PROCEEDINGS

of the

RADIO CLUB OF AMERICA

Musical Reproduction Has Improved

A Paper Delivered Before the Radio Club of America on Dec. 3, 1925

By A. F. Van Dyck

Development Engineer, Radio Corporation of America

Volume 3, No. 8 August, 1926

SPECIAL NOTICES

The Membership will be interested to know that the new headquarters of the Radio Club of America are now located in Room 469 in the Bryant Park Building, 55 West 42nd Street, New York City. The telephone number is Longacre 8579. In the future it is respectfully requested that all communications be sent to this address. This is one of the first big steps which the officers of the Club are taking to make the Radio Club of America the most outstanding organization of its kind.

In the near future it is expected that a library will be installed at Headquarters that will contain a complete set of the Proceedings as well as a sizable library of engineering books on radio and other kindred subjects where members so desiring may drop in any time during the day to seek information.

The last Board of Directors meeting of the season was held on July first at the Columbia Club, New York, where plans for expansion of the Club's activities were discussed and definite recommendations made for action this fall. The next meeting of the Board of Directors will take place in September.

There have been so many requests from members on the Pacific Coast that a new section be installed in their vicinity, that at the last meeting of the Board of Directors a resolution was passed that a section of the Radio Club of America be organized at San Francisco and that Mr. W. W. Lindsay, Jr., of 927 East La Jolla Avenue, Hollywood, Cal., be appointed Chairman pro tem. This is another move in the direction of expansion of the Club's activities and it is believed that it will be welcomed by our friends in San Francisco and adjacent territory.

The Secretary of the Club is now preparing the new Membership Certificate, a copy of which will be duly inscribed and forwarded to every member when available. These certificates should prove a valuable source of identification and honor to the recipient and it is respectfully suggested that they be duly framed and hung in a conspicuous place either at home or at business.

The 1926 year book of the Radio Club of America was recently published and a copy was forwarded to every member of the Club. Those who have not received a copy, either through change of address or otherwise, are requested to communicate with the Secretary so that another copy may be promptly sent.

How do you like the new form and size of our Proceedings? The Proceedings will be sent to you regularly in the future. If you change your address, please notify the Secretary.

At the last Board of Directors meeting on July first, the following members and Fellow were duly elected.

New Members: James F. J. Maher, 2554 Mansfield Place, Sheepshead Bay, L. I.; J. L. Bernard, c|o Radio Corporation of America, 233 Broadway, N. Y. C.; Noel Stans Hamilton, Royal Air Force Club, London, W. England.

Fellow: Mr. W. A. Winterbottom, c|o Radio Corp. of America, 66 Broad St., N. Y. C.

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Chairman Committee on Publications
Room 2040, 233 Broadway, N. Y. C.

Musical Reproduction Has Improved

How the Improvement in Loud Speaker Design Has Brought Well-Nigh Perfect Acoustical Reproduction—The Electrical Phonograph Allows the Perfect Combination With Radio

By A. F. VAN DYCK

Development Engineer, Radio Corporation of America

SINCE our subject is Modern Radio, there is no need to discuss radio as it has been in the past, and I shall refrain from the usual tracing of growth of the art from the beginning, in the belief that all of you are familiar with the milestones of radio progress. It would be possible to start with a description of Marconi's work, or even that of Hertz, or Maxwell, and continue right up to that of, say, Graham McNamee, but so much is happening in radio current events that we must, and can afford to, confine attention to the present day. My remarks at first will be very general and will probably seem very simple to Radio Club members, but there are a few fundamentals which it is well to recall once in a while so that we will not lose sight of the radio picture as a whole.

Radio broadcasting here requires most attention, of all the branches of radio, but I should like to mention the other branches briefly, for the sake of completeness, and to give a full and true picture of radio today.

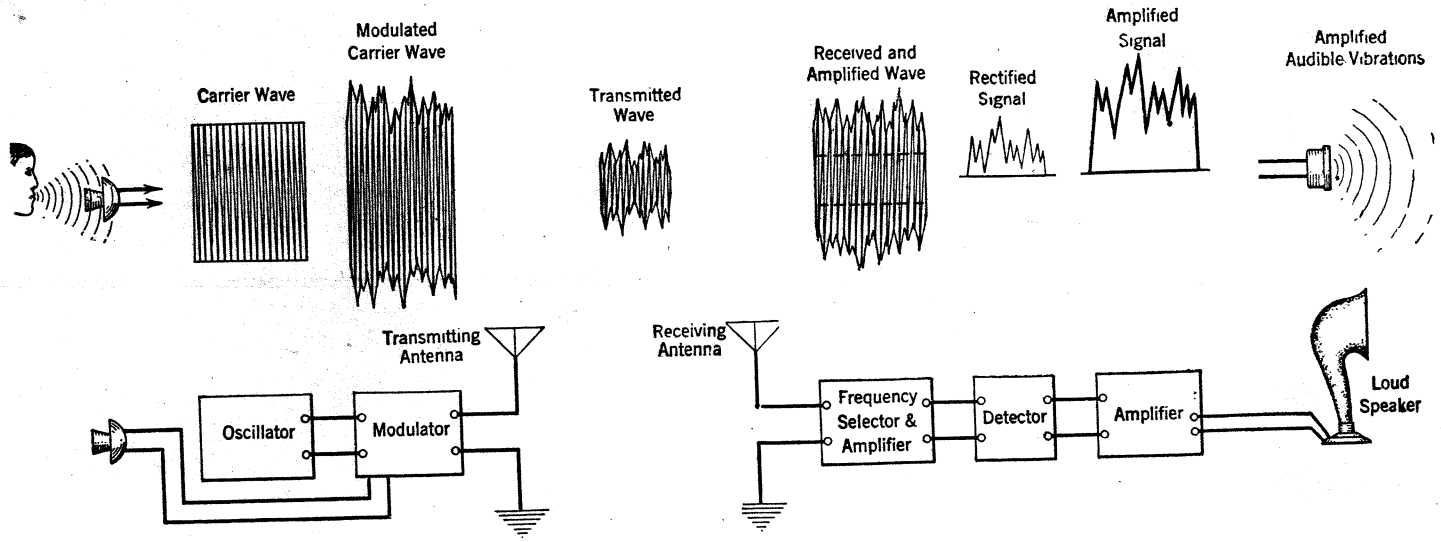
First, in transoceanic radio telegraphy, additional channels to South America, Central America, and Europe, have been added during the past year (1925). Channels to the Orient are being studied. Very soon, this country will have radio telegraph channels to nearly every important country. The importance of this service is quite obvious. International trade and international goodwill follow the courses of communication, wax and increase in effect with the enlargement of the contacts afforded by communication. The service afforded by radio in this field is steadily improving, not only in the number of channels existing, but in speed of operation, and various other technical respects.

Transoceanic radio telephony is not yet ready for public service use. Experimenting and development of technique are proceeding with great promise, but it is too early to see definitely the degree of success which this service may have, or the degree of usefulness which such service would have if technically satisfactory.

Marine radio telegraphy, that is, ship-to-shore communication, which is the oldest branch of radio, has improved steadily, and the ship service has reached a degree of speed, distance, and reliability which is quite remarkable, but which is accepted without remark or surprise, for this branch has long been considered an established public service. The halo of mystery and mysticism which once surrounded the radio operator at sea is no more, and he is accepted as part of a system of service understandable and fully established. There has been improvement in the apparatus used in marine radio, and some change in the frequencies (wavelengths) used, both of which have lessened the conflict of this branch with that of broadcasting in respect to interference.

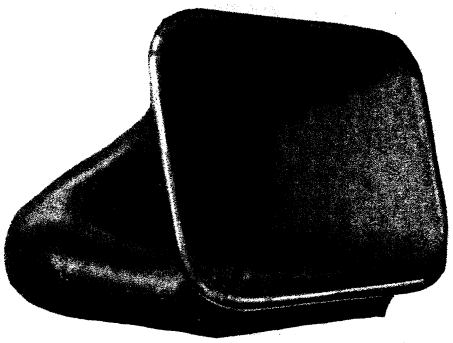
Navigational radio, that is, the use of radio for the determination of position of ships at sea, and in general, their safeguarding when near coasts, is being extended in scope and usefulness. There can be no doubt that this service will eventually be the primary and unfailing means by which navigators may guide their vessels safely and surely, regardless of weather. I believe it is correct that eighty to ninety per cent. of sea disasters occur near the coasts, arising from ignorance of the true position of the ships, and it is therefore obvious that a method of location which is accurate and faithful at all times is of enormous help to navigation.

It should not be forgotten, in thinking of these marine uses of radio, that their interests are paramount. Broadcasting means entertainment and instruction to millions of people, but radio at sea often means safety of life to hundreds and thousands. Fortunately there has been no serious conflict of interests between these



HOW SOUND WAVES ARE BROADCAST AND RECEIVED

The broadcast transmitter is composed of two main parts, the oscillator and modulator systems. The former produces a steady signal called the carrier wave while the latter superimposes voice variations upon the carrier wave, so that the transmitted signal assumes a varying shape depending upon the variations in amplitude, which go to make up a complete radio signal. At the receiver, this wave must first be selected or tuned-in, then amplified at radio frequencies so as better to actuate the detector which rectifies and makes audible the radio signal, and then amplified at audio frequency to operate the loud speaker. At the transmitter, sound is changed into electrical energy by means of a microphone and at the receiving end, electrical energy is changed into sound by means of a loud speaker, causing a column of air to vibrate in synchronism with the vibrations of the diaphragm or other actuating mechanism of the loud speaker



RADIO BROADCAST Photograph

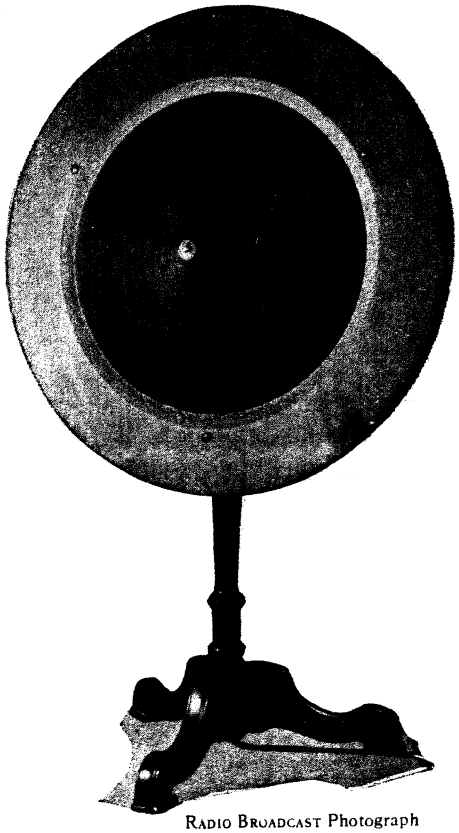
A GIANT HORN

Within predetermined limits, the longer the air column that is actuated within the walls of a horn, the more pleasing to the ear will be the signal delivered. The horn shown here has an exceptionally long air column which gradually increases in width, terminating at the bell of the horn, which is some 25 inches wide and 18 inches high. Despite its size, this horn is not unduly heavy on account of the composition employed

two branches, and they are developing side by side in amity and effectiveness.

BROADCASTING—THE PRECOCIOUS RADIO PRODIGY

AND so we come to broadcasting—the precocious prodigy of the radio family. This child is perhaps afflicted more or less with growing pains at present,



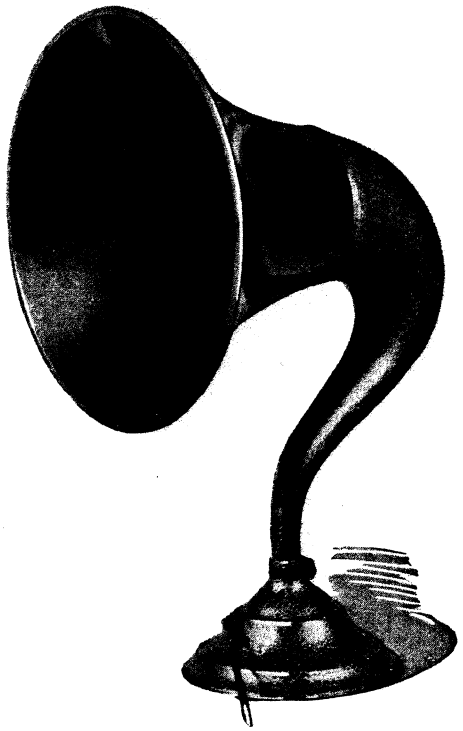
RADIO BROADCAST Photograph

A NEW THIRTY-SIX INCH CONE

In this instrument are found several of the features which are predominant in the baffle board type of loud speaker construction. The cone itself is situated within a wide band or ring of wood which serves as the baffle board. In the rear, three arms attached to the baffle board support the driving mechanism which actuates the cone by means of a driving pin

but it is apparent that it has a strong and healthy constitution, and will have a long and useful life. Broadcasting has grown with an amazing rate, as you all know. Even during the past year its rate of growth has not lessened.

To-day, radio is an industry—a public service, filling a place in the daily lives of a large proportion of the people of this country, and of a sizable percentage of the people of the earth. Any device which extends the range or the power of the major human senses, and does so with sufficient



RADIO BROADCAST Photograph

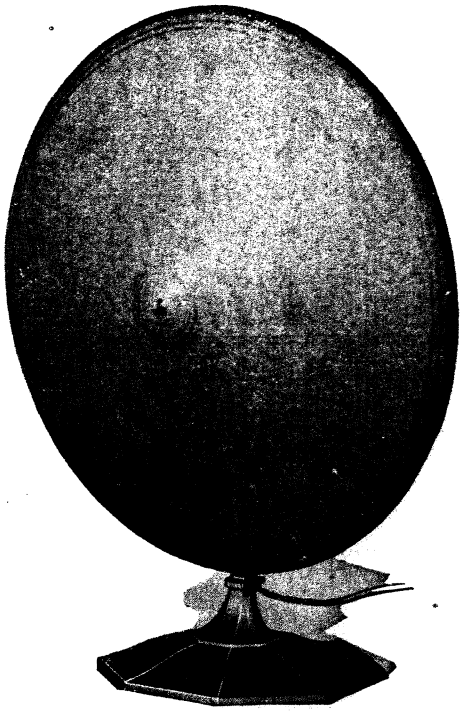
A TYPICAL HORN

This horn type of loud speaker depends entirely upon the movement of a column of air confined within the walls of the throat and bell of the horn to cause air vibrations which may be heard. The driving mechanism is a loud speaker unit of the conventional magnet and diaphragm type

similarity to the unaided sense, has instant appeal and widespread usefulness. Radio broadcasting is in this category, and hence, has had the stimulus of ready and increasing public demand.

The nature of radio broadcasting is such that an extraordinary interest in its purely technical aspects has taken hold of the public. Its nature is also so complicated technically, since it utilizes the most involved electrical relations known to electrical science, that it has been very difficult for the layman to grasp the subject adequately, or to separate its fundamentals from the interesting but non-essential matters.

To-day, nearly every automobile purchaser and owner understands the theory of automotive vehicles sufficiently well to be able to see clearly the differences between the various existent types, and he has little difficulty in choosing the type which most nearly meets his individual

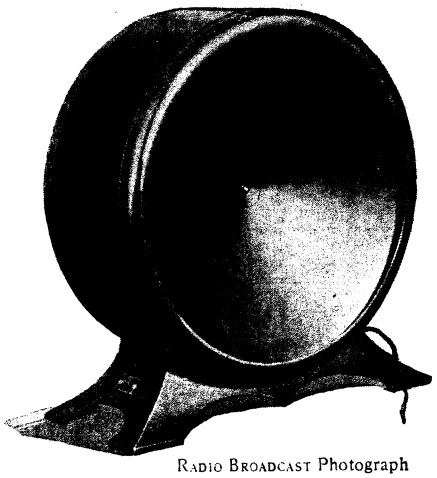


RADIO BROADCAST Photograph

AN EIGHTEEN-INCH CONE

Of the several types of loud speaker illustrations accompanying this article, the eighteen-inch one shown above is a distinctive type. The cone proper consists of a front and back of convex shape. In an opening in the back is situated the operating mechanism connected by means of a driving pin, to the apex of the front side of the cone

needs, desires, and preferences. For example, he knows that such vehicles require fuel, and that the fuel may be gasoline, steam, or electricity. Further, in the gasoline type, he knows that there is necessary a system of fuel feed to the motor, a fuel carburetion system, a fuel ignition system, a cooling system, a gear system, a braking system, and so on. He knows that there are certain types of body from which to choose.



RADIO BROADCAST Photograph

A "FREE-EDGE" CONE

Here is shown a recently developed loud speaker that employs two concave cones which are of the "free edge" type. The cones are so arranged that their apexes are brought to a common point at the driving mechanism, producing what might be termed a "push-pull" action

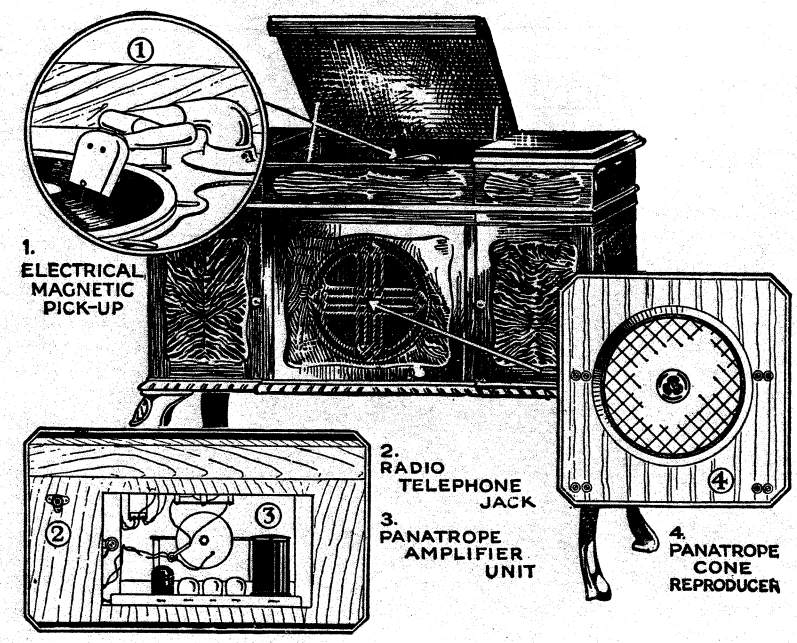
Similarly, in the radio receiver, there are fundamental considerations which govern design, and determine performance. We must consider also the radio transmitter, for the transmitted signal is the "fuel" of our radio system. Progress in transmission has kept pace with that in reception, and to-day it is true that good transmitters and good receivers are well matched in characteristics. A radio telephone transmitting station is an installation which sets up waves in the ether and does so by generating electrical currents in its antenna. These currents are alternating back and forth, thousands or millions of times per second, and this is the first fundamental which must be understood. The chief characteristic of a transmitting station is the frequency of these currents, or its wavelength. This frequency of the currents is also the frequency of the waves sent out in all directions, and waves of this frequency are therefore associated indissolubly with this station. If other waves originate from any other source, having this same frequency, they become interlopers, traveling under the disguise of our first station and entering into any receiver ready to receive that station. It can be seen readily, therefore, that every station should have a frequency all its own. This involves a radio problem which is perhaps the biggest one in the art to-day. I have said that each transmitting station requires a frequency at which it can radiate alone and undisturbed. Actually each station requires more than a single frequency—it needs a *band* of frequencies, rather than a single frequency. The frequencies of waves which can be utilized to-day by all branches of radio, range from about 15,000 cycles to about 15,000,000 cycles per second. This range is divided up among the various branches of radio service, and the part assigned to broadcasting, and in fact the only part which can be used satisfactorily for that purpose at present, lies between about 550,000 and 1,500,000 cycles. In other words, there is available for broadcasting, in the radio wave spectrum, a range of frequencies *about one million cycles wide.* The band of frequencies required by every radio telephone station is at least 10,000 cycles wide for reasons which need not be discussed here, and this figure can not be made less. Therefore it is obvious, by dividing one million approximately, by ten thousand, that there is room in the ether for about 100 broadcasting stations. Of course, if two stations were located so far apart geographically that their waves did not reach to the same points, they could use the same frequencies without any interference, but even our great country is not large enough to permit this duplication on a very large scale. At present this country has 578 broadcasting stations, instead of 100, and this has been arranged partly by dividing time of operation between two or more stations in the same territory, and partly by using the same frequencies for different stations. The ether is therefore overcrowded. The National Radio Conference called by Secretary of Commerce Hoover last fall, adopted a recommendation that no additional stations should be licensed, since more would simply add to the congestion. Various problems arising from this situation remain to be solved.

STRENGTH OF SIGNALS AT THE RECEIVER

THE strength of the signals at a receiver depends upon the strength of the waves reaching it, and the strength of the waves depends upon the power of the transmitter. Transmitters first used for broadcasting, had a power of ½ kilowatt, mainly because that size transmitter was standard, being already in use in other services. As the quality of broadcast service improved, it became apparent that transmitters of this size did not deliver, at reasonable distance, waves sufficiently strong to dominate other electrical waves which also caused responses in receivers, and which originate in various electrical services. It is not sufficient, for good broadcast service, merely to be able to hear a transmitting station—its program must be clear from all other sounds to make its service really proper and enjoyable. Under this standard, the average year-round range of the ½-kilowatt station is less than twenty-five miles, and under some conditions is as low as ten miles. Since such a small area of service per station is not economical, there has come about a general increase in the power of stations, until now thirty-two stations have one kilowatt, twenty-five have five kilowatts, and two are experimenting with as much as fifty kilowatts. It was feared at first by some, that higher power stations would interfere with other lower power stations. This was not expected by experts however, and actual experience has demonstrated high-power stations not only to be harmless, but to have realized the advantages sought. Stronger signals, with consequent greater freedom from interference, from static and other noises, is a most important improvement in modern radio.

The remaining part of our radio "fuel," which is of interest, is the program. This needs little description because you are familiar with its improvement. The entertainment and instruction provided by modern radio, the nation-wide broadcasting of nationally interesting events, has increased, with consequent improvement in quality of entertainment over the country at large.

A summary of modern radio transmission shows that high quality programs are available; transmitting apparatus, from the microphones to the antenna, has been refined, and stronger signals are being delivered to the receivers.



THE PANATROPE

This is the Brunswick phonograph employing electrical reproduction and amplification of sound. In this device, a baffle-board speaker, together with a power amplifier, produce plenty of volume of pleasing quality

WHAT THE RECEIVER DOES

SO WE come to the receivers. Receivers are devices which transform traveling electrical waves of certain kinds into sounds. The more nearly the reproduced sounds are like the original sounds which operated the transmitter, assuming a perfect transmitter, the more nearly ideal is the receiver.

The fundamental parts of receivers are four in number. First, a wave pick-up system, or antenna; second, a tuning system; third an amplifying system, and fourth, a mechanism for converting electric currents into sounds, commonly called the loud speaker.

The pick-up system is necessary to intercept the traveling waves. When it does so, electric voltage is created in it. The tuning system is necessary to *select* that particular voltage which has the frequency which is desired, and reject all others. The antenna has electric currents in it resulting from all the various waves which pass it, but it is the function of the tuning system to increase the currents which are desired, and decrease the currents which are not desired. The degree to which it is capable of doing this determines the ability of the receiver to avoid interference from

other stations. This ability is called "selectivity."

The amplifying system is necessary because the currents which are generated in the antenna and tuning system are exceedingly small, and must be made larger before they will be powerful enough to operate the loud speaker. These magnified, or amplified, currents, are fed into the loud speaker, and cause sound waves to be produced.

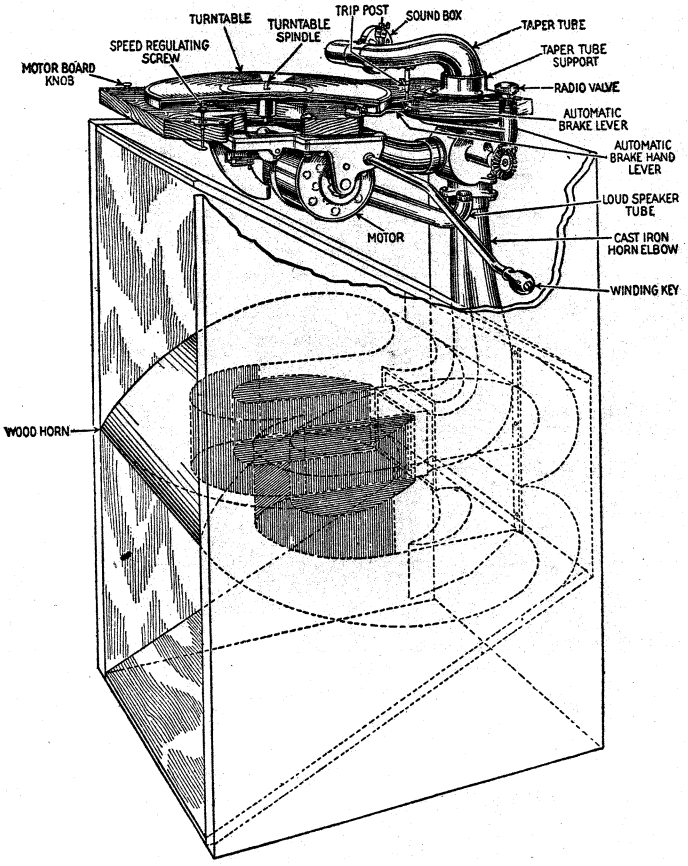
To repeat, the antenna system picks up energy from all waves, the tuning system selects the desired one, the amplifier amplifies it, and the loud speaker reproduces it. Now, each one of these parts, except the antenna, has been undergoing improvement continuously. All these parts were used in radio telegraph sets before radio telephony and broadcasting were developed—except the loud speaker. Consequently, they had been developed to a greater extent than had the loud speaker. Until very recently, the loud speaker was the "weak link" in the chain of parts of the broadcasting system. Tuning systems of various sorts, and amplifying systems of various types, both satisfactorily effective, were available, but the loud speaker was then subject to great improvement.

The outstanding feature of the past year, has been the development of loud speakers. Loud speakers are now available which accomplish their part of the receiver system work, as efficiently as the tuning and amplifier parts do theirs. This means that there is no longer a weak link in the chain of transformations of energy which take place between the microphone and the loud speaker. In fact, the improvement in loud speakers has been so great as to be startling to any one hearing it for the first time.

Radio receivers may be looked at in a different way, namely, from the performance point of view, instead of from the design point of view, as we have done so far.

To use the automobile analogy again—in buying a car, the buyer is interested in performance features, such as power, speed, acceleration, maintenance cost, comfort, ease of handling, and so on. The radio receiver owner is interested in performance features such as sensitiveness, selectivity, ease of operation, maintenance cost, and quality of reproduction. A proper degree of sensitiveness is required to permit the reception of long distance signals when desired. A sufficient degree of selectivity is necessary to permit the desired program to be picked out from all the others in the air without interference. The operative characteristics should be such that special skill is not required to operate the receiver, and that desired stations can be tuned-in quickly and, without fuss or difficulty. The maintenance care and cost must be small. The quality of reproduction must be sufficiently close to the original to be enjoyable and, to be ideal, must be such as will permit the illusion of the performer being in the room.

Of the four radio receiver fundamentals—sensitiveness, ease of operation, selectivity, quality of reproduction—the first two, sensitiveness and ease of operation, were incorporated in the very first broadcast receivers. The third, selectivity, was introduced as soon as the number of broadcasting stations had increased to the point where it was necessary. The fourth, quality of reproduction, was not so easy, and was not accomplished until recently. Of course, good reproduction by the receiver depends also upon good transmission quality at the transmitting station end of the system. There are many stations on the air to-day which will not reproduce properly on any receiver, no matter how good the latter may be. In fact, as many such stations sound worse, the better the receiver.



THE ORTHOPHONIC'S SOUND CHAMBER

This new Victrola differs greatly from the old type of phonograph because a carefully designed wood horn having a winding passage, as shown here, is used. Provision is made for the attachment of a loud speaker unit so that the horn may be used as a loud speaker.

GOOD LOUD SPEAKERS ARE HERE

THE recent improvement in loud speakers has removed the last barrier to substantially perfect reproduction of sound. The steady improvement in broadcast programs, and the entrance of leading artists into broadcasting, have focused public attention upon the tonal quality and fidelity of the reproduction. Mere long distance reception, which usually involves weak and distorted signals, has simultaneously decreased in interest. Sustained interest, and real service, require high quality of reproduction, and I wish to emphasize, as the most important fact of modern radio, that high quality reproduction is now possible, as it never was before, and that it greatly enhances the value of broadcasting, and extends its service possibilities.

The fundamental requirements of a loud speaker to have perfect reproduction, are that it shall be omnitonal and equitonal. To be omnitonal, it must respond to all frequencies or pitches within audibility range, and to be equitonal it must respond to all frequencies equally, and proportionately to their intensities as performed. The faithful musical frequency range of loud speakers one year ago was less than four octaves. To-day the best types have a faithful musical range of seven octaves.

It should be understood clearly that high quality faithful sound reproduction by the loud speaker requires something more than the proper loud speaker. No matter how good the loud speaker may be itself, it cannot respond faithfully unless faithful, undistorted, currents are fed to it by the receiver. This means that the receiver must not distort the signals, but must select them and amplify them without loss or change of any tones. The amplifying part of the receiver is the most critical factor in reproduction, next to the loud speaker.

There is another characteristic of loud speakers which requires mention, in addition to faithfulness of reproduction. It is the volume, or loudness of sound, which it will deliver without distortion. This is dependent upon the nature of the receiver's amplifying system as well as upon the speaker itself. A loud speaker and its associated amplifying system should be capable of reproducing sounds to values as loud as the original, but modified to suit the room conditions at the point of reproduction. Good, modern reproduction is so like the original in this respect, that many of the precautions which have to be taken in the original rendition—for example, the location of pianos in the room—have to be followed with the loud speakers. It is quite likely, in fact practically certain, that many homes of the future will be designed with consideration of the acoustic characteristics of the rooms, in order that the fullest enjoyment may be had from high quality broadcasting.

THE ELECTRIC PHONOGRAPH

THE chief characteristic of radio is, of course, that its reproduction is simultaneous with the original performance, and is available at many different receiving points simultaneously. There is another form of reproduction which is also useful, that of reproducing, from a previously made record of the performance, at any desired later time. This is accomplished by the phonograph, and the magnitude of the phonograph industry is evidence of the usefulness of, and the demand for, this type of reproduction.

Even with a perfect radio broadcast service in existence there will still be the desire for hearing a particular artist, or a particular musical selection, at a particular time, and this need can be met only by the phonograph.

The phonograph reproduction capabilities available until recently were limited and were, in fact, about equal to those of the radio receivers available at that time. Now, however, the *electrical* phonograph has been developed, and this utilizes several parts found in radio receivers, so that the two instruments are closely parallel in technique, and in possibilities of reproduction quality.

The phonograph instrument with which we are all familiar through past years was mechanical throughout—from the making of the record to the final reproduction. In the recording process, the sound waves of performance acted upon a diaphragm to which was attached a cutting tool, this latter being moved by the vibrations of the diaphragm and which cut impressions upon a wax master record. The final records, when played upon the phonograph, gave vibrations to a diaphragm through movements of a needle attached to the diaphragm and bearing upon the record. The diaphragm movements set up air sound waves which were amplified by a horn attachment. All of these processes were, therefore, dependent upon small mechanical forces and employed mechanical resonance, which prevented equal response to all frequencies. There have been great improvements in this type of phonograph recently, with which most of you are doubtless familiar.

ADVANTAGES OF THE ELECTRICAL PHONOGRAPH

IN THE electrical phonograph, we have further possibilities. Electrical forces are more easily and more flexibly controlled and used than are purely mechanical forces. In electrical recording, the tool which cuts the master record can be actuated by electrical means, and the electric power for this be obtained from powerful amplifiers, which, in turn, are fed by sensitive and faithful pick-up devices. For example, the artist may perform before a microphone of the broadcasting type, or its equivalent, and the electrical output of this microphone can be amplified faithfully to any power necessary to operate the record cutting tool. In other words, the power necessary to cut the record does not come from the voice of a singer, for example, but from the power supply of the amplifier. This means that modern records are more nearly omnitonal and equitonal than old type records, and considerable improvement in phonograph reproduction results.

On the reproducing end, the needle which runs in the record groove and is moved thereby, can be attached to a tiny electric generator which will generate currents exactly in accord with the movements of the needle. These small currents can be amplified, by an amplifier identical with those used in radio receivers, and the amplifier output transformed to sound by a loud speaker, also identical with those used in radio receivers. This process is therefore electrical from beginning to end, and is practically omnitonal and equitonal, that is, it reproduces all the musical frequencies, and reproduces them equally and proportionately to original intensities. All the technique of vacuum tube and loud speaker practice is therefore directly applicable to the phonograph art, which benefits accordingly.

Since the electrical phonograph is operated entirely by electricity, and electrical forces can be amplified to any desired extent by vacuum tubes, and can be controlled easily, we find that it is capable of producing enormous sound volume when desired, and that the sound can be reduced to a whisper when desired. The instrument is therefore suited to reproduction under all conditions of the home, as well as being capable of supplying sufficient volume for a large auditorium.

To demonstrate the capabilities of the electrical phonograph, a series of records can be selected, to be chosen not with the idea of providing a balanced program of entertainment, but to illustrate the technical performance features. Records of various kinds, orchestral, band, choral, and vocal, can be used to see how faithful the reproduction is compared with the original. In particular, in vocal-choric work you will be able to distinguish the individual voices clearly, and in orchestral selections—the individual instruments. This is possible only when practically all frequencies are being reproduced faithfully. Also in speech and song, note the intelligibility.

I believe that any one who has heard the modern radio and electrical phonograph instruments will agree that there has dawned a new era in sound reproduction. It is my own belief that such reproduction has now reached the stage of development, where it is ready to provide a public service of complete merit, and of inestimable value.

And that is the thought I would leave with you—that science, in its continual struggle to master and use the infinite resources of Nature, has given another service to mankind, to make life broader, more enjoyable, and more valuable.

Suggested Future Papers

The Chairman of the Committee on Papers respectfully suggests that members consider the following subjects for papers to be presented at future meetings of the Club.

1. Advantages of Resistance-Coupled Amplification
2. Practical A, B, and C Power Supply Systems
3. Short wave transmission and reception on Amateur Wavelengths

The Committee will be glad to receive further suggestions on any other subject that may prove of interest to Members.

The Radio Club of America

Bryant Park Building, Room 469

55 West 42nd Street, New York, N. Y.

Telephone—Longacre 8579

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