)

$$x = k_1\epsilon^{p_1t_1} + k_2\epsilon^{p_2t_1} \quad \ldots\ldots (40)$$

where

$$p_1 = -\rho + \sqrt{\rho^2 - 1} = -\rho + \delta,$$

$$p_2 = -\rho - \sqrt{\rho^2 - 1} = -\rho - \delta,$$

$$\delta = \sqrt{\rho^2 - 1}.$$

The terms k_1 and k_2 are the integration constants which are to be determined from the boundary conditions of the problem. Equation (40) can be rewritten as follows:

$$x = \epsilon^{-\rho t_1}(k_1\epsilon^{\delta t_1} + k_2\epsilon^{-\delta t_1}) \quad \ldots\ldots (41)$$

This shows that the amplitude of the transient in the mechanical system decays exponentially at the rate

$$\epsilon^{-\rho\omega_0 t}.$$

Whether this decay is oscillatory or not depends on the magnitude of δ. We have


Deflection vs Time
Start of a 300 cycle forced oscillation
TRIODE drive (α = 0.25)
Beff. = 5000 .10⁻⁸ Volt sec/cm² (1.8 field watts)
Frequency of mechanical resonance = 52.5 cycles
ς = 0.228
Steady state voice coil current = 0.040 Amps peak
" " " " input power = 2.0 Watts
" " maximum cone excursion = 4.3 .10⁻³ cms
.10⁻³ Cm
.10⁻³ Sec.
Deflection vs Time
Start of a 300 cycle forced oscillation
PENTODE drive (α = 11.5)
Beff. = 5000 .10⁻⁸ Volt sec/cm² (1.8 field watts)
Frequency of mechanical resonance 52.5 cycles
ς = 0.0394
Steady state voice coil current = 0.040 Amps peak
" " " " input power = 2.0 Watts
" " maximum cone excursion = 4.3 .10⁻³ cms
.10⁻³ Cm
.10⁻³ Sec.
Deflection vs Time
Start of a 300 cycle forced oscillation
TRIODE drive (α = 0.25)
Beff. = 11,000 .10⁻⁸ Volt sec/cm² (12.0 field watts)
Frequency of mechanical resonance 52.5 cycles
ς = 1.033
Steady state voice coil current = 0.040 Amps peak
" " " " input power = 2.0 Watts
" " maximum cone excursion = 9.5 .10⁻³ cms
.10⁻³ Cm.
.10⁻³ Sec.
Deflection vs Time
Start of a 300 cycle forced oscillation
PENTODE drive (α = 11.5)
Beff. = 11,000 .10⁻⁸ Volt sec./cm² (12.0 field watts)
Frequency of mechanical resonance 52.5 cycles
ς = 0.120
Steady state voice coil current = 0.040 Amps peak
" " " " input power = 2.0 Watts
" " maximum cone excursion = 9.5 .10⁻³ cms
.10⁻³ Cm
.10⁻³ Sec.
Deflection vs Time
Start of a 300 cycle forced oscillation
TRIODE drive (α = 0.25)
Beff = 14,000 .10⁻⁸ Volt sec./cm² (29.5 field watts)
Frequency of mechanical resonance 52.5 cycles
ς = 1.66
Steady state voice coil current = 0.040 Amps peak
" " " " input power = 2.0 Watts
" " maximum cone excursion = 12.1 .10⁻³ cms
.10⁻³ Cm
.10⁻³ Sec.
Deflection vs Time
Start of a 300 cycle forced oscillation
PENTODE drive (α = 11.5)
Beff. = 14,000 .10⁻⁸ Volt sec./cm² (29.5 field watts)
Frequency of mechanical resonance 52.5 cycles
ς = 0.1825
Steady state voice coil current = 0.040 Amps peak
" " " " input power = 2.0 Watts
" " maximum cone excursion 12.10 .10⁻³ cms
.10⁻³ Cm
.10⁻³ Sec.

Fig. 16

for $\rho > 1$; δ is real, . . . decay is non-oscillatory
for $\rho = 1$; $\delta = 0$, *critical damping*
for $\rho < 1$; δ is imaginary . . . decay is oscillatory.

According to equation (39) the transient simply superimposes itself upon the forced oscillation. The condition of non-oscillatory decay is, of course, most desired, because only then the mechanical system can immediately follow the waveshape of the driving voltage. This condition is given by the relation

$$\rho \overset{>}{=} \frac{1}{2} \frac{1}{\omega_o m} \left(r + \frac{B^2 l^2}{R'} \right) \quad (42)$$

where ω_o is the frequency of mechanical resonance. For the term R′, we have to take: the voice-coil resistance R plus the resistance reflected from the driving source into the voice-coil circuit. Thus from Fig. 11:

$$R' = R + \frac{1}{n^2} R_p .$$

Using the "loading factor," α, which was defined previously, we have

$$R' = R(1 + \alpha) .$$

Equation (42) becomes finally

$$\rho \overset{>}{=} \frac{1}{2} \frac{1}{\omega_o m} \left(r + \frac{B^2 l^2}{R} \frac{1}{1 + \alpha} \right) \quad (43)$$

This is the condition for non-oscillatory decay of the transient.

The radiation resistance r is usually very much smaller than the term

$$\frac{B^2 l^2}{R} \frac{1}{1 + \alpha} .$$

The loading factor α is for triode amplifiers about 1/3 to 1/10, for pentode amplifiers from 5 to 20. Thus, for a pentode output stage, the numerical value of

$$\frac{B^2 l^2}{R} \frac{1}{1 + \alpha} .$$

and consequently also of the factor ρ, is only about 1/5 to 1/20 of what it would be with a triode output stage. This indicates that a pentode output stage is much more liable to generate non-oscillatory decay, or "hangover" effects, in a loudspeaker than does a triode output stage.

Fig. 16 shows what effects upon the transient condition are obtained with weak and strong magnetic fields, both for triode and pentode drive. The figure refers to a very high quality 12″ loudspeaker, having data as follows:

Overall diameter = 12″
Normal field watts = 12 – 15
Diaphragm mass = 15.8 grams
Voice coil diameter = 2″
" " resistance = 25.3 ohms d-c
Resonant frequency (infinite baffle) = 52.5 cycles
Approximate copper weight = 4.5 lbs
" iron weight = 13 lbs

Additional data appear in the figure. For all diagrams, the steady-state voice-coil input is the same (2 watts). It is seen that weak magnetic fields produce a long transient wave train. For triode drive and very strong fields, non-oscillatory transient decay is obtained with this speaker; with pentode drive the transient decay is oscillatory in every case. This is in agreement with previously known experimental data.[1]

To the author's knowledge there do not at present exist any data regarding the importance of transient effects and what constitutes the minimum permissible value which the factor ρ might have. Practically all commercial loudspeakers, except those working into a horn, have values of ρ considerably below 1 even with triode drive. With pentode drive, values of ρ in the order of 0.05 are quite common. As seen from Fig. 16, such values of ρ produce a wave train of frequency ω_o, which lasts for quite a number of cycles. On the other hand, experiments have shown that a tone must be sustained for a certain time before it becomes perceptible as such by the human ear.

[1] H. Neumann, "Transients in Electrodynamic Loudspeakers with Strong Magnetic Fields," Zeitschr. f. Technische Physik; 12, 627, 1931.

THE MAGIC VOICE

(*Continued from page* 10)

In Fig. 8 is represented a plan view of a conventional open back cabinet placed near a wall. With a program being received let the listener place his ear close to the cabinet (at about the distance indicated by the dotted semicircle) or better still pass a microphone slowly around this semicircle, the listener in this case wearing a pair of headphones connected to the output of the microphone amplifier. In the area designated "C," good low-frequency response will be noted and similarly at "A" and "E." At "B" and "D," however, the low-frequency fundamentals will be noticeably lacking since this is the area in which the back wash of the 180° out of phase components from the front and back surfaces of the cone occurs and the low frequencies are neutralized to a great extent in this area. This demonstration is quite striking if a low-frequency continuous tone from an a-f oscillator is impressed on the loudspeaker. In this case only the upper harmonics of the tone will be heard in the areas "B" and "D" and those fan-shaped areas will be found to extend for quite some distance from the cabinet.

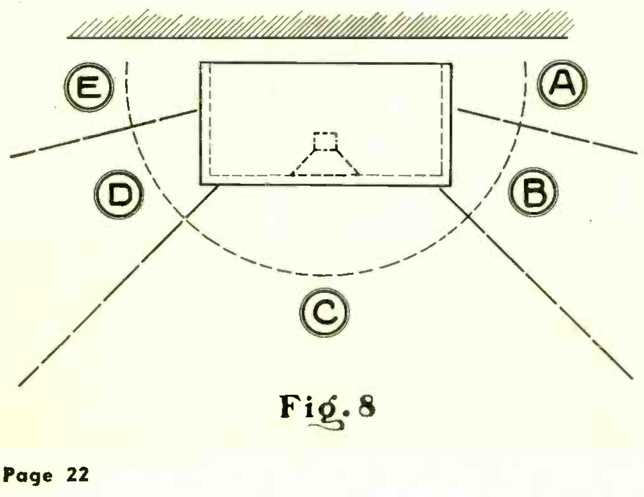

Fig. 8

Performing a similar test on a cabinet employing the "Magic Voice" results in no such loss of low-frequency fundamentals in the areas "B" and "D." Even if a similar exploration arc is described in a vertical plane (the listening microphone would then pass vertically down near the front of the cabinet and around underneath it) we find no such neutralization area since the back wave coming out of the bottom of the cabinet is in phase with that from the front.

In closing the authors wish to acknowledge the valuable assistance received from the direction and encouragement of Mr. F. X. Rettenmeyer, consultation with Dr. H. F. Olson and from Mr. A. S. Briggs who assisted in the development work on this device.

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"MIRROPHONIC"— WESTERN ELECTRIC'S NEW SOUND SYSTEM

A NEW WESTERN ELECTRIC reproducer set is employed as standard in the "Mirrophonic" system. This unit employs a film-pulling mechanism known as the "Kinetic Scanner," in which a damped mechanical impedance is utilized to provide uniform film velocity. It has also an improved optical system in which the physical slit is replaced by a cylindrical lens combination.

The amplifier equipment is of an advanced type. In addition to an excellent frequency characteristic and high degree of reliability, there is employed an important new device termed a "Harmonic Suppressor." This may be compared to an electrical governor which automatically, and without any moving parts, causes the amplifier to maintain constant quality over an output range so enormous that the loudest sounds heard in the theatre may exceed the weakest by more than 100,000,000 times.

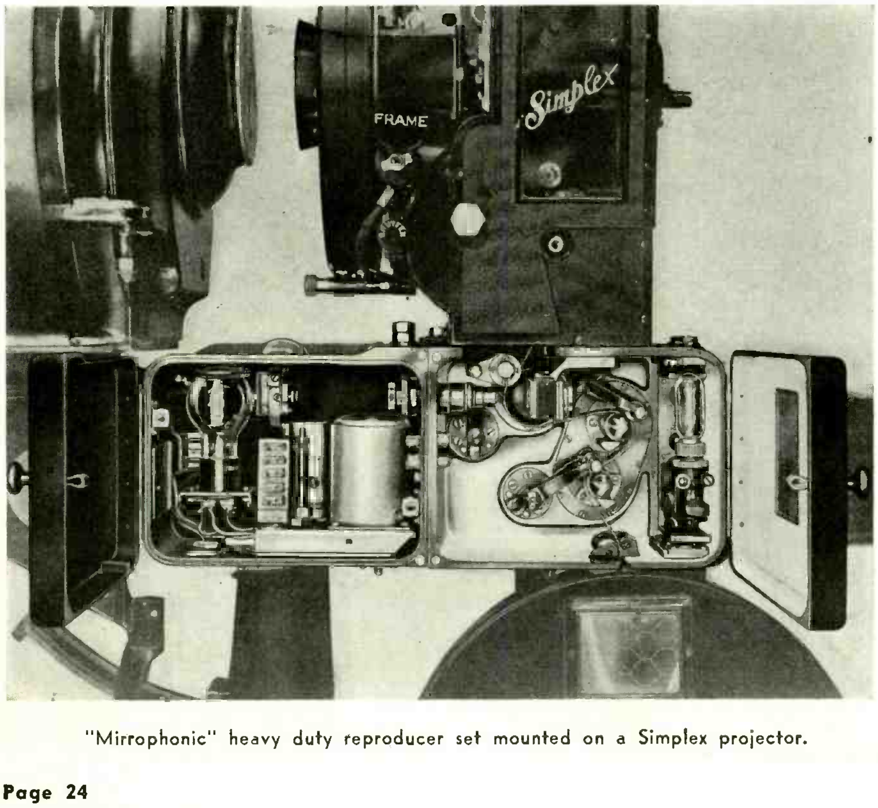
The new amplifiers are very simple to operate. They run entirely on a-c, and it is unnecessary for the projectionist to remember such things as filament or plate current values because all parts of the circuit requiring adjustment can be checked by means of a selector switch associated with a "Percentage Meter"; that is, a meter whose scale is graduated to read percentages of the normal or correct value, which is taken as 100 percent. All that is required, therefore, is to adjust the system controls so that the meter reads 100 percent on each part of the circuit that needs to be checked.

The "Di-Phonic" speaker system which is employed has an interesting background. In April, 1933, the music of the Philadelphia Symphony Orchestra was transmitted from Philadelphia to Washington by engineers of the Bell Laboratories, in an experimental demonstration which showed that extraordinary possibilities existed for the realistic reproduction of sound in large auditoriums, provided suitable amplifiers and loudspeaker equipment were employed.

This demonstration of Stereophonic sound, or auditory perspective, made under the auspices of the National Academy of Sciences was everywhere hailed as a remarkable forward step in sound reproduction. On August 17, at the Hollywood Bowl, Leopold Stokowski conducted a concert which was brought to an audience of more than 26,000 persons by a perfected Stereophonic sound reinforcing system. The ERPI "Di-Phonic" speaker system forms part of the Stereophonic system. The term "Di-Phonic" indicates that the sound is reproduced in two frequency ranges, upper and lower. The upper range is handled by cellular high-frequency horns of the type employed in the Philadelphia-Washington demonstration which insure that the sound shall be evenly distributed throughout the theatre instead of being chiefly concentrated in a beam over one area. The low-frequency speakers are of the dished-baffle type, in which the principle of cellular sub-division is again employed to obtain proper low-frequency distribution.

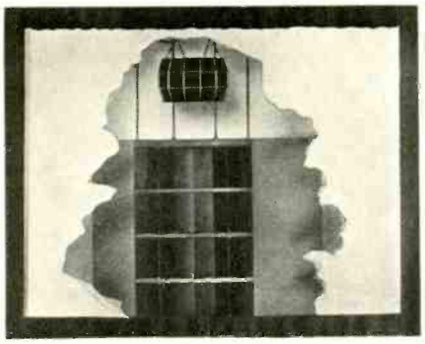
Besides the standard type reproducer set there is also a heavy-duty deluxe type of reproducer set. Designed to match the finest types of projectors, it has the solidity of construction and the refinement of design associated with equipment of the highest grade. Particularly interesting in this connection is the fact that, while this reproducer set will, of course, give an exceptional amount of service by virtue of its durable construction, it has also been built in such a manner that it can readily be adapted to take advantage of the improvements in recording methods or other changes that may reasonably be anticipated in coming years, since the motion picture art shows no signs of having lost its capacity for steady progress.

Coming to some of the leading features of this heavy-duty reproducer set, the drive is from a motor which is built into the front of the unit, silence and smoothness of operation being assured by the use of gears running in oil. The film-pulling mechanism employs an oil-damped film velocity control which is a highly developed form of the "Kinetic Scanner." In scanning, the conventional narrow scanning beam has been superseded by an arrangement termed the "Optical Bridge," in which an image of the illuminated sound track magnified ten times is projected on a slit 12 mils wide. This greatly facilitates adjustment and maintenance and provides increased illumination for the photoelectric cell which, in turn, makes possible a higher output. The exciting lamp is operated from a separate power unit,



"Mirrophonic" heavy duty reproducer set mounted on a Simplex projector.

Comment . . *Production*



The "Di-Phonic" speaker.

insuring freedom from noise at this point. Ball bearings with automatic lubrication are used throughout. Repairs and replacements are greatly facilitated by readily interchangeable motors and automatic projector alignment. The latter permits of removing a projector and replacing it again without any need to readjust the picture on the screen.

On the recording side is a new channel which represents one of the many combinations possible with the new line of recording equipment which is being brought out this year. This channel is a portable system designed for recording on a film separate from the picture film. It can be mounted in a light-weight truck or used for almost any type of portable service. The various units are housed in substantial duralumin cases provided with carrying straps. The system has a long list of features that embody the best of up-to-date recording practice such as high-speed noise reduction and the use of heater-type vacuum tubes throughout. The system also employs the new Western Electric small non-directional dynamic microphone which is described below. Very flexible motor combinations are available, making it possible to operate the channel directly either from batteries, 50 or 60 cycle a-c, or the standard Western Electric studio power system.

Another recording system is the portable channel for newsreel work, which weighs complete only 88 pounds, can be carried with camera in the baggage compartment of a small coupe, and can be set up ready for operation in three minutes. It makes its sound record on the same film used for the picture. With this equipment, a crew of only two, namely, soundman and cameraman, can make sound pictures anywhere that a camera can be operated.

A new amplifier has been designed for use in the newsreel system. This amplifier includes a two-position mixer, facilities for using two dynamic microphones (or a condenser-transmitter if desired), dialogue equalization, low-pass filter, 1000-cycle testing oscillator and headphone monitoring circuit.

The new Western Electric small non-directional dynamic microphone is another recording item. Its frequency characteristic, which is substantially uniform from 40 to 10,000 cycles, is practically unaffected by the direction of the sound. This greatly facilitates the work of the boom man. The small size (only 2½ inches in diameter) and light weight also make it a very convenient instrument to handle or conceal. Although generally similar in principle to the well-known earlier design of Western Electric dynamic microphone, the non-directional design embodies so many changes and improvements as to be a new instrument. Besides its small size and spherical shape, its most striking external feature is the acoustic screen placed over the diaphragm outside the case. The effect of this screen is to attenuate sounds coming from the front, while those coming from the rear are reflected back on the diaphragm. It is, therefore, an important factor in conjunction with the spherical shape in giving the microphone its non-directional properties.

THE ACOUSTIC LABYRINTH

THROUGH THE COURTESY of Messrs. Manson and Olney of the Stromberg-Carlson Telephone Manufacturing Company, we are privileged to present some of the details of the Acoustic Labyrinth which is used in some of the receivers manufactured by that company.

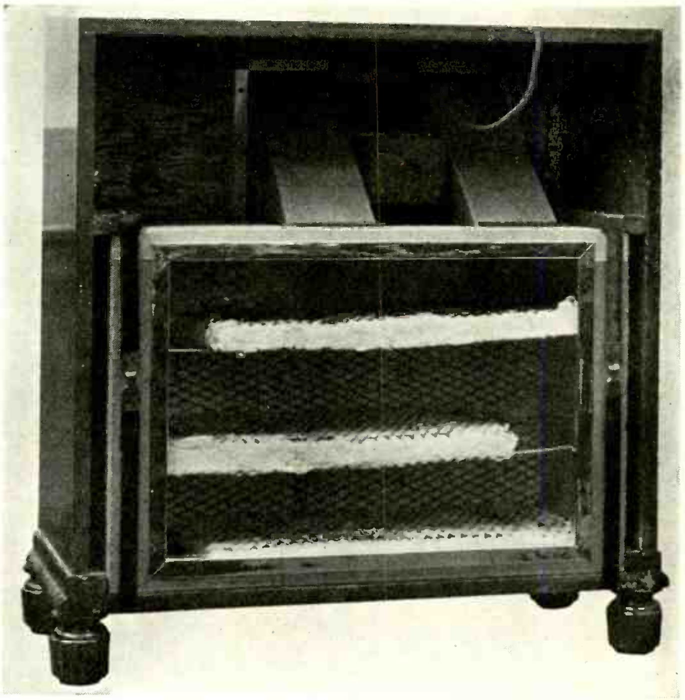
The overall dimensions of the Labyrinth proper are: 23 inches long, 16 inches high, and 11 inches deep. The sound passage has a cross section of 4 inches by 8 inches throughout.

In the illustration—which is of a cut-away demonstration model—the sound absorbent lining is composed of 1 inch rock wool blanket. In production models, the back is closed by panels of rock wool blanket the same as shown for the front side, and the supporting rods are omitted.

The housings connecting the back of the speaker cone with the Labyrinth are lined with ⅜ inch felt and fit closely around the loudspeaker frame so that all of the back radiation is conducted to the Labyrinth.

The material of the housings and the Labyrinth box is unimportant.

Mr. Olney, who is in charge of Stromberg-Carlson's acoustic laboratory, presented a paper on the Acoustic Labyrinth before the Acoustical Society of America in May of this year.



The Stromberg-Carlson Acoustic Labyrinth.

RMA NEWS

RMA PROGRAMS OF U. S. SHORT-WAVE STATIONS DEVELOP WIDE INTEREST ABROAD

FOREIGN LISTENERS ARE avid for American short-wave broadcast programs and many foreign newspapers are now translating and publishing American programs supplied by the RMA and distributed by the U. S. Department of Commerce. American government officials have sent numerous reports to the Department of Commerce telling of the wide interest developed in many foreign countries by the RMA programs of American short-wave stations. This weekly program service was inaugurated last June by the RMA in cooperation with the Bureau of Foreign and Domestic Commerce of the Department of Commerce. The weekly programs collected by RMA and sent to all commercial representatives abroad of the Department of Commerce are now being published in many foreign newspapers.

While the programs of American short-wave stations have not yet been developed to the point of the British, German, French and some other foreign countries, the official reports to the Department of Commerce tell of the great desire of foreign listeners to receive the programs from the U. S. short-wave stations. As a result and at the request of American officials abroad, the RMA is arranging with the U. S. stations to speed up and further develop, farther in advance, the American broadcast programs.

Andrew W. Cruse, chief of the Electrical Division of the Bureau of Foreign and Domestic Commerce, has received wide approval from the Government Commercial Attaches of the American program service. The trade promotion value of short-wave broadcasting is emphasized and some attaches state that the short-wave broadcasts have definite sales promotion value not only of American radio but other products of the U. S. In Latin America especially, the RMA programs of the U. S. short-wave stations are now widely published.

Foreign representatives of several American radio companies also have cited the benefits which have followed the American program service made available abroad by RMA.

In addition to the program service of American short-wave stations distributed abroad by the Department of Commerce, the RMA is continuing its wide program service of foreign short-wave stations to the American press. An increasing number of the leading U. S. newspapers are now publishing the RMA programs giving each day the outstanding short-wave broadcasts from all foreign countries as well as by the American stations. Foreign embassies and legations in Washington are cooperating with the RMA in securing short-wave programs from their respective countries and additional governments are arranging for inclusion of their programs in the RMA service.

JUNE 1936 LABOR INDICES

Increases last June of 12.6 percent in employment and 14.2 percent in payrolls of radio and phonograph factories were detailed in the latest labor report of the U. S. Department of Labor, Bureau of Labor Statistics, and ascribed to seasonal activity. Radio factory employment was 46.6 percent above that of June, 1935, and the June employment index figure was 242.5 compared with the three-year official average of 1923-25.

Radio factory payrolls last June were 60.6 percent above June, 1935, and the June index figure was 162.0 percent compared with the three-year official average.

Average weekly earnings in radio factories last June were $20.69 compared with $20.42 during the previous month of May, an increase of 1.4 percent, and the average weekly earnings during June were 9.8 percent above those of June, 1935. For all durable goods manufacturing industries, the average weekly earnings in June were $25.82.

Average hours worked per week in radio factories last June were 38.7 hours, an increase of 2.3 percent over May and 14.7 percent above June, 1935. The average in all durable goods factories was 41.1 hours per week.

Average hourly earnings during June of radio factory employees were 53.5 cents, a decrease of .8 percent from the previous month of May and 4.7 percent below June, 1935. In all durable factories the national average hourly earnings were 61.8 cents.

JULY EXCISE TAXES SHOW LARGE INCREASE

Production activity in the radio industry is reflected in the July, 1936, report of payments of the 5 percent federal excise tax. The Internal Revenue Bureau collections during July were $595,713.31 from the 5 percent tax on radio and phonograph apparatus. This was an increase of 307 percent over the collections of $146,320.19 in July, 1935, and the figures do not include additional taxes on automobile sets and radio automotive accessories.

RMA PREPARED FOR COMMISSION HEARING OCTOBER 5

Two RMA committees, including both executives and engineers, were preparing for the important broadcasting hearing of the Federal Communications Commission at Washington on October 5. A special committee of executives headed by James M. Skinner of Philadelphia and the RMA Engineering Committee of which Dr. W. R. G. Baker of Bridgeport is chairman, both were assembling data on subjects scheduled at the Washington hearing. Broadcasters appeared in force at the hearing which was to compile information for future allocations in the regular broadcast band. High power, clear channels and many other important subjects were scheduled. Ten stations have applications pending for increase of their power to 500,000 watts. There is also the question of division of time on regional channels in future allocations. Standards of selectivity and fidelity are special subjects in which the RMA is interested and on which it made detailed recommendations at the Commission's hearing.

RMA BOARD MEETS TO PLAN WIDER ACTIVITIES

New projects and services for the RMA membership, improved merchandising practices, and sales promotion, came before the RMA Board of Directors at a meeting Thursday, September 24, at the Hotel Roosevelt in New York City. President Leslie F. Muter of the Association called the fall meeting of the RMA Board to consider several new Association projects as well as many important problems now before the industry. Merchandising practices, especially in view of the new Robinson-Patman Act, were prominent in the discussions of the radio industry leaders. Also a further conference is planned of the special RMA Fair Trade Practice Committee of which Director E. F. McDonald, Jr., of Chicago, is chairman.

A special survey of the administration of the federal excise tax has been made by the RMA Set Division under Chairman Arthur T. Murray to develop uniformity in excise taxes of set manufacturers and effect tax savings in many cases.

Plans also were approved by the RMA Board for representation of the Association at the October 5 hearing of the Federal Communications Commission in Washington on broadcasting allocations.

Problems affecting parts and accessory manufacturers, especially in connection with radio parts shows and exhibitions, will be considered by a special committee of which Fred D. Williams of Philadelphia, former president of the RMA, is chairman.

TELEVISION MUST CONTINUE "EXPERIMENTAL," COMMISSION ORDERS

Television development must continue indefinitely on an "experimental" basis, without any commercial status or privileges, according to formal orders issued by the Federal Communications Commission on August 22. The new rules were made effective September 15 and follow the informal engineering conferences held in Washington last June in which the RMA participated. The rules also apply to international, facsimile, high-frequency and relay broadcasting.

No service charges can be made, directly or indirectly by licensees of television broadcast stations, under the Commission's new orders. In experimental television broadcasting, no commercial announcements will be permitted except the name of the sponsor or product or the televising of the trademark, symbol, slogan or product made. The only exception is permission for limited commercial announcements aurally when the television experiments are incidental and not featured.

To insure that future experimental broadcasting of television shall be actually "experimental" and non-commercial, the Commission's new rules also prohibit any

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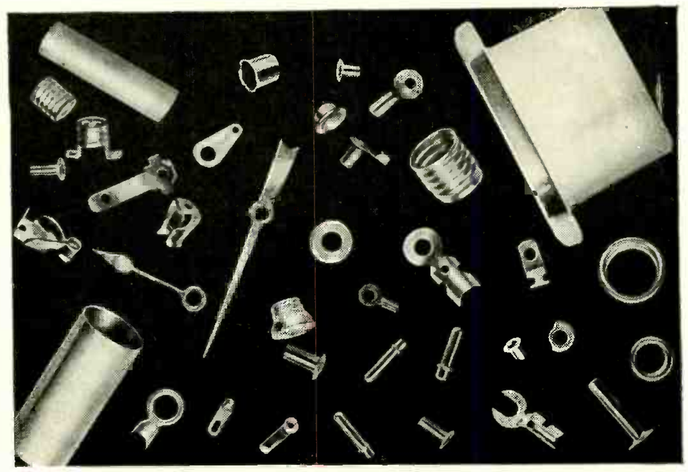

VACUUM tube base pins, plug and socket parts, eyelets, rivets, grommers, terminals, contacts, aerial hardware, electrodes, fuse clips, sockets, screw shells, condenser shells, miscellaneous stampings, shells, etc. The Waterbury Brass Goods Corp., as this division of The American Brass Company was formerly known, has long been a recognized source of supply for these and similar radio parts of copper and copper alloys.

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broadcast announcement except of the call letters of the experimental television station and prohibits any charges by stations or networks or solicitation of commercial accounts for the aural and visual programs of experimental stations. Similar restrictions also apply to future facsimile, international, ultra-high frequency and relay experimental broadcasting.

In providing for future experimental broadcasting of television, facsimile and on ultra-high frequencies, the Commission adopted substantially the allocation recommendations made by the RMA last June. For television, in addition to limited allocations between 2,000-2,100 kc, the Commission provided for wide bands, from 42,000-56,000 kc and from 60,000-86,000 kc and also additional allocations of 6,000 kc bands above 110,000 kc, except 400,000-401,000 kc. These were virtually the recommendations made to the Commission last June by the special RMA committee of which James M. Skinner of Philadelphia was chairman.

For facsimile and also high-frequency broadcasting the Commission also adopted substantially the allocation recommendations of the RMA committee.

All allocations formally ordered by the Commission emphasize the indefinite "experimental" and non-commercial restrictions during development of the new future radio services.

To prepare material for the Washington hearing, Chairman Virgil M. Graham of the Standards Section called a meeting of the special broadcasting committee, Wednesday, September 16 at the Governor Clinton Hotel in New York. Afterward there was to be a meeting of the receivers committee of which E. T. Dickey of Camden, N. J., is chairman, to consider other industry standards and projects.

CREDIT COMMITTEES REASSEMBLE

After summer recesses, monthly meetings of the RMA eastern and western credit committees have been resumed. The first fall meeting of the eastern group with Vice Chairman Edward Metzger presiding was held September 9 at the Hotel New Yorker in New York, and the western committee, of which P. C. Lenz is Vice Chairman, met in Chicago, September 11. The RMA membership exchange of credit information each month is with the usual cooperation of the National Credit Office, the official credit agency of the Association.

CANADIAN SALES

Canadian radio manufacturers during the six months ending June 30, 1936, sold 62,325 receiving sets with a list value of $5,427,233, according to information received by the RMA through the cooperation of the Canadian RMA. The half yearly Canadian sales during 1936 compared with 47,368 sets valued at $4,216,087 in the first six months of 1935. Included in the six months' sales for 1936 were 42,923 a-c sets valued at $4,120,486; 9,642 battery sets valued at $721,708, and 9,760 automobile sets valued at $585,039.

The June, 1936, sales of Canadian manufacturers were 7,731 a-c sets valued at $694,225; 3,742 battery sets valued at $269,385, and 1,907 automobile sets valued at $114,085. June inventories including stocks of jobbers and branches, were 21,577 a-c sets, 12,606 battery sets and 1,572 automobile sets.

Canadian sales during July, 1936, were 13,035 a-c sets valued at $1,850,893; 6,840 battery sets valued at $450,285, and 1,389 automobile sets valued at $82,951, a total sale in July of 21,264 sets valued at $2,384,129. Canadian inventories on July 31 were 27,553 a-c sets, 14,670 battery sets, and 1,359 automobile sets, a total of 42,582 of all types.

Production projected by the Canadian manufacturers from August 1 to October 31 included 67,314 a-c sets, 20,456 battery sets, and 1,263 automobile sets, a total projected production of 89,033 of all types.

COMMUNICATIONS COMMISSION FINDS MANY OBSOLETE RECEIVERS

Among rural owners of radio receivers there is a large percentage of obsolete sets, according to an official survey by the Federal Communications Commission. The farm survey was made early in 1935 by the Commission's engineers to develop information regarding rural service of broadcast stations but the Commission's report was much delayed and not published until September 1.

The Commission's survey included 116,000 postcard questionnaires sent February 1, 1935. It was concluded a month later, with total usable returns of 32,671 postcards from rural owners of radio sets. Therefore, very few 1935 receiving sets were included in the survey, but the Commission's official returns showed that nearly half of the rural receivers in use at the time of the survey were more than four years old. More than two-thirds of the farm sets contained from five to seven tubes and this, according to the Commission's report, indicates that the average farm receiver was a superheterodyne of fair quality. The report stated that this belief also was strengthened by the fact that 75 percent of the receivers were manufactured subsequent to 1930.

Following is a tabulation in the Commission's report:

Year of Manufacture of Radio Receiver

Year of Receiver	*Percent*
1929 or earlier	26.1
1930	12.7
1931	10.1
1932	12.1
1933	13.8
1934	21.6
1935	3.6

Number of Tubes in Receiver

Number of Tubes	*Percent*
4 or less	5.6
5 to 7	69.9
8 or more	24.5

The survey also developed that 75 percent of rural radio listeners preferred programs from the powerful clear channel broadcast stations rather than those of regional or local stations. The survey and the report are regarded as strong support for the chain networks and clear channel stations as well as the demand for further high-power allocations by the Commission.

The percentage preference of rural listeners for clear channel stations, according to the Commission's survey, was 76.3 percent, while 20.6 percent indicated a preference for tuning in regional stations; 2.1 percent for local broadcast stations, and 1 percent only for foreign programs. In this connection, however, it should be noted that neither short-wave broadcasting nor subsequent large sales of short-wave sets had developed substantially at the time, in the mid-winter season of February, 1935, when the Commission's inquiry was conducted.

AUSTRALIAN IMPORT RESTRICTIONS

Limited quotas for certain radio imports are being granted by the Australian Government, according to a late report from Assistant Trade Commissioner Wilson C. Flake of the U. S. Department of Commerce at Sidney, Australia, but importation of many radio items from the U. S. is completely barred. Under the Australian import restrictions, effective on May 22, prohibiting the importation of many products, including radio, from non-British countries without special approval of the Australian Government, numerous applications for permits to import goods, including radio apparatus, from the U. S. have been refused but certain radio parts not on the prohibitive lists are being admitted under quota permits.

According to the U. S. Department of Commerce report, Australian quotas have been established in order to give importers a "breathing spell," and the importers have been warned that they should endeavor to arrange other sources of supply (i.e., sources other than the United States) for the future. They have been informed that the granting of permits, under the quota arrangements, for imports from the United States does not necessarily mean that future quantities will be permitted entry.

Under the quota arrangement, permits will be given for a supply equivalent to that imported during the 12 months May 1, 1935 to April 30, 1936, in respect to the following items:

1. Radio broadcasting transmitting tubes.
2. Steatite mouldings such as "Isolantite."
3. Tubes (valves) for use in the manufacture of short-wave diathermy, and cutting and coagulating machines.

Permits will be granted for a supply equivalent to that imported (a) during the 6 months' period July-December, 1935; or (b) one-half the quantity imported during the 12 months from May 1, 1935 to April 30, 1936, whichever is greater, in respect of the following goods:

1. Radio receiving tubes.
2. Rectifier tubes for use in the manufacture of factory and garage battery charging plants.
3. Distributor suppressors for automobile-radio sets.
4. Vibrators (synchronous and non-synchronous) for use in automobile- and battery radio sets.
5. Shielded condensers for generators for use in automobile-radio sets.
6. Volume controls.
7. Switches, including midget switches.
8. Fuse holders for automobile- and battery radio sets.
9. Insulating board of punching quality only.
10. Linen inserted bakelite for use in the manufacture of loudspeaker spiders.
11. Voice-coil paper for use in the manufacture of loudspeakers.
12. Fixed carbon resistors.
13. Electrolytic condensers.
14. Carbon element rings.
15. Carbon-sprayed sheets for tone control.
16. Resin compound strip for carbon volume controls.

Permits will be granted for a supply equivalent to that imported during (a) the 3 months July-September, 1935; or (b) one-fourth of the quantity imported during the 12 months from May 1, 1935 to April 30, 1936, whichever is the greater, in respect of the following goods:

1. Aerial connection for automobile-radio sets.
2. Condenser gear assembly for automobile-radio sets.

In connection with the above quotas, it must be remembered that they are granted to individual importers on the basis of their past business. Therefore, neither the American exporter nor his commission agent in Australia can apply for a permit under the quota. The applications must be lodged by the *importer* (who, however, in some cases may be the American company's "agent"—i.e., an agent who imports on his own account). Obviously, American exporters cannot hope to sell to any importers in Australia except those importers who are entitled to import under the quota arrangement.

Except in those cases where quotas have been established, all applications to import prohibited goods from the United States are being refused.

TARIFF THREAT IN PERU

Increase of 50 percent in Peruvian import duties on radio receivers and accessories has been authorized, according to advices to the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce. The government is authorized by executive order to apply the import duties collected on radio sets and accessories to the cost of the government broadcast station now being completed. Increase of the present duties by 50 percent is authorized for this purpose and is possible although formal orders for the increase have not yet been issued.

TRADE INQUIRY FROM ARABIAN GOVERNMENT

The Director General of the Arabian postal, telegraph and telephone administration is interested in securing a number of battery or d-c receivers for use in 37 wireless stations of the Arabian government. Devices for recording messages from foreign radio stations also are desired. Manufacturers interested should address Sayid Mohamed Khalil, Director General of Post Offices, Telegraphs and Telephones at La Meque, Arabia.

SWEDISH TUBE FACTORY

Manufacture of radio tubes in Sweden is planned by the Radio-fabriken Auditorium, Vasagatan 23-25, Stockholm, according to a report received by the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce. The Swedish company has applied to its government for a loan of 50,000 crowns to finance machinery purchases, contending that tube prices in Sweden are controlled by foreign producers.

SAVINGS ON FREIGHT BILLS

Several RMA members have reported recent substantial savings on their freight bills through the RMA Auditing Bureau. T. P. Scanlon of 1608 Milwaukee Avenue, Chicago, is traffic auditor for the RMA. The auditing service is free to RMA member companies who are requested to send in their freight bills to Mr. Scanlan. The bills will be carefully checked and claims filed for all overcharges detected. The service has been very satisfactory to RMA members and it is hoped that larger use of the Association's traffic auditing bureau will be made.

New Products

TRIPLETT VT VOLTMETER

The model 1250 vacuum-tube voltmeter, just announced by The Triplett Electrical Instrument Co., Bluffton, Ohio, is built on what is said to be a new tube bridge circuit. It is claimed that this circuit makes the instrument independent of tube characteristics and to insure exceptional stability.

Complete details may be obtained from the manufacturer.

— RE —

BRUSH MICROPHONES

A recent development in microphone construction tending toward quietness in use is the newly developed spring mounting in the BR2S microphone manufactured by The Brush Development Company, Cleveland, Ohio. This mounting makes unnecessary any external mounting ring or rubber stand shock absorber.

A new public-address microphone known as the B-1 has been placed on the market by this company. It offers at a lower price, though somewhat lower output, many of the operating features found in the Brush Sound Cell Microphones.

— RE —

UNITED ELECTRONICS TUBES

United Electronics Company, 42 Spring Street, Newark, N. J., announces a line of oscillator tubes for use in short-wave diathermic equipment.

— RE —

TOBE ANTENNAS

A new antenna for auto-radio use has been announced by the Tobe Deutschmann Corporation. This antenna, in the form of a pole which telescopes to a minimum height of three feet, is said to provide 17 db gain when fully extended. Full details may be obtained from the manufacturer whose address is Canton, Mass.

— RE —

SPECIAL DETREX DEGREASER

The line of degreasers manufactured by Detroit Rex Products Company, 13005 Hillview Ave., Detroit, Mich., has been augmented by a special vapor-spray-vapor machine equipped with a monorail conveyor. The unit has been designed to handle small racked parts such as poppet valves, flat sheets, etc. Hangers are spaced at intervals along a conveyor to carry the work-holding racks.

STANLEY SOLDERING IRONS

A new line of electric soldering irons is now manufactured by the Stanley Rule & Level Plant, New Britain, Conn. Produced after two years of extensive research, Stanley electric soldering irons are of improved design, operated efficiently and economically on either a-c or d-c current.

These new Stanley tools have compressed pure copper tips, accurately machined for a valve-fit connection with the heating heads, to assure effective heat conduction and to protect metal connecting surfaces from oxidation and flux corrosion. Hermetically sealed heating heads protect the "built-in" windings and solid copper cores from air, flux fumes and moisture.

There are eight different sizes of Stanley soldering irons, ranging from 52 watts with a 7/16-inch tip to 435 watts with a 1 9/16-inch tip. Each iron is equipped with a 6-foot flexible heating cord with an effective cord strain relief, attached to convenient terminals. A metal resting stand is packed with each tool.

— RE —

EISLER WELDING MACHINE

The Eisler Engineering Co., 740 So. 13th St., Newark, N. J., announces its large press type electric resistance welding machines. Press type welders, made in sizes up to 250 kva, are intended for handling metals of various thicknesses and are supplied with throat depths from 16 to 48 inches. They may be had in foot, air or motor-driven models with speed changes varying from 30 to 100 welds per minute.

Perhaps the feature most important to the manufacturer is the fact that this welder is a self-contained unit. That is, the timer, contactor and switch are assembled in the welder making a compact unit. With this welder the operator has all the welding accessories handy and can increase efficiency with economy of time.

— RE —

GLYPTAL CEMENT MARKETED BY GE

Glyptal cement, a derivative of Glyptal alkyd resins that is flexible, transparent, and exceptionally adhesive, is currently being placed on the market by the General Electric Company's Appliance and Merchandise Department, Bridgeport, Connecticut. It will mend or adhere to all common materials except rubber and is both water- and oil-resistant.

— RE —

HEAT-RESISTANT MOLDINGS

Temperatures up to 450° F will not affect moldings made of improved heat-resistant material recently developed by General Plastics, Inc., No. Tonawanda, N. Y. The new material, available in black and brown and known as No. 34 and 37, is intended for such uses as electric iron handles, heater and appliance plugs, and other parts which must retain their dielectric strength without carbonization under relatively high heat. The material preforms well, molds almost as fast as standard materials, and has excellent arc resisting properties as well as a smooth finish. It also has a very low water absorption rate.

POWER RHEOSTAT

The new D-150 power rheostat has just been announced by Hardwick-Hindle, Inc., 40 Hermon Street, Newark, N. J. It is a compact, continuously-variable unit that measures 4 inches in diameter with a maximum depth behind the panel of 1½ inches.

All live parts other than the terminals are enclosed. The contact surface of the wire is protected from dirt and mechanical damage. All moving parts are back of the panel and are smooth and flush with the surface of the rheostat.

Resistance wire is wound on a toroidal ceramic core and coated with vitreous enamel. A minimum of ¼ inch air space or adequate ceramic insulation separates all live parts from the shaft, base, etc., which may be grounded.

The contact shoe is of metal-graphite composition and travels on the inside circumference of the ring where the turns of the winding are necessarily most closely spaced. The shoe has a narrow face that

is said to insure a smooth variation of resistance and freedom from unsteadiness due to shift of contact from one side of the shoe to the other. A coiled pigtail, one end of which is molded within the shoe, has its other end riveted to the central stationary terminal so that the only sliding electrical contact is that between the shoe and the winding itself. A heat-treated coil spring holds the shoe in contact with the winding, while shoe, spring and pigtail are enclosed in a ceramic cavity.

The new D-150 rheostat has a free air rating of 150 watts. It conforms to Underwriter's Laboratories and NEMA specifications based on a maximum temperature rise of 250° C for continuous operation in free air.

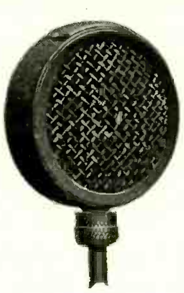
— RE —

ALADDIN TRANSFORMERS

A new series of Polyiron-core i-f transformers has been made available by Aladdin Radio Industries, Inc., 466 W. Superior Street, Chicago, Ill. These transformers are tuned by means of movable Polyiron cores, the resonant circuits being completed by high-quality fixed condensers. The gain and selectivity of the units are said to be entirely adequate for present-day requirements.

ASTATIC MODEL 218 MICROPHONE

This is a single-diaphragm type instrument having wide-angle uni-directional



pickup. It is 2⅛ inches in diameter by ⅞ inch maximum thickness. The case is ⅝ inch thick; net weight 3½ oz.

The back of this unit is flat and the screen front is domed. Cable attaches through a collett-type ferrule. The output level is approximately —56 db using a 5.0 meg load.

A high-capacity grafoil crystal element is employed which permits of using long cables without serious loss of output. This high internal capacity is also said to be advantageous when transformers are employed to match to low-impedance circuits. Standard finish is telephone black. Standard cable is single-wire rubber-covered 8 feet long.

Further information may be obtained from the Astatic Microphone Laboratory, Inc., Youngstown, Ohio.

— RE —

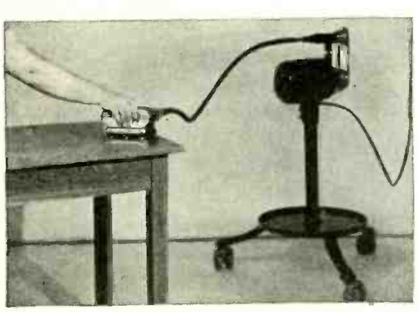
MEISSNER TRANSFORMERS

Meissner Manufacturing Company, Mt. Carmel, Ill., has announced an i-f transformer which is said to eliminate "drifting." The new transformer employs a micrometer adjustment having a total of 3,600 degrees of rotation. The transformers are available in all frequencies from 170 to 3,100 kc, and in either air- or Ferrocart-core.

— RE —

STERLING SANDER

A new sanding machine, electrically driven, which sands with a reciprocal motion duplicating hand sanding has been developed by the Sterling Products Company, Detroit, Michigan. The machine can be applied to curved or flat surfaces of metal, fabric, wood, composition leather and marble for such delicate operations as finishing and buffing, or to the heavier production requirements of finishing tools, trains and auto bodies. Wet or dry sanding may be used.



PHASE-ROTATION INDICATOR

Ferranti Electric Inc., 30 Rockefeller Plaza, New York City, announce a new addition to their line in the form of a small 2½ inch phase-rotation indicator weighing less than 13 ounces.

This instrument consists of a small three-phase induction motor mounted in a bakelite case and fitted with an aluminum disc, which instantly indicates the direction of phase rotation on a three-phase supply. The portable model which can readily be carried in a pocket, is fitted with three 30-inch leads having crocodile clips of different colors.

These instruments can be used on voltages of from 110 to 650 volts, 25 to 125 cycles, and are extremely useful wherever it is necessary to know the phase rotation of a three-phase circuit.

Instruments for switchboard mounting can also be supplied in either of the 2½-inch flush or projecting patterns.

Complete descriptive information will be sent upon request.

— RE —

PORTABLE RECORDING MACHINES

A portable recording machine, the result of more than two years of laboratory tests and research, was placed on the market early in October by the Universal Microphone Co., Inglewood, Calif. They already manufacture professional and other types of recorders.

The portable is said to have eliminated all waver at 33⅓ rpm transcription speed and 78 rpm phonograph speed. It records equally well in either direction, and cuts lines at 90, 110 and 130.

The equipment contains a complete switching arrangement for headset monitoring, either from the playback or the cutting head. The standard Universal floating head is used, and the turntable is a 16-inch one. The voice coil of the cutting head may be cut out of the circuit or may be included by means of an anti-capacity switch.

The power drive is a synchronous motor operating on 110-volt, a-c 50- or 60-cycles, self-starting type and starts without shock or impact. It drives by means of an endless belt running on the outside edge of the turntable, and is driven by a two-step pulley mounted on the vertical countershaft of the motor.

NEWS OF THE INDUSTRY

WESTON LINE DESCRIBED

The complete line of Weston radio servicing instruments, including the new Model 772 analyzer which operates at a sensitivity of 20,000 ohms-per-volt, are described and illustrated in a new folder published by the Weston Electrical Instrument Corporation, Newark, N. J. Specifications for sixteen fundamental test instruments each designed to meet the requirements of some particular phase of service work, are included in the folder. The instruments described not only permit analysis of modern receivers and their component parts, but extend dependable direct-reading measurement to many other types of electronic circuits and equipment—television, public-address system, talking picture recording, and the like.

Fields of application, ranges, operating characteristics, size and price are shown for each instrument, thus providing the basis for selecting a coordinated group to meet specific needs. In addition, the new models are described point-by-point, with emphasis on features of design essential for servicing present and future receivers of increasing complexity.

— RE —

WEBSTER MANUAL

The first completed series of the Webster Sound Manual is being announced by The Webster-Chicago Company, 3825 W. Lake Street, Chicago, Ill. The manual contains eighteen diagrams covering different phases of sound engineering from details of microphone construction to complete installations.

— RE —

AEROVOX LICENSES AUSTRALIAN CONDENSER MANUFACTURER

The appointment and licensing of the Continental Carbon Co., Pty., Ltd., of Melbourne, Australia, as manufacturers of electrolytic and other condensers under Aerovox patents and using Aerovox production methods, is announced by Aerovox Corporation of Brooklyn, New York.

— RE —

REPUBLIC STEEL BOOKLET

Silicon Sheets and Coiled Silicon Strip for the Electrical Industry is the title of a new, 36-page book currently being distributed by Republic Steel Corporation, Cleveland, Ohio.

Designed primarily as a technical guide for electrical engineers concerned with the application of silicon steels, the book contains a wealth of useful data on core loss, rolling limits, coil dimensions, etc. A series of clearly reproduced curves showing magnetization and permeability, features the discussion of each grade.

— RE —

GENERAL CABLE APPOINTEE

H. E. Eagleston, formerly Pacific District Manager of the General Cable Corporation has been appointed General Sales Manager with headquarters at 420 Lexington Avenue, New York City.

CENTRALAB CATALOG

A new catalog of controls, resistors and selector switches has been received from Centralab, 900 E. Keefe Ave., Milwaukee, Wis. Among the many items listed will be found the new Isolantite-insulated switches recently developed by Centralab, and a complete list of replacement volume controls.

— RE —

GENERAL RADIO CATALOG J

The General Radio Company, 30 State Street, Cambridge, Mass., have just issued Catalog J. This 170-page book contains complete technical information on General Radio industrial devices, resistors, condensers, inductors, frequency- and time-measuring devices, oscillators, amplifiers, bridges and accessories, standard-signal generators, oscillographs, cameras and analyzers, meters, power supplies, parts and accessories. This catalog is available on request.

— RE —

NEW CUTLER-HAMMER PLANT

Cutler-Hammer, Inc., manufacturers of electric control apparatus, Milwaukee, Wis., announce the extension of their manufacturing facilities to the west coast. A new plant, at 970 Folsom Street, San Francisco, Cal., began operation in September. Other factories are located in New York City and Milwaukee.

— RE —

KEN-RAD BULLETIN

An engineering bulletin entitled "616 Operation Data Showing Effects of Power Supply Regulation" has just been released by the Ken-Rad Tube & Lamp Corporation, Owensboro, Kentucky. It contains information valuable to radio engineers, technicians and servicemen. It is available on request.

— RE —

PATENT SYSTEM CENTENNIAL

A nation-wide celebration of the founding, in 1836, of the present American patent system will be held in Washington on November 23, 1936.

— RE —

AMERICAN SCREW COMPANY APPOINTS NEW EXECUTIVES

William F. Henning has been appointed Domestic Sales Manager of the American Screw Company, Providence, R. I. Mr. Henning has been assistant manager of this department for fifteen years and succeeds to the post vacated by the death of Albert B. Peck.

Walter Bromley, formerly sales representative in the Central States and the New England district, has been made Assistant Domestic Sales Manager.

Vincent Roddy, formerly director of the planning and research division, has been appointed Assistant to the General Manager, Eugene E. Clark.

Harry Mayo will continue as Sales Promotion Manager, the position to which he was recently appointed.

MAGNAVOX CONDENSER BULLETIN

An engineering bulletin giving recommended test procedure for wet electrolytic condensers is being offered by The Magnavox Company, Fort Wayne, Ind.

— RE —

A PROMISING ERA

An optimistic keynote to still further improvements of conditions in business, based on recent substantial increases in the nation's express traffic, is given in the September issue of *The Express Messenger*, in discussing "A Promising Era Ahead." Fluctuation in the volume of this business has always been considered an index of changing commercial conditions.

"An upward trend is discernible in many lines of manufacturing and distribution," declares this publication, adding that "not only have railroad and freight traffic been making new records, but department store sales show very definite upturn and retail stores generally are enjoying better and more lucrative patronage than for the past several years.

"Express traffic, too, started its gains even before increases were recorded for general business. With the betterment of conditions, there will certainly come an even greater demand for efficient and fast transportation service."

In the same issue, L. O. Head, president of the Railway Express Agency, announces his belief in a sharp upturn in the shipping of merchandise during the fall and winter months and states that his company has made special preparations to handle increased traffic expected in the near future.

— RE —

CORRECTION

We regret the omission of the name of the Transformer Corp. of America from our annual Buyers Directory. This company, with headquarters at 69 Wooster Street, New York, N. Y., manufactures public-address equipment, pre-amplifiers, portable sound equipment, and record players. These are marketed under the trade name of Clarion.

— RE —

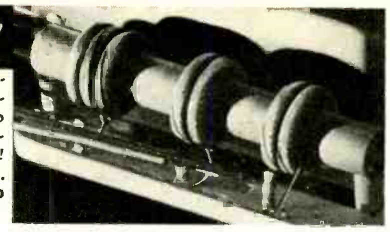
NEW ORGANIZATION FORMED

Following the purchase of a modern manufacturing plant at 5216-18 W. Kinzie St., Chicago, the Simpson Electric Company has announced a new line of radio instruments, service equipment and other electrical measuring devices. The president of the Simpson Electric Company is Ray R. Simpson who was formerly president of the Jewell Electrical Instrument Company, and in charge of all design and manufacturing of Jewell Instruments during the long and successful career of that company prior to its merger with the Weston Electrical Instrument Corporation.

— RE —

RADIO RECEPTOR BULLETIN

The Radio Receptor Company, Inc., 106 Seventh Avenue, New York City, now have available a bulletin featuring the Radio Receptor Series "7" dynamic microphones.



STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912 AND MARCH 3, 1933, OF RADIO ENGINEERING

Published monthly at New York, N. Y., for October 1, 1936.

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

Before me, a Notary Public in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of RADIO ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Bryan Davis Publishing Co., Inc., 19 East 47th Street, New York. Editor, W. W. Waltz, Tottenville, Staten Island, N. Y. Managing Editor, None. Business Manager, B. S. Davis, Ghent, N. Y. 2. That the owners are: Bryan Davis Pub. Co. Inc.; B. S. Davis, Ghent, N. Y.; J. C. Munn, Union City, Pa.; J. A. Walker, Richmond Hill, N. Y.; A. B. Goodenough, New Rochelle, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1% or more of the total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where a stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also, that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) B. S. DAVIS, Business Manager.

Sworn to and subscribed before me this 26th day of September, 1936.
(Seal) J. A. WALKER, Notary Public.
Queens Co. Clk's No. 3149, Reg. No. 7476.
New York Co. Clk's No. 831, Reg. No. 7-W-514.
Commission expires March 30, 1937.

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