RADIO BROADCAST

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JANUARY, 1926
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CONTENTS

BEHIND EDITORIAL SCENES

JAMES Stokley. who writes "Ether Waves You Cannot Hear" is an associate of Dr. Edward E. Slosson, the director of Science Service in Washington. Science Service is a most interesting and unusual organization, devoted to presenting in an able fashion the facts about science in any of its branches. The board of directors of the organization number some of the greatest scientists now living in America. For the benefit of those readers who do not know, Professor J. H. Morecroft whose "March of Radio" has appeared in RADIO BROADCAST ever since its first issue is a professor of electrical engineering at Columbia University, where he has trained many a radio engineer. Austin Lescarboura, the writer of "What's New in Radio" was formerly Managing Editor of the *Scientific American*. He is now a free lance writer. Some interesting slants—as the baseball writers put it—on broadcasting are offered by the new conductor of "The Listeners" Point of View," John Wallace, whose first department appears in this number. The changes in call letters, and frequency of Canadian and American broadcastings tations during the past few months have been many and we have made every effort to have the list appearing on page 337 the most accurate to be found anywhere. Readers who have access to a razor blade and a pin can quite easily make up a sixteen-page booklet from the list.

Some misunderstanding has arisen about the description of a new N-P coil for the Roberts Knockout receiver printed on page 66 of RADIO BROADCAST for November. The author was Ralph D. Tygert, an engineer on the staff of the F. W. Sickles coil company at Springfield, Massachusetts. Mr. Tygert's findings have been incorporated in the new coils now being marketed by that company for the Knockout receiver.

OCTOBER and November have been the months of radio shows throughout the country; November especially was a red letter month in American radio affairs, for the third of Secretary Hoover's radio conferences was held in Washington and everyone agrees that the policies recommended for radio are most wise and calculated for the best interests of radio in this country. Too much credit can not be given to Mr. Hoover for his ability and foresight in causing the varied and sometimes sharply competitive interests of radio to settle their complex problems by amicable conference where reason has almost always prevailed.

MUCH activity is seen in the Laboratory these days. The staff is experimenting with three distinct receiver circuits, all of which have great merit and technical interest. If the receivers are proved worthy, each one will be described in an early number of the magazine. The Laboratory is collecting data on radio tubes and Keith Henney, director of the Laboratory, will have an article showing curves on all the popular tubes with a mass of highly valuable information for every radio user, which, as far as we know, has never been put together in one article before. The February number will also present "How Long Will My B Batteries Last?" by George C. Furness, an engineer who probably knows as much about radio batteries as anyone in the business. We shall also give the latest plans for the 1926 International Radio Broadcast Tests which will occur one week after the February magazine is on sale. Those Tests, by the way, give promise of being more interesting and successful than either of the two which have so far been held.—*W. K. W.*

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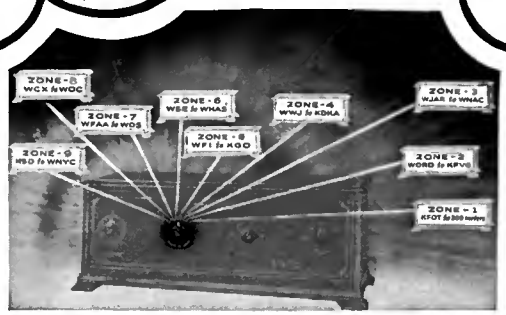

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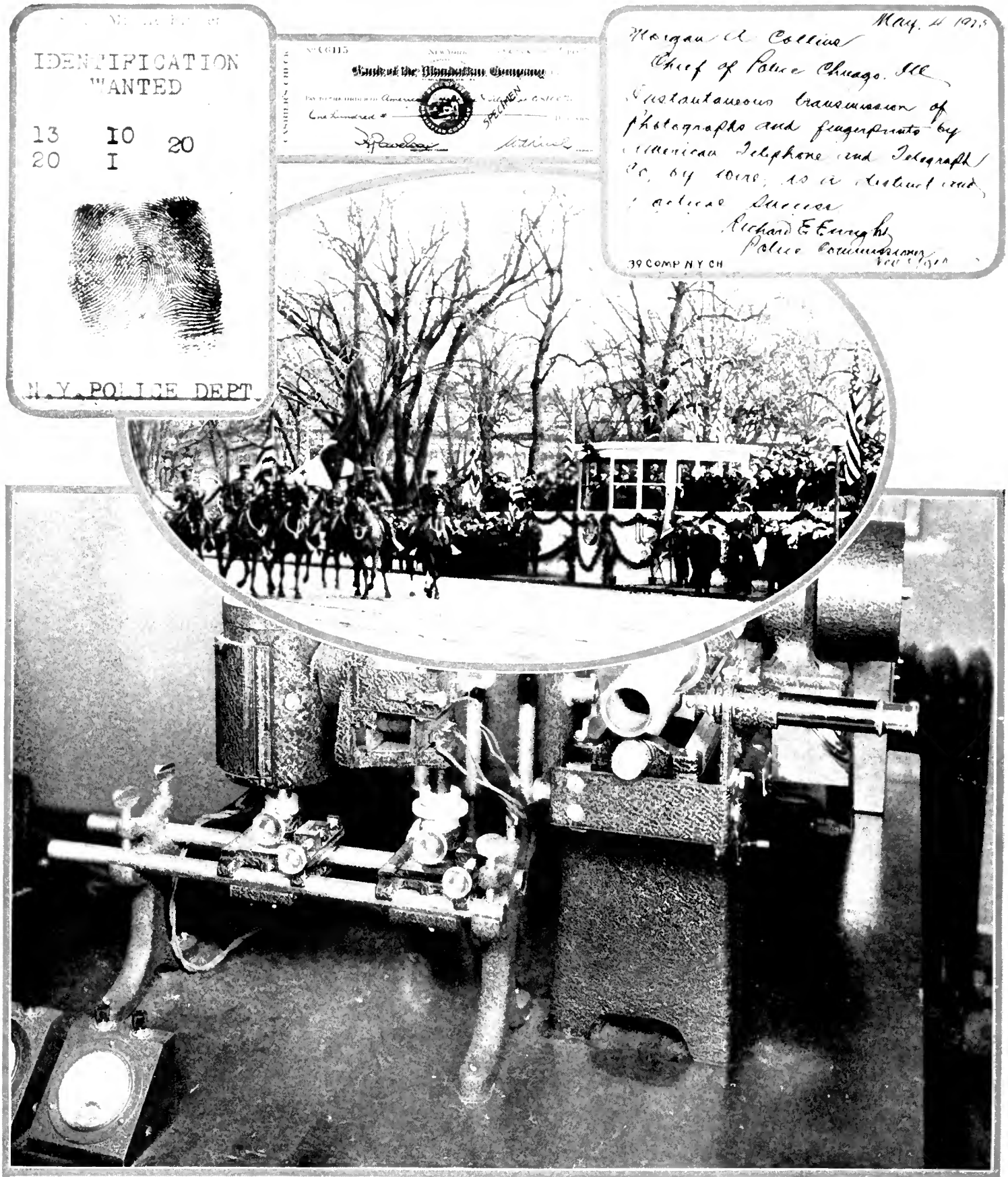


HOW "TELEPHONED" PHOTOGRAPHS LOOK

Radio men have been interested in the announcement of the American Telephone & Telegraph Company of the successful sending of photographs by wire. The center oval shows a transmitted picture of the parade a President Coolidge's inaugural. Note the great detail preserved. Checks and business papers are frequently sent by wire. The check shown was sent from New York to Chicago in seven minutes. The finger print is shown upper left, as received in Chicago after it was sent from the files of the Police Department in New York to the Chicago police, for indentification, which was made and confirmed in three minutes after reception. Directly above is shown the picture receiving device. On the left is the lamp house, next the "light valve," operated by electric impulses received from the sender The rolled unexposed film is shown on the drum in the foreground; behind it is the synchronous motor.

When pictures are received, the room is kept dark. The only light on the receiving film is that which passes through the light valve

RADIO BROADCAST

VOLUME VIII NUMBER 3

JANUARY, 1926

Ether Waves You Cannot Hear

The Few Isolated Facts Known About the Ultra Short Waves of Heat and Light —The Characteristics of X- and Radium Rays—Taking Photographs Through Dense Mists by Aid of Infra-Red Rays—How the Gap in Knowledge is Being Bridged Between Radio Waves and the Much Shorter Ones Familiar as Heat and Light

By JAMES STOKLEY

MOST radio enthusiasts are aware that when they listen to a broadcast concert or lecture, the ether is frequently full of commercial messages in code sent from ships or land stations, yet, in the best receiving sets, these are not heard because their wavelength is much greater than that to which the sets are tuned. Likewise short-wave transmission, using wavelengths down to a few meters, which has been so much discussed as making possible the sending of messages over great distances in daytime, does not affect the ordinary set, but requires a special one that is tuned to these waves.

Even a short-wave receiving set, however, will not make audible the multitude of still shorter waves that are continually fleeting through space, for radio waves are not the only kind of ether waves. Thousands of times shorter but otherwise identical with them, are the waves of light, and still shorter are the X-rays, and the rays of radium.

Thus there is a complete range of vibrations, all the way from those with waves whose lengths are measured by the millionths of an inch, to others whose waves are miles long. Some occur in nature, some are produced by man with his various pieces of scientific apparatus, and still others are yet to be produced. There are undiscovered gaps in the series which have not yet been filled, but physicists and many other tireless workers in allied fields in many countries are busily engaged in closing these gaps, and making the series an unbroken one.

Most familiar to us, more familiar even than the radio waves, are those which make up visible light. The wavelengths of these are between $\frac{1}{30000}$ and $\frac{1}{65000}$ of an inch, the shortest making up violet light and the longest red. Between these are the wavelengths of the other colors, but longer than the longest red waves, and shorter than the shortest violet ones, are the waves which make up what is often referred to as "invisible light." Those that are too long to see are called infra-red, and the short ones ultra-violet.

When a beam of white light is passed through a prism, the familiar rainbow-like spectrum is the result, a band of colors varying from red at one end to violet at the other. But the red and violet parts are not really the ends; the fact that they seem so is only because our eyes are not as sensitive as some scientific instruments. Take a radiometer, the little device consisting of small vanes, black on one side and silvered on the other, inside a glass bulb, which is often seen in an optician's window, and spins merrily when the sun shines on it. This is operated by the heat rays, and if it is placed a little beyond the red end of the spectrum, it will twirl, thus showing the presence of heat waves, which are identical with the infra-red.

On the other hand, if we allow the spectrum, and the part of it beyond the violet, to fall upon a photographic film, the most impression on the film will be made not by the yellow part of the spectrum, which appears brightest to the eye, but by the darker blue, and there will be a prominent image caused by the presence of the short waves called the ultra-violet.

In the realm of invisible light, things are not always what they seem. During the World War, several allied airplanes arose from their own lines bearing what was apparently an enemy insignia,

TWO EXAMPLES OF X-RAY TUBES

The largest and smallest ones made. These tubes have been invaluable for surgical work during the past few years. By placing the hand, in which, let us suppose, a piece of metal has become lodged, between the tube and a phosphorescent screen, the flesh will be found to cast a very faint shadow; the bones, a stronger one; while the embedded metal object will show a clear defined shadow

and they could easily have flown over the German lines without molestation from anti-aircraft guns. Neither did any of the allied soldiers attempt to capture the occupants of the planes when they landed, nor were any bombs dropped before the planes came down, for although to the unaided eye they bore a strange insignia it was transformed to the familiar design of an allied craft when observed through red color screens provided the allied observers. The enemy insignia was painted on the airplane in paint that reflected visible light, but that of the allies was painted with pigment that reflected its shape and form only in deep red light.

Even the secrets of the spheres are revealed through astronomical photography with invisible light. Last summer at the Mt. Wilson Observatory, in California, when Mars made a close approach to the earth, it was found possible for the first time to measure the extent of the planet's atmosphere, and indeed, to prove to a certainty that it has an atmosphere. These pictures were made with the great 100-inch telescope, the largest in the world. Two sets were made, one by blue light, and the other by infra-red. Not only did the latter exposures show numerous markings on the planet, which were completely obscured in the blue set, but they also showed the diameter of the planet appreciably smaller! This, of course, is what we would expect if Mars had an atmosphere like the earth's. The blue light photographs could not penetrate the Martian layer of air, but the infra-red ones did, and enabled us to see the planet's surface.

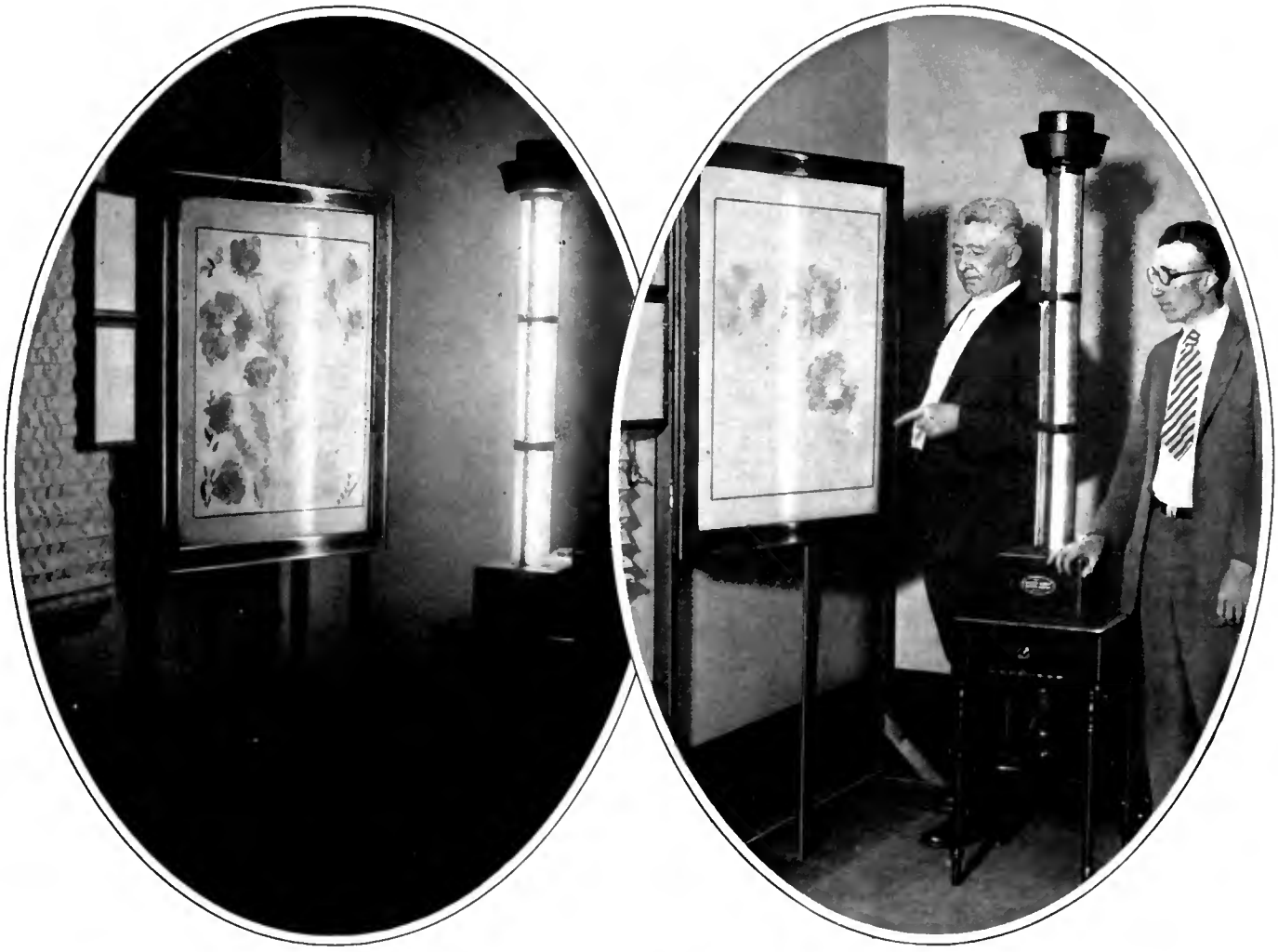
This same principle also permits photographs to be made on the earth through great depths of atmosphere, and even through mists so dense that the human eye cannot see through them. Airplane photographs from great heights are made in his manner, and the special plates used reveal all the detail on the ground below. The photographer ordinarily uses a red light in his dark room because light of that color does not affect his sensitive emulsions, but by bathing the plates before use in special dyes, they become sensitive to this part of the spectrum, and may be used with sufficiently fast shutter speeds to permit aërial photography with red, or even infra-red light.

The bathing beauties and the brave life guards browned by the sun have ultra-violet rays to thank for their coloration. For sunburn is largely due to light waves shorter than the visible spectrum. Babies are endangered when they lack this sort of light, for it is necessary to their health. One of the most important recent discoveries in the field of nutrition is that foods, such as milk and even lard, when exposed to ultra-violet rays, develop properties that prevent and cure rickets in animals and human beings.

The sun is the greatest and best ultra-violet ray machine we have. The sun is a great doctor. Mercury, vapor lamps can, of course, substitute for the sun, when days are dark or short. Moreover, there should be little or nothing between the sun and the patient for the most effective treatment

MODERN X-RAY APPARATUS

Which is due to the discoveries of Röntgen, in 1895, of certain rays called X- or Röntgen rays. These rays are invariably produced by the sudden stoppage of cathode rays by a solid obstacle. In modern X-ray tubes, the rays are as a rule allowed to impinge on a tungsten target placed in the center of the bulb. X-rays are then emitted only on the side of the bulb facing the tungsten. These Röntgen rays, like cathode Rays, excite fluorescence when they strike a suitable object. The exact nature of X-rays is still a matter of controversy, but most people now maintain that they are simply ultra-short light waves



TWO EXHIBITS AT THE NATIONAL ACADEMY OF SCIENCES, WASHINGTON

To the left is shown an ultra-violet lamp which has been photographed by means of its own light. The photograph to the right shows another picture of this instrument. The mercury-vapor lamp, as it is termed, is rich in ultra-violet light

For most substances, glass among them, are opaque to these short rays. A sun bath behind a window pane would be ineffectual and for the same reason many violet-ray machines with lamps housed in glass, are valueless.

WHAT CAUSES LIGHT

BUT what causes light, or other ether waves, and how are they transmitted? Many years ago it was supposed that a luminous body gave off myriads of tiny particles, or "corpuscles," which traveled in straight lines, and when they entered the eye, produced a physiologic effect. This, however, gave way to the wave theory which is still held, though with some modifications. In studying light, one of the most useful instruments has been the spectroscope.

When light is passed through a prism and the proper combination of lenses, a band of colored light, the familiar spectrum, is the result, and if the prism and lenses are properly adjusted, there appears, when sunlight is being analyzed, a number of dark bands or lines which cross the spectrum at right angles. These were long ago shown to be due to incandescent gases, and by their use, astronomers have been able to tell what substances the sun contains, almost as well as if they had a piece of it in the laboratory to study.

Each element has certain lines in the spectrum. Thus many thousand are known for iron, while others do not have so many. Hydrogen has a number in various parts of the spectrum, and corresponding to the color, or wavelength of the part that they occupy. In 1885, Balmer found that a simple law would give the wavelengths of the lines of one of the series due to hydrogen. Since then, similar series have been found for other series of hydrogen lines, and also for other elements.

This, then, showed that there must be some order in the structure of these elements, but it is a different thing to find, by trial and error, a law that fits a series of cases, and to work out the reason that such a law is followed. But the talent was not lacking to find such a reason, and the best explanation, and the one that is most generally accepted by physicists, is that given by Prof. Niels Bohr, of Copenhagen, Denmark. It explains not only the series spectra of hydrogen, but also of the other elements for which such spectra have been determined.

According to the Bohr theory, the atom consists of electricity. At the center is a charge of positive electricity called the proton, and around it revolve one or more negative charges, which the physicists calls electrons. These resemble the planets of the solar system, while the proton is similar, in its relative position, to the sun, around which the electrons revolve in definite orbits. But here is an important difference between the celestial and atomic cosmogony. While the planets in the sky always move in the same orbit, the electrons have the power of jumping from one orbit to another, and every time that such a change occurs, either visible or invisible light, or possibly one of the other forms of radiation, is given off.

The simplest atom is that of hydrogen, and thus it is understood why the spectral series of that element was first determined. Its atom consists of a single proton, or nucleus, around which revolves a single planetary electron. Every time the planetary electron changes its path, a radiation is given off. But, one asks, how is it that there are so many lines in the spectrum of hydrogen, when a single wavelength is given off with each change? As a matter of fact, if it were possible to isolate a single hydrogen atom, it would not radiate light of the entire hydrogen spectrum. But when there are a great number of atoms together, as there are in even the smallest

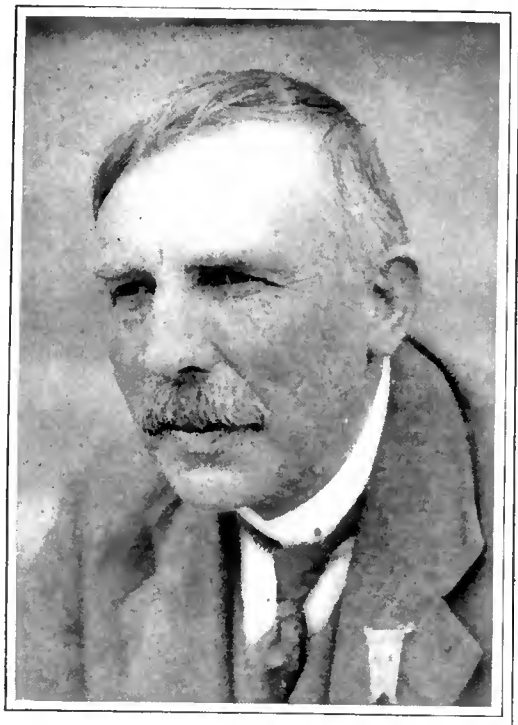
quantity of hydrogen that we can work with, there are so many that at any instant every possible change is going on in one or more atoms, and the combination produces the spectrum.

THE SOLAR SPECTRUM

As defined by the spectroscope and photographed on a sensitive plate. The ray to be analyzed is passed through a narrow slit before the prism. The slit tends to prevent overlapping of the various colors. Note that the photograph shows, at the violet end, a part of the spectrum beyond the limit of human visibility

X-RAYS USED TO ANALYZE THE ATOM

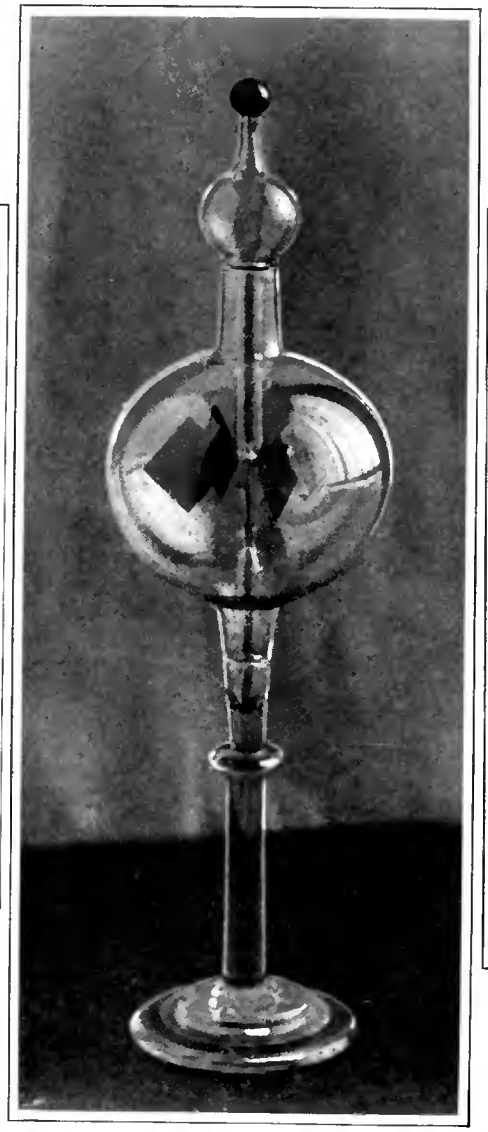
WITH the shortest ultra violet waves about $\frac{1}{300,000}$ of an inch in length, and the atoms so much smaller than that, it would seem hopeless to expect to study them by that means, but here the X-rays came into use. Much like lifting one's self with one's boot straps is this method, for the X-rays have been used to analyze the atom, and at the same time the study of the structure of matter has thrown light on the nature of the X-rays. In 1895, on the 8th of November, Prof. W. K. Röntgen, at Wurzburg, Germany, discovered these rays which bear his name, and as their nature was not known, they were also called X-rays.



SIR ERNEST RUTHERFORD

An English physicist, born in New Zealand in 1871. He has been responsible for much developmental work in radio-activity, and published papers on the subject as early as 1904. He has done a lot of useful work in bre aking up atoms by means of radium rays, and was awarded the much coveted Nobel Prize in 1908

In 1912, however, another German scientist, Laue, found that by passing a beam of X-rays through a crystal they were deflected, in much the same way as a beam of light is deflected when it passes through a grating consisting of fine lines ruled on a glass plate, thousands to the inch. This effect is called "diffraction," and will only take place when the distance between the lines is not very much greater than the wavelengths of the light waves themselves.



A RADIOMETER

The device invented by Sir William Crookes to exhibit motion caused by action of light. It consists of a light horizontal vane formed of four metal discs, supported by cross arms at right angles, on an easily moving pivot. The whole is mounted in a highly exhausted glass bulb. The four metal discs are polished and blackened on alternate sides. If light rays are concentrated on the instrument, what little gas remains therein, is heated, and the discs are affected, the black ones becoming the hotter. The gas molecules acquire a greater velocity when flying off the black discs than they do off the bright ones, and the difference of velocity causes motion. The rate of rotation depends on the brightness of the light

Laue thought that X-rays were really light waves of very short wavelength, and that the reason they could not be diffracted was because the distance between the lines on even the finest grating that can be made artificially, some 15,000 to the inch, was so much greater than the wavelengths of the X-rays that the effect was not appreciable, So he set to work to use a natural grating, and he chose a crystal which, according to the accepted ideas, consisted of molecules arranged in layer fashion.

Many facts previously observed made this theory of the structure of crystals the accepted one. When Laue passed X-rays through a crystal and found them deflected, the molecular layers themselves acting as a very fine grating, he investigated the nature of crystals and of X-rays at the same time, and we now know the X-rays to be short waves, about $\frac{1}{25,000,000}$ of an inch long.

PROFESSOR R. W. WOOD

Of Johns Hopkins University, Baltimore, who has interested himself in spectrology. While a Major in the United States Army (1917 to 1919), he developed a system of secret signalling, employing both visible and invisible light. One of his earlier inventions, curiously enough, can hardly be compared even remotely with his present work. It was a device for thawing frozen pipes by means of electricity

Since then, Sir William Bragg, of the Royal Institution of London, and his son, W. L. Bragg, who is now professor of physics at the University of Manchester, England, collaborated on a remarkable piece of research, which in 1915 won for

them the Nobel prize in physics, probably the highest honor that can be given a scientist. They made an exhaustive study of the way crystals deflected X-rays, and from their results were able to deduce many facts about the very structure of the molecules of which the crystals were made.

Another Englishman, Sir Ernest Rutherford, also a Nobel prize winner, has since carried the work into the very heart of the atom. According to the Bohr theory, the atom consists of electrons revolving around a central nucleus, and if we could hit the nucleus hard enough, something should happen. This seems impossible, at first sight, because there is apparently no instrument small enough to get into the atom. Such a device would have to be as small as the atom itself, and as every kind of known matter is itself made of atoms, it is hard to imagine how we could knock an electron out of its orbit.

Here Sir Ernest made use of that wonderful element, radium, which is continually changing into another element. A small particle of radium constantly emits atoms of helium at a speed which would take them half way around the world in a single second. Actually, they cannot travel more than a few centimeters, but by placing the material—he used nitrogen—the atoms of which it is desired to knock apart in close contact with the radium, the alpha particles, as the helium atoms are called, hit with a high velocity. They are so small themselves that they can enter the atom, and, when one hits the nucleus of an atom, its high speed can do a lot of damage.

This is not quite so easy to accomplish as it sounds however. Even in the most solid matter, the atoms are so spread out that, in proportion to size, there is as much empty space between the electrons and those of their neighbors as there is between the stars in the heavens. As there is no known way of aiming the alpha particles at the nucleus, the only possible procedure is to shoot a great many, by letting the radium act for a long time, and then waiting for an accidental hit. The process has been well compared with throwing keys at a door and waiting for one to lodge right in the keyhole.

But while the English scientists have been working on the problem, our American scientists have not been idle. Chief among those active in this branch of scientific research is Dr. Robert A. Millikan, of the Norman Bridge Laboratory of the California Institute of Technology, at Pasadena, California. Within the past year, by means of what he calls high vacuum, hot spark spectrometry, he has been able to remove some of the electrons from an element and to detect the difference with the spectroscope.

Although it represents probably the greatest achievement of physical science in recent years, the study of the atom and the forces within it, is barely beginning. Now we have but a glimmering of the time when atoms can be changed from one element to another at will, and when the tremendous forces that hold the atoms together can be utilized in our daily work. One difficulty has been suggested that may arise when this is accomplished. If we start the atoms disintegrating, will we be able to stop them, or will the disintegration continue until the entire world has been reduced to hydrogen, perhaps, and, like Icarus, our efforts result in our own annihilation? Whether this will happen cannot be foretold, but it seems likely that the physicists of the future who succeed in breaking up the elements at their pleasure, will not be without a means of controlling their efforts.

LATE NEWS ON THE INTERNATIONAL TESTS

By WILLIS K. WING

PLANS for the third International Radio Broadcast Test are progressing so rapidly that it is impossible to make a complete and accurate announcement in RADIO BROADCAST at this time because this is written about a month before the magazine appears on the newsstands. The last week in January, 1926, is the time fixed for the tests. American, Canadian, Mexican, and Cuban broadcasters will transmit from 10 to 11 P. M. Eastern Standard time beginning on the evening of January 24 (Sunday), and running throughout the week. English and Continental broadcast stations will be on the air during the same week from 11 to 12 P. M. Eastern Standard time.

Although the arrangements are not completed at the moment of going to press, it is probable that on Friday night, of that week, American listeners especially will have the opportunity of sharing in a most unusual broadcast experiment. During the first fifteen minutes of the American transmitting period, broadcasters in the Eastern time zone will broadcast while all other North American stations are silent. During the second fifteen minutes, stations in the central time zone will send, while all others are silent. And during the third fifteen-minute period, all the broadcasters in the mountain time belt will be on the air and every other station silent. During the last fifteen-minute period, the stations in the Pacific time belt will send out their programs under the same conditions.

It is expected that British and Continental stations will engage in a similar north and south broadcasting experiment during their transmitting hour on the next to the last night of the test. The transmissions for the first fifteen-minute period will begin with the English stations in the Greenwich Mean Time zone and progress across the Continent, if the present plans go through.

On the final night of the test, the British and Continental stations are expected to engage in a north and south broadcasting test, which will be similar to the one in which the North American broadcasting stations will take part. The north and south schedule for American stations follows:

EASTERN STANDARD TIME

From 11 to 11:15 P. M., Canadian stations will transmit.
From 11:15 to 11:30 P. M., stations in the northern half of the United States will transmit.
From 11:30 to 11:45 P. M., stations in the southern half of the United States will transmit.
From 11:45 to 12 M., stations south of the United States will transmit.

This schedule will not only give American listeners a chance to hear stations in this country never heard before because of the station operating on a frequency used by some near-by station, but this arrangement will also give the overseas listeners a chance to pick up some American stations that are more distant from them than the stations almost on the edge of the Eastern seaboard. The arrangement of the American tests so that on the first night (Friday, American time) the stations will progressively transmit from east to west, and on the second night of those tests (Saturday, American time) transmit north and south, will give American listeners a chance to experiment with DX reception such as they have never before had.

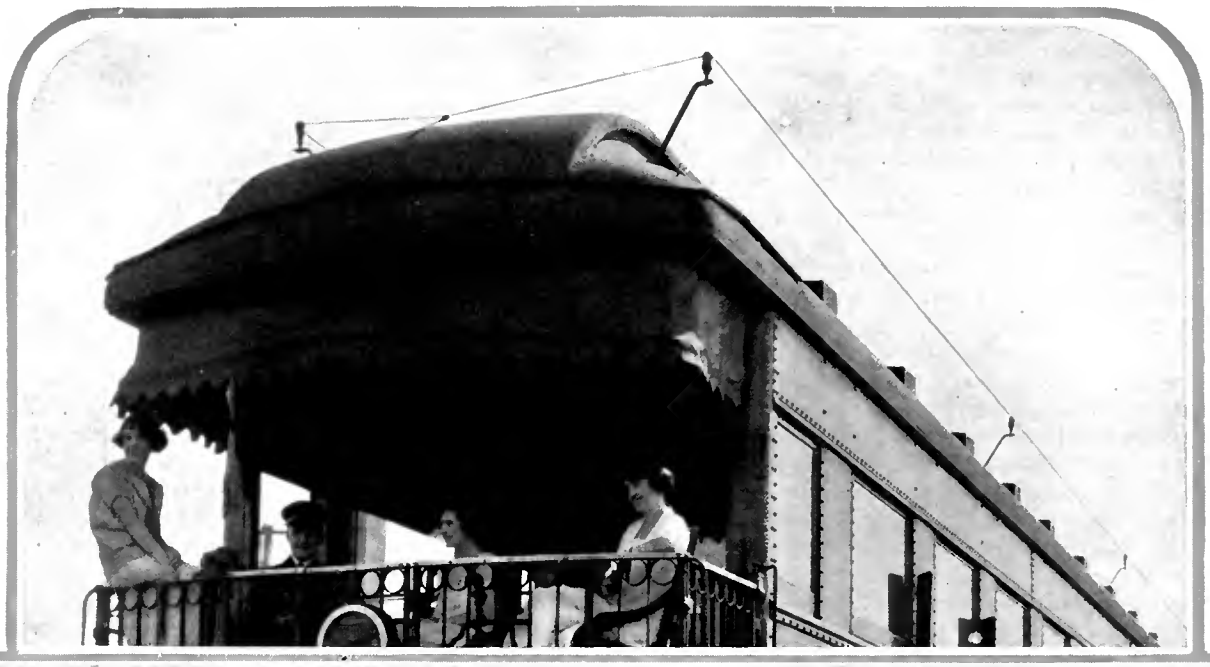
The Continental and British stations, if they follow the same plan for their territory, on the last two nights of the test, will be on the air just one hour earlier than the American stations. This will keep the air clear for the American transmissions which follow. The British and Continental broadcasters will undoubtedly appreciate this arrangement, for it will give them a chance to get a bit more rest. Since the transmissions from abroad come at from three to four o'clock in the morning, London time, the physical strain on the various station staffs is bound to be quite heavy by the end of the test week

The time chosen, which is a distinct hardship on the foreign broadcasters, is necessary because only during those hours is there a complete band of darkness clear across the Atlantic and as far as the Pacific coast of this country. It was hoped at one time, to interest the Australian broadcasters in joining the experiments, but the serious difference in time made that simply out of the question.

In every city of importance in the United States and Canada, one official "International Radio Week newspaper" will be chosen by the International Radio Week Committee. That paper will print the official, verified programs as transmitted from the overseas broadcasters. This will allow every listener to verify his reception the day after he has heard a foreign station. Newspapers throughout the country will carry frequent announcement of the latest development in the plans for the International Radio Broadcast Tests of 1926.

But if all those who had verified reports last year will send a description of their apparatus and something about the results they have with their receiver, to "International Radio Broadcast Test Committee, RADIO BROADCAST magazine, Garden City, New York" the Committee will pass on their equipment and wherever possible, appoint them as an official listening post for the Tests.

Results of successful reception can be sent to the Test Committee by mail, telegraph, and telephone. We can then verify reception. Reports of successful reception of the overseas stations can also be forwarded to the Test Committee by amateur radio. Station 2 GY, operated by RADIO BROADCAST Laboratory will be in continual operation and will receive and acknowledge all messages which outside listeners file with amateur radio stations in their home localities.



THE MARCH OF RADIO

By J. H. Morecroft
Past President, Institute of Radio Engineers

The Fascinating History of the Vacuum Tube

ABOUT a year ago the question of vacuum tube patents was discussed in these columns and the occasion was the expiration of the seventeen-year life of De Forest's "third electrode" patent. This patent of De Forest's, combined with the Fleming valve patent, completely tied up the vacuum tube industry for years, and during those years, six dollars was the price we had to pay for even the poorest type of tube. The De Forest patent had been acquired by the Radio Corporation and for years the price stayed where it had been put by De Forest when his output was measured in the hundreds and the cost of his hand made article was necessarily high.

The Radio Corporation had a complete monopoly of the manufacture of triodes and could fix the price as they chose. But in the last year or two with the rapidly expiring life of the De Forest patent, independently made tubes began to appear in large numbers and coincidentally, the price of RCA tubes began to fall to somewhere near a reasonable value. Whether the possible competition forced the RCA price down or whether it was purely an act of thoughtfulness for the good of the public on the part of this corporation, the broadcast listener can probably best judge. At any rate, we do know that when there was no competition, the price remained very high.

Because of this very recent situation, we are somewhat perturbed to see that the "high vacuum" patent has finally been granted to Dr. Irving Langmuir of the General Electric Company—which means also the Radio Corporation of America. This basic patent has had a checkered career since the application was made in 1913. Almost allowed by the patent examiner at one time, and then withdrawn to permit interference proceedings in behalf of Arnold of the Bell Telephone Laboratories, the patent has been the subject of most exhaustive and expensive litigation. A decision by one authority in favor of Dr. Langmuir was nullified by a reverse decision by another and only during the last month has the patent been adjudged Langmuir's by the Court of Appeals of the District of Columbia.

This patent may prove to be so important in the development of radio apparatus that it well behooves us to know just what it is; and in deciding upon the possible effect of a renewed monopoly in the vacuum field we have only to remember that not longer ago than a year or two, companies making receiving sets were actually being sued by the Radio Corporation on the basis of their tube patents. The contention was that a radio receiver was evidently intended to be used with tubes and that therefore the set manufacturer should pay tribute, and turn in a percentage of his income to the Radio Corporation! The percentage was demanded not because he was making tubes but because he was making sets for which tubes were required!

In the half dozen years before 1912, vacuum tubes were obtainable only in the form manufactured by De Forest; modified small electric lamps is all they pretended to be. Their degree of vacuum was only as good as the commercially available methods permitted at that time. The tubes were far from uniform. One contained little gas and another had ten times as much, so that the performance of the tubes as detectors and amplifiers was erratic and unreliable. De Forest apparently didn't know why his wonderful devices were so variable in character, so that the ground was prepared for the procedure which started shortly after. It was not long before the Western Electric and General Electric Companies began to appreciate the significance of the De Forest audion, and to perceive its possibilities. Their research staff was put to work to find out why it was so variable and how to make the tubes more uniform. The American Telephone and Telegraph

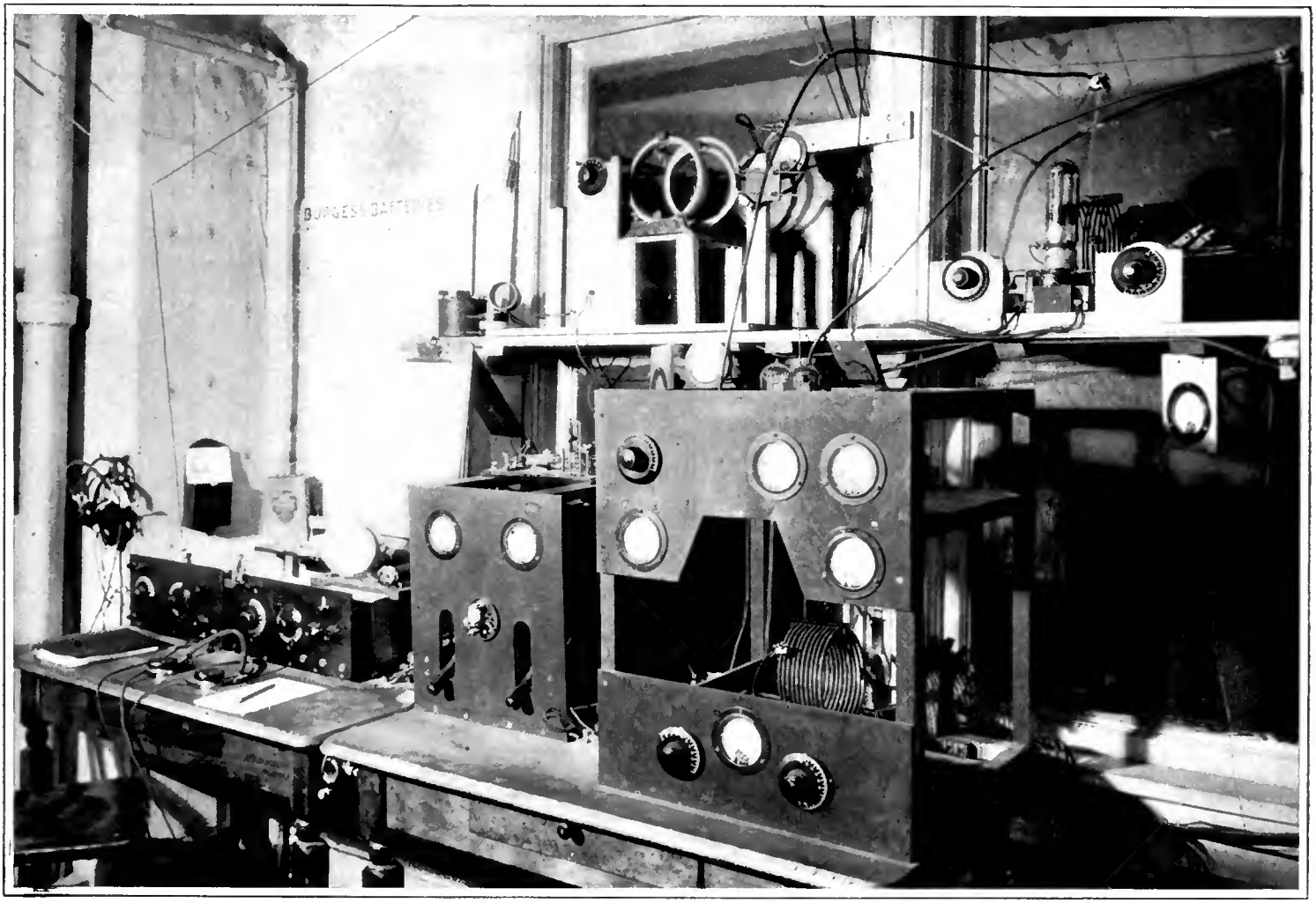
Company was already using vacuum tubes as "repeaters" in its long distance lines and the General Electric Company had been for years greatly interested in vacuum devices so that both groups of research workers began intensive experimentation on the problem. The Western Electric engineers in their work of improving De Forest's relay (as they were using it) didn't consider their improvements in evacuation as anything really novel, although the improvement in the vacuum was the one thing De Forest's audion needed to change it from a toy to a reliable and most important piece of engineering apparatus. If a vote were taken to-day in one of our national societies of scientists as to whether the improvement in vacuum of De Forest tubes could be considered an invention, the result of the vote would undoubtedly be negative; the General Electric Company nevertheless had Langmuir apply for a patent on a *new kind of audion.* The patent claimed that the General Electric tube, evacuated better than De Forest's had been, was sufficiently novel and new to be patentable.

At first the American Telephone and Telegraph engineers maintained (as would any reasonable scientist) that there was no patentable idea involved—that Langmuir had simply done a little bit better than De Forest had been doing for years. Langmuir contributed to the problem no really new ideas but simply brought the facilities of a great laboratory to help do the work De Forest's incompetent workmen had been trying their best to accomplish.

When it was finally decided by the patent office that these highly evacuated audions (given "Greco-Schenectady" names, to quote De Forest) actually constituted an invention, the American Telephone and Telegraph engineers started proceedings to show they had achieved the improvement of the vacuum first. Testimony was taken from the best scientists in England as well as America, the court was treated to elaborate laboratory demonstrations on the methods and results of getting high vacuum. Altogether the report of the proceedings covered some thousands of pages.

The upshot of the proceedings is now before us. The Government says that to improve the evacuation of De Forest's audion does constitute a patentable idea and that the General Electric Company is entitled to the patent. This means, evidently, that every highly evacuated tube is subject to Langmuir's patent. But nowadays we use nothing but highly evacuated tubes so that we must conclude that every tube we have to-day is subject to this new Langmuir patent. This constitutes a most dangerous situation, one which the Radio Corporation of America can apparently freely use to their advantage if they desire. If we read the patent aright, it appears that now, and for the next seventeen years, all of our tubes are legally produced only by RCA so that the price is again at the mercy of this radio trust.

Possibly the RCA will not now push their advantage as they might have done had the patent been granted three years ago. The present Federal Trade Commission inquiry will probably effectually prevent the Radio Corporation from attempting crude monopoly. Seventeen years is a long time, and if the Radio Corporation lasts that long (a matter open to some doubt) it may still exert a strangle-



THE SHORT WAVE EXPERIMENTAL STATION

Of the Burgess Laboratories at Madison, Wisconsin, operating under the calls 9 EK and 9 XH. This elaborate station contains three distinct transmitters, one, in the immediate foreground operating on 3748 kc. (80 meters), another, directly above it tuned to 7496 kc. (40 meters), and a third, next to the 7496 kc. transmitter adjusted to 14,990 kc. (20 meters). A 70-foot telephone pole, three feet from the window shown at the right in this view, supports a rigid vertical antenna. The receiver at the left has a range of from 19,990–2998 kc. (15–100 meters). The next one to it works on 4997 kc. (60 meters). This is an example of a very well planned station, although it is considerably more elaborate than many successful amateur stations whose short wave signals bridge distances on the map as easily as a navigator does with a pair of dividers. One of the low powered transmitters here is operated entirely from heavy duty B batteries

hold on America's radio before the expiration of the life of this patent.

We believe that the Court was unfortunately advised in deciding that any man is entitled to a patent on the improvement in vacuum of a well known device. Unfortunately our opinion does not affect the legality of the situation. If Jones conceives a new and novel device and builds it to the best of his ability it appears that Smith may take one of Jones' devices and improve it by the help of better tools and thereby get a patent on it. Smith's patent represents no real inventive genius on his part but simply the application of better tools, which Jones would probably have used if he had access to them.

It may be that some legal step yet remains by which this threatened strangle hold of the Radio Corporation on the tube situation may be broken, but just what means are to be employed are not quite evident.

Pure Science Becomes Practical

TO THE scientist it is most fascinating and gratifying to see the apparatus and phenomena which he studies as his life-work, coming to be of general service to mankind. And in the last few years, many are the cases in which this has come to pass.

Twenty-five years ago, most of the people who are broadcast listeners would have classed Richardson as a crazy visionary, not dangerous to be sure, but certainly unbalanced, when he dared to speak of *evaporating electricity from a hot metal.* To-day the Radio Corporation makes millions of dollars each year in the utilization of this idea.

Ten years ago, some American and European investigators had to delve through ancient and unused textbooks to find out what was known regarding piezo electricity. The older textbooks said that if certain crystalline substances were properly squeezed, their surfaces developed electric charges; the amount of electricity which thus became available was so infinitesimal that engineers would have laughed at the idea of applying these crystals to useful service. Yet to-day these very piezo-electric crystals are being used in the broadcast stations to maintain the frequency constant. Furthermore this same piezo crystal has been found to be the most efficient sound producer we have for sounds above the audible range. As a submarine detector these piezo-electric sound generators gave more promise than any other device, and intensive development was carried on during the war to push the piezo-electric detection scheme to completion.

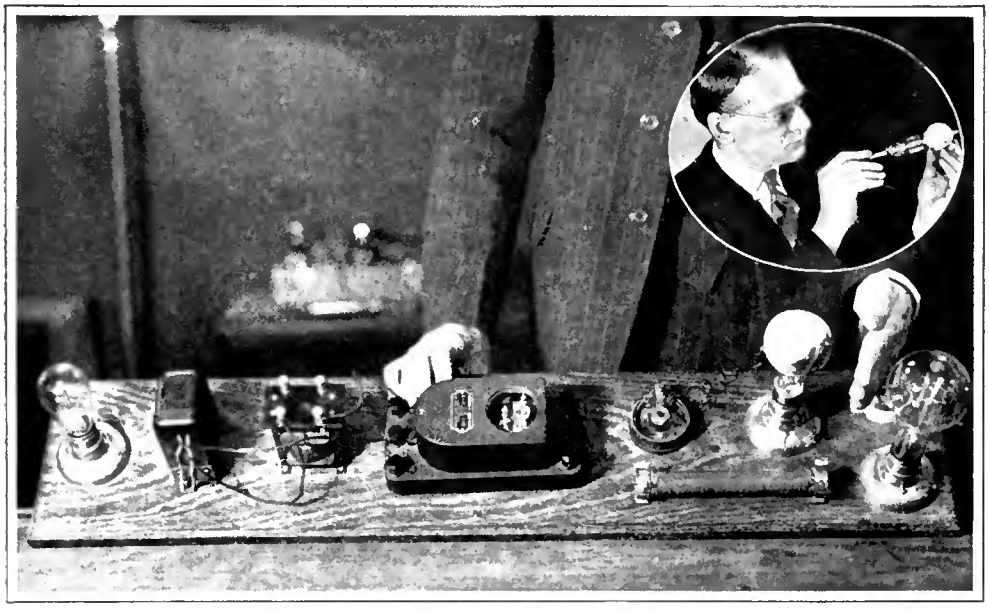
Radio Times, London

Householder (to departing burglar): "Er, would it be too much to ask you to take the loud speaker from the flat below?"

Now another discovery from the realm of pure science promises to push itself into the purview of the layman. It has been known for years that if light, especially that toward the blue end of the spectrum, is allowed to fall on the fresh surface of such a metal as sodium, the surface being in vacuum, electrons will pull loose from the metal surface in some way by the action of the light waves. Small indeed was the amount of electricity thus set free, but to the scientist it was all important—as it allowed him to check his theories dealing with the constitution of matter. But now this photo-electric effect, as it is called, is to be used to check the stationary fireman to see how much smoke he sends up his chimneys.

The possibilities of the photo-electric cell have been realized for many years. Many experimenters in university laboratories have spent long hours of research and investigation to discover and formulate the laws governing its action. It has been used in talking movies to change light impulses into electric currents which could then be amplified by the vacuum tube amplifier. It remained for one of the Westinghouse engineers, V. K. Zworykin, however, to combine the photo-electric cell and the triode to make a more compact, and possibly more reliable, piece of apparatus. The electrons freed from the photo-electric cell in the tube are made to affect the potential of the grid of the tube and thus the plate current; this in turn opens or closes relays or performs other similar services.

As the light falling on the photo-electric surface varies, so does the plate current of



V. K. ZWORYKIN AND HIS THERMIONIC PHOTO-ELECTRIC TUBE

Which was recently developed at the research laboratories of the Westinghouse Company at Pittsburgh. The large illustration shows a special set-up to demonstrate the capabilities of the tube. A 75-watt bulb is at the extreme right; next to it is the photo-electric cell, which is really an improved vacuum tube, showering millions of electrons when light falls on an electrically sensitive substance, inside the tube. This light-sensitive substance in turn operates a relay. In the demonstration, the smoke of a cigarette, coming across the plane of the light caused a bell to ring, and the slightest shadow caused the cell to howl. The cell may be used to measure the light of the stars, through combination with a device developed by Dr. R. A. Millikan

the triode; by arranging an incandescent lamp to throw its light on the sensitive surface of sodium, the smoke recording device became possible. The smoke, passing between the incandescent light and the sensitive surface of the photo-electric cell, perhaps one hundred feet away, cuts off part of the light, thus operating proper relays to record the event. At one of his demonstrations, Mr. Zworykin showed that if the smoke from a cigarette passed between the lamp and his sensitive cell the latter was sufficiently activated to cause the opening or closing of a switch.

Short Waves Are Growing Shorter

THE daily press recently gave considerable space to an announcement of John Hays Hammond, Jr., that he had perfected a scheme for sending as many as eight radio messages on the same wave. The frequency of his carrier wave, 30,000 kilocycles, shows how short these short waves are becoming.

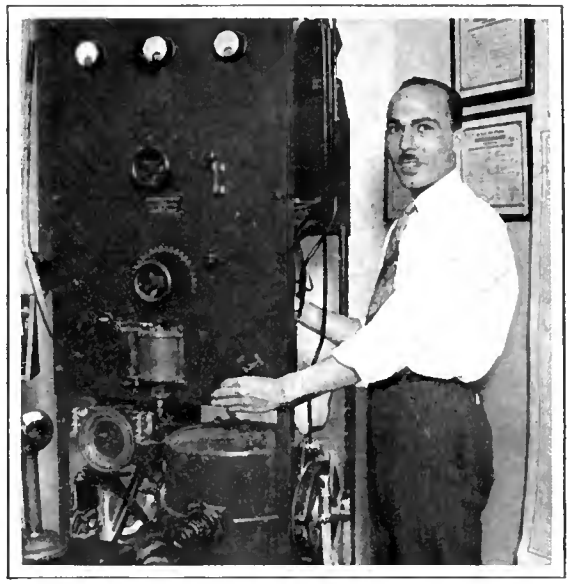
It is not evident that the Hammond transmitter has anything of real merit in it or that any new ideas are involved. Patents have apparently been granted on the method, but that indicates very little nowadays. To the best of our knowledge, Mr. Hammond has not yet explained the merits and new features of his scheme to any of the engineering societies, and we cannot help but feel that announcements of engineering accomplishments which are first divulged through the daily press instead of through the transactions of an engineering society, the members of which are able to judge its real merits and rate it at its proper worth are decidedly open to question.

A wireless dispatch to the New York *Times* from Berlin states that Professor Esau of Jena University has invented a wireless sender using a frequency so high that the wavelength is only two meters. It is reported that Professor Esau finds these very high frequency waves are not affected by the conditions which give absorption and fading on the longer waves and that he expects to telephone to America with his set "before Christmas."

Another report tells of experiments at the University of Iowa, in which wave-lengths of only 74 centimeters were used. Just what was done with these short waves, we do not know.

Before anyone else "invents" more of these short waves, we hurry to say that waves much shorter than any of these recently reported have been experimented with and measured years ago. Radio seems to be a field in which things are continually re-invented. At Columbia University, Professors Nicols and Webb years ago performed a number of striking experiments with short waves—really short ones. It is our recollection that they went as low as two centimeters, that is, about one inch. These waves were measured for length, were focused by mirrors and lenses, and reflected back and forth across the laboratory. Later Professor Nicols worked with waves much shorter, so short that his waves practically joined the spectrum of heat waves, which also are electro-magnetic.

If anyone else thinks of "inventing" some other short waves he had better look up scientific papers recording the work of earlier experimenters and then go back to the father of them all, Hertz. In his book on electric waves, Hertz describes practically all the phenomena which the recent inventors have been giving us. Some of these recent announcements of short wave "inventions" read almost like sections of Hertz's book; published thirty-five years ago.



I. H. KORDI, EGYPTIAN RADIO ENGINEER

Sent to the United States by King Fuad to study American radio methods. M. Kordi is shown inspecting a 1½ kw. arc telegraph transmitter at station WCG, New York

JOHN HAYES HAMMOND, JR.

With a bit of apparatus from his laboratory. Mr. Hammond, whose inventive talents are active in many fields beside radio, is probably best known for his secret system for radio control which several years ago was sold to the United States Government. The inventor recently sold certain rights on a directive and secret "broadcasting" system to the Italian Government. Many of Mr. Hammond's radio experiments have been carried on at Cruft Radio Laboratory at Harvard

How Radio Has Improved

THREE general moves in the direction of improvement in the broadcast field we have consistently advocated and it is a pleasure to see them all coming to pass. The single-circuit regenerative receiver has come in for the universal condemnation it deserves and for which these columns called years ago. Improved quality of reproduction was the next general suggestion RADIO BROADCAST called for—hornless speakers, improved transformers, and power tubes for loud speaker operation. All of these are featured to-day in the best radio sets. Next we repeatedly called attention to the absurdity of continuing with batteries as the only source of power supply for radio sets. The crudest devices of the home use power from the light socket, yet radio outfits, the most scientific piece of apparatus the average home will ever have, continued with the crudest form of power supply. Only this year have the A and B batteries both been eliminated from any standard set and even now the price of such a set is absurdly high. The man with two hundred dollars to spend for radio, still has to depend upon batteries for his power, and how many times he runs into trouble as a result of this power supply! Dry batteries give out altogether, or become noisy; storage batteries call for a charging outfit and are troublesome to some listeners: all this time the light socket has unlimited power supply at negligible cost.

Commander Elmer Langworthy, U. S. N., who designed and built sets for the White House says, "About ninety-five per cent. of the trouble fans have with reception is due to their power supply." When called upon to diagnose reception troubles (for the President, we suppose) the Commander "usually finds dead or low low B batteries, defunct C batteries, and broken or loose battery leads." These troubles with the vexatious performances of the radio outfit, or no performance at all, will disappear when radio tinkering changes to radio engineering. An engineer depends upon batteries for power only when absolutely necessary, but in radio reception this is not so. The greatest need of the radio listener to-day, who is eager enough to get good quality without

WILLIAM DUBILIER

New York; Quoted in the British press on his recent European tour

"Radio broadcasting is only four years old in America, yet the radio industry there is the sixth largest in America, and equals the automobile industry. The sales in America alone this year will be at least £100,000,000. As regards broadcasting, it may interest those who are continually criticizing broadcasting methods in Great Britain to know that in this connection you are in a much better position here than we are in America. The conditions in New York are intolerably worse than those of London. In my opinion, the British system is easily the better of the two. I am certain that good broadcasting is the key not only to international amity, but to world peace."

further urging, is a reliable and reasonably cheap apparatus for supplying the power to his set from the light socket.

The Month In Radio

EVER since the development of broadcasting on an important scale, the Commerce Department has been deluged with complaints from owners of radio sets relative to the great interference encounted from ship signals. Fans will be delighted to hear therefore that the Department of Commerce has agreed with British and Canadian authorities to prohibit the vessels of the three countries from using frequencies in the broadcast band when within 250 miles of the United States, Canada, or the British Isles.

ONE of the most famous American stations has outlived its usefulness and has been retired. After the outbreak of the war in Europe, all of Germany's communications to this country had to be carried out through their Sayville station on Long Island. Many an amateur listened-in on the dot and dash signals which went out over this channel—and so did Uncle Sam. Although United States officers were stationed there as censors, it was said that "contraband" messages were continually coming and going over Sayville's channel. We now know through an article in *World's Work* (Nov. 1925) that the famous Zimmerman telegram inviting Mexico to take whatever of our Southwest territory she desired, with the additional suggestion that Japan join her, traveled by way of Sayville in one of its routes to Mexico City. When we entered the war, the station was, of course, taken over and the Navy has operated it ever since. Now it has been decided that Sayville's traffic can well be routed over other Navy channels. The famous Sayville station will now be held for reserve duty only.

THE Columbus (Ohio) *Dispatch*, has just issued a most interesting compilation of statistics for the radio dealers of that State.

All information of any value about prospective radio buyers is contained in the folder. How many buyers there are, percentage of male and female owners, number in family, character and earning capacity of the people in the different towns of Ohio, how many own automobiles, etc. We find the number of radio sets bought last year, number of radio dealers, number of clerks and employees, whether parts or sets satisfied the average buyer, whether the dealers serviced their sets and how it is done, how much advertising the radio trade does and where it is placed. This is the best piece of statistical work of value to radio manufacturers that we have seen.

THE Radio Corporation is in for a thorough airing. The Corporation will have to convince the Federal Trade Commission of their fair and just treatment of competitors and the radio public in general. There are one or two unsavory reports of the Corporation's activities still in our minds and it is to be hoped that no more will be brought to the light.

The companies being investigated by the Federal Trade Commission in addition to the Radio Corporation are The General Electric Company, American Telephone and Telegraph Company, Western Electric Company, Westinghouse Electric and Manufacturing Company, International Telegraph Company, the United Fruit Company, and the Wireless Specialty Company. The Federal Commission expects to bring out that a monopolistic trust exists in the radio field. It is possible they will prove such to be the fact. That isn't the thing that really counts, however; the question is, Has the trust (if such exists) been reasonable in the prices it has charged for its wares?

Interesting Things Said Interestingly

HASKELL COFFIN (New York; artist): "Men have good color and they don't put anything on their faces. For youth to rouge and paint is just like gilding refined gold and losing the perfection and modesty of a sweet girl. A couple of glasses of cold water, a good walk in the park, or exercise in the morning by radio are a great deal more efficient in assisting beauty."

LORD GAINFORD (London; chairman of the British Broadcasting Company): "On a conservative basis it is estimated that ten millions of the inhabitants of these islands listen to our programs either regularly or occasionally. The peculiarly intimate character of this medium—the fact that the programs are received at the fireside—adds greatly to the burden of our responsibility. In a little more than two years, broadcasting has not only been established as a necessary part of the machinery of civilization, but it has come to exert a definite influence on the minds of the people. It is something that so far we have built this influence on definite ideals and standards of public service. But it is of greater importance that in future the medium of broadcasting should exercise no increasingly beneficent influence, and that nothing be done to endanger this influence."

DR. IRVING LANGMUIR

Schenectady: Research Engineer, General Electric Company

"No branch of electrical engineering has had more interest for the physicist than radio. Hertzian waves, the vital element of radio, were discovered in a physical laboratory. Electrons, the discovery of another great physicist, J. J. Thompson, found their first engineering application in the form of a pure electron discharge in the hands of the radio engineer. Studies in the physical laboratory of phenomena in high vacuum, such as "clean-up" effects of electron emission, of diffusion of one metal through another, of contact potential, and of other interesting physical phenomena, have all contributed to the development of the vacuum tube, which has been called the 'heart of the radio system.'

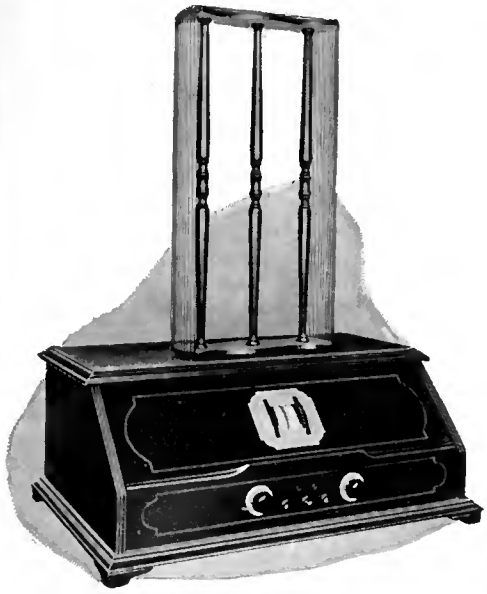
"Now, when a high stage of development has been reached in transmitting and receiving apparatus, the problems of the transmitting medium become more fascinating than ever. We are just beginning to understand the nature of the much-discussed Heaviside layer, and something of the polarization, reflection, absorption, and interference of radio waves."

DR. IAGO GALDSTON (New York; New York State Medical Society): "Five of the largest broadcasting stations in and near New York City are now coöperating with the Medical Society of the County of New York in its endeavor to present authentic health information to the public, to the extent of accepting voluntary supervision of all health talks going out over their wires. . . . There are still, however, certain agencies, both radio and journalistic which, to our great regret, have not closed their avenues of publicity to the insidious propaganda disseminated by persons whose ignorance of medical science is unbounded. They employ gross falsehoods daily in their attempts to discredit scientific medicine, and they advocate healing theories whose fallacies are largely veiled by the plausible manner in which they are presented. The medical profession has been unable to stem the flow of this propaganda."

What's New in Radio

Many Interesting Refinements were Exhibited at the Fall Radio Shows, Which Started the Radio Season Off, But No Startling Developments Were Shown—Improved Quality Striven for by Nearly All—The Artistic Appearance of the Receiver Is Improving

By AUSTIN C. LESCARBOURA



A SIX-TUBE SUPER-HETERODYNE

The second harmonic principle is embodied and a loop is used. While this type of receiver is not absolutely new, it has been redesigned and its appearance considerably enhanced. It is manufactured by the Radio Corporation of America

A FINE T. R. F. RECEIVER

Made by the Pathé Company. Such an instrument would not disgrace the appearance of any living room. The built-in loud speaker should gratify the most descriminating of tastes

TWO radio shows recently held in New York and those in other cities have served the usual ends. There has been the institutional round of handshaking, banquetting, chinning, praising, knocking, arguing, and agreeing—the social business of any gathering, radio or otherwise; and there has been the business of laying the radio cards on the table, in the form of new offerings to the radio public—the real, honest-to-goodness excuse for a radio show or exposition, and the very thing which attracts the crowds. These shows have well served as the national window display of the radio industry.

NO STARTLING CHANGES BUT NO END OF REFINEMENTS

THERE isn't a single genuinely startling change among this season's offerings—at least, if there is, it hasn't been exhibited at the radio shows thus far. Of refinements, however, there are many, indicating that radio engineers and manufacturers are keen to keep apace with the radio march of progress, devoting their attention to details when there are no prospects of immediate changes in fundamentals of radio reception.

Indeed, the whole atmosphere of this season's offerings is a happy one. Thus the fellow who bought a receiver a year or so ago, can feel happy in the assurance that he hasn't been "stung," because the same fundamentals that were included in his receiver are still being employed in the latest offerings. For the fellow who has waited until now, there is likewise much satisfaction; because, while the fundamentals may remain unchanged, there have been numerous refinements which go to produce greater selectivity, simpler operation, better tonal qualities and, in a few instances, more volume. For the manufacturer, too, there is much happiness in the stability of radio engineering. The more critical radio enthusiasts are bound to want the very latest refinements and will therefore purchase the new receivers, happy that these refinements have been made. So everyone is happy with the present state of affairs.

THE PRIME CONSIDERATION IS TONAL QUALITY

THE keynote of this season's offerings is tonal quality. A year ago, the general trend among radio receivers was toward sensitivity, selectivity, and volume; but to-day the prime consideration is tonal quality, which, like charity, begins at home with the radio receiver itself. In other words, the radio enthusiast now realizes that tonal quality is not a matter of trying one loud speaker after another, always in the fond hope that some day, somewhere, a suitable one will be discovered, which will produce the long desired realism. Distortion and poor tonal qualities originate in the radio receiver, and more particularly in the audio-frequency transformers and in the amplifying tubes. Poorly designed audio-frequency transformers fail to amplify with equal volume the wide range of audio frequencies.

THE CAMPBELLS ARE LISTENING: TRA LA, TRA LA!

An interesting photograph showing two instances of being all dressed up. The general trend at the recent radio exhibition was not toward anything revolutionary in design but rather toward improvement of existing models, both in general design and outward appearances. The receiver depicted is a Premier

Also, transformers constructed with poor quality of iron for their cores, are unable to keep up with the rapid magnetic changes caused by the audio frequency currents, with the result that the tonal qualities are blurred.

Until recently, the audio frequency end of

A NEW PARAGON RECEIVER

Of particularly handsome appearance. Its operation is quite simple, two main controls accomplishing the tuning. There is plenty of room in the cabinet for the inclusion of batteries

radio reception has been sadly neglected in the merry chase after new circuits. The audio-frequency transformers employed have often been the same as those originally intended for radio telegraph work, in which it is desirable to have a definite amplifying peak at 500 to 1000 cycles, so as to produce the utmost strength of signal at the usual audio frequencies employed in signaling. However, with radio telephony it is quite different. A flat amplifying curve, providing uniform amplification of signals from at least 100 to 8000 cycles, is absolutely essential if real tonal quality is to be had from the loud speaker.

So it is to be expected that this season's offerings stress the audio-frequency end. All sorts of queer terms are heard in this connection, such as acoustical synchronization, omni-tonal, ortho-sonic, polytonal and so on, which, reduced to plain English, mean improved audio-frequency amplification so as to produce loud speaker results comparable with those obtained from the simple crystal detector receiver and head set—the cheapest yet highest acoustic development in radio telephone reception! A glance at the working parts of the new offerings discloses larger audio-frequency transformers. In some instances, the transformers have been replaced by resistance-coupled stages of amplification; in other instances, the transformers are employed in conjunction with special by-pass condensers and special resistances designed to aid the tonal qualities.

THE HORN VS. THE HORNLESS LOUD SPEAKER

THE radio shows have indicated a decided swing in favor of the hornless loud speakers, although, truth to tell, the horn type still is in the majority in numbers by a very comfortable margin. The hornless type is represented by a number of exposed parchment cones, all more or less alike in design and mechanism; by an exposed cone of wood veneer—a very beautiful thing to gaze upon and presumably of excellent tonal qualities; and by enclosed or concealed parchment cones, which are provided with wooden cabinets or metal barrels.

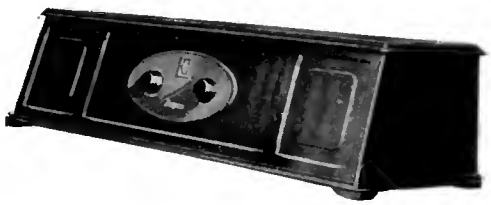
With the present state of the radio acoustic art as applied to loud speaker horns, it is safe to say that the cone type of loud speaker has advantages which are not to be denied. However, the last word has not been said in connection with the horn type of loud speaker, although the radio shows failed to promise anything startlingly new in that line. There are some interesting horns of moulded construction—veritable pretzels, designed to produce deep, mellow notes, yet fitting in a surprisingly small space.

Just what the latest loud speakers can or cannot do was not demonstrated at the radio shows. One cannot think about the early radio shows without recalling the bedlam of shrieks and groans and distorted music from hundreds of loud speakers all going at once. Fortunately, most radio shows to-day do not attempt to emulate the Tower of Babel, although it has always seemed to us that a radio show ought to demonstrate what a radio receiver can do. Individual sound-proof booths provided for the various exhibitors with something to demonstrate in the way of loud speaker performance, would solve this perplexing problem. However, at the Grand Central Palace exposition, excellent radio music was provided by Hewlett induction loud speakers, two of which were employed for the entire vast hall.

AND NOTHING NEW IN THE WAY OF HOOK-UPS

GETTING down to the real fundamentals of radio—the hook-ups—there is nothing new to report, so far as the present season's offerings are concerned. There is an overwhelming majority of receiving sets employing the five-tube radio-frequency layout, with two tubes for radio frequency, one for detector, and two for audio frequency amplification, and with the usual three tuning controls so much like the neutrodyne receiver that there is often some confusion in the lay mind. In some instances the number of controls have been reduced from three to two, and even to one, either with a single fixed means of tuning the circuits in combination, or with a fixed means and an optional means, so that each circuit may be tuned in combination or individually for maximum efficiency. In the simpler tuned radio frequency receivers, various means are employed to prevent regeneration.

Even though radio frequency receivers comprise the greater number of offerings, particularly in the low-priced group, this must not be taken to mean that this circuit is preferable to others. It should be remembered that the patent situation has no little influence on the choice of circuits by manufacturers, and that the regenerative, reflex, and super-heterodyne circuits are more or less dangerous ground to tread upon. As a matter of fact, a well designed three-tube regenerative receiver will usually do as well, if not better, than a five-tube radio frequency receiver, although its operation is more critical and is not so well suited to lay operation.



SIMPLICITY OF CONTROL

Is the keynote of this Ferguson receiver. The two controls are for volume and sensitivity, while a numbered revolving dial behind the face of the panel enables one to write down the settings for the various stations

There is little change in the reflex circuit, as the original arrangement has been found quite satisfactory. The number of tubes for commercial reflex receivers is five or six, with two or three control dials. The reflex receivers are arranged for either antenna or loop operation. Some still employ the crystal detector, while others have gone to the tube detector which is simpler and more stable in its operation.

While the neutrodyne circuit remains basically the same, with the familiar three tuning dials, numerous refinements have taken place in producing the present season's neutrodyne receivers. The standard layout of five tubes has, in several instances, been increased to six, with the additional tube employed either in the radio frequency end or the audio frequency end. One neutrodyne receiver now employs three stages of tuned radio frequency, a detector, and two stages of audio frequency, with but two tuning controls. The antenna coupler tuning condenser operates on one tuning control, while the three remaining interstage condensers are ingeniously coupled together and operated by a single tuning control. The four radio frequency sections are individually shielded, to prevent the interplay of energy and to permit of increased voltage amplification. One neutrodyne manufacturer offers a six-tube set, with the extra tube used in the last stage of audio-frequency amplification, so as to have two tubes in parallel to handle the increased energy without distortion, even when employing standard vacuum tubes.

The regenerative circuit has all but disappeared in present offerings, being retained only in connection with the lowest-priced offerings.

The super-heterodyne is represented by just a few offerings. This circuit, in its highly developed commercial form, is now offered in two popular models, a six-tube receiver and an eight-tube receiver, both employing a decorative loop. Also, there is an elaborate decorative set containing an eight-tube super-heterodyne receiver and enclosed loop, together with concealed cone-type loud speaker and battery eliminator. This radio receiver, as it stands, is beyond doubt the greatest achievement so far scored in radio reception. Operating from the standard alternating current socket, without batteries of any kind, this radio receiver produces remarkable tonal quality in any volume from a mere whisper to a beautifully modulated output that will fill the largest hall. Antenna-operated receivers still lead by a big margin, despite the large number of loop type receivers.

NO A B OR C BATTERY

Is required for this receiver. It is connected directly to the house electric light socket—its only source of power. There is nothing unusual about the circuit itself, it being of standard radio frequency pattern. It is made by the Batteryless Radio Corporation, New York

A CABINET-MAKER'S BOOTH

Unless the trend in present day design was toward a more beautiful receiver outwardly, it is obvious that the above exhibitor would not waste time and money at the show. Now the public wants a good cabinet for the receiver

BATTERIES OR NO BATTERIES—THAT IS THE QUESTION

A VERY definite phase of this season's offerings, as reflected in the New York radio shows, is battery elimination. There are many offerings which have for their object the simplifying of storage battery operation, on the one hand, and the total elimination of batteries on the other. Some offerings are in the form of complete receivers with self-contained battery eliminators, but most of them are presented as accessories, intended for use with any receiver. Again, some offerings eliminate both A and B batteries, and even the C battery; but for the most part, merely the B battery is eliminated, because, after all, that is more readily achieved with satisfactory results than the elimination of the filament battery.

Due to ingenious methods of recharging the storage battery, this old-time radio device has received a brand new lease of life. This season's offerings include various combinations of storage battery and recharger, which do away with the usual storage battery. An interesting development is the trickle recharger, through the use of which a storage battery is constantly on charge at a very slow rate so that the current consumption is virtually negligible. Certain it is that these automatic storage battery outfits, if such they can be called, restore the storage battery in the good graces of the radio fan because of their steady output of current and their relatively low upkeep.

MORE AND BETTER TUBES THAN EVER

IT IS with keen satisfaction that we note the tube developments for the coming season. Instead of being limited to just a few types of tubes for the various purposes encountered in modern radio reception, the radio enthusiast now has a wide range of vacuum tubes to choose from. To the former standard tubes, now appearing with the new standardized base, there have been added power tubes for taking care of the last stage of amplification in storage-battery as well as dry-battery receivers. The growing use of battery eliminators and power amplifiers has also called for special tubes, such as rectifiers, ballast tubes, special power amplifier tubes and so on. To what extent the radio industry aims to give the very best it possesses, is exemplified in the special vacuum tubes now available for resistance-coupled amplification. More and more it is coming to be recognized that the vacuum tube is part and parcel of a radio circuit, and must therefore be designed for the specific purpose intended. There is no such thing as a universal tube.

The A. C. tube has not as yet received wide recognition, although a few sets have been designed specifically for it.

THE IMPORTANCE OF LITTLE THINGS

IN LITTLE things as well as big things, the keynote of the present radio season is improved reception. With no startling developments to monopolize attention, the radio engineers and the radio manufacturers have found time to concentrate on the numerous details of radio.

Even a hasty survey of radio parts and accessories discloses no end of refinement and improvement. Condensers have undergone marked changes, particularly toward the straight-line frequency type of plate, which prevents the crowding of radio stations at the lower end of the tuning dial. Sockets have been improved not only in mechanical details but also toward better insulation, with the former metal shell replaced by dielectric material. There is a definite trend toward broken-away bases, with the object of forming an air gap between plate and grid to reduce possible leakage.

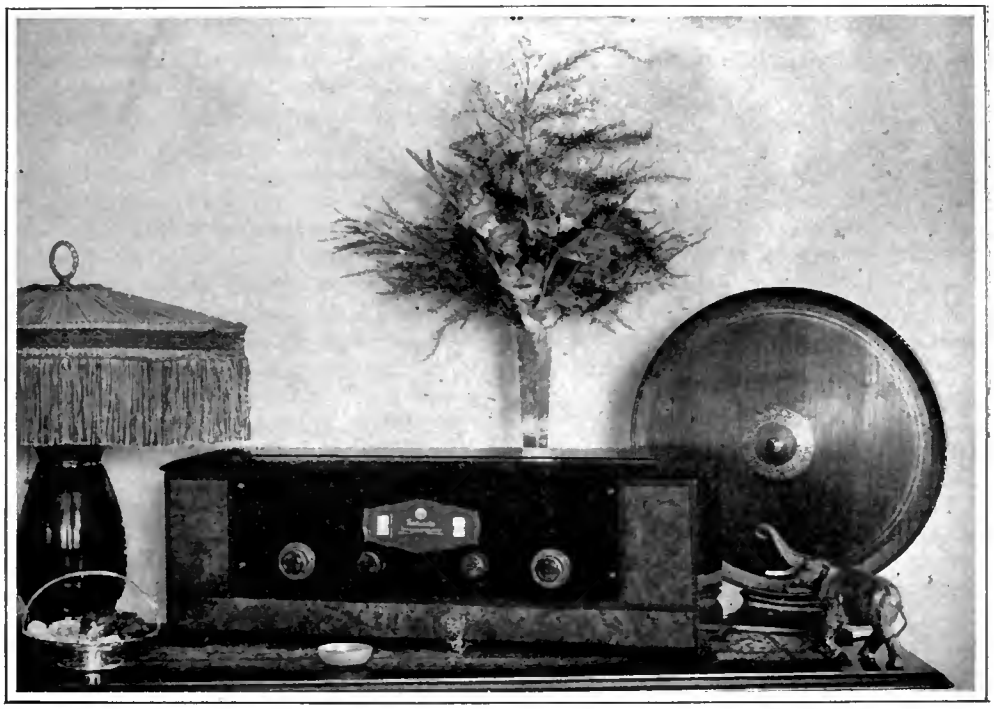
And so it goes with all other parts, such as rheostats, potentiometers, plugs, jacks, fixed condensers, grid leaks, and binding posts. No radical changes, please understand, but plenty of evidence to prove that engineers and manufacturers have been hard at work.

LESS ACCESSORIES AND MORE SELF-CONTAINED RECEIVERS

THE order of the day, if we read the signs correctly, is a steady move toward self-contained receivers. More and more the radio manufacturers are coming round to the practice of a single cabinet with batteries, loud speaker, and, in some cases, wave interceptor, complete. Thus what were once accessories now become integral parts of the self-contained receiver, not only making for greater efficiency, since all components must obviously be better balanced in such an arrangement, but also making for remarkably attractive radio cabinets.

Then, too, there is a definite tendency toward beautiful appearance, with all signs of radio mechanism artfully submerged in the more advanced offerings. Thus the insulating panel with its dials, rheostat knobs and jacks, has been giving way to decorative wood fronts, with the radio controls artfully blended with the general decorative scheme so as to be inconspicuous. The standard tuning dial and knob have disappeared in many receivers, and in their place we have ingenious controls in the form of drums or rims which protrude through decorative slots; or, again, we have small knobs which control dials placed behind the panel, with just the immediate readings appearing through small windows. Some receivers have the tuning controls entirely concealed from view, until they are exposed by a drop front or other means.

Fortunately, however, this move toward camouflaged radio is devoid of freak effects. There are no radio receivers made to look like pianos or ice boxes or reading lamps. The move is a safe and sane one, which must go far to convince Milady that she should have the finest radio obtainable for that corner of the living room. It certainly makes things lots easier for us men who must sell the radio idea to Friend Wife!



BLACK BEAUTY

Is a title befitting the new Bosch Amborola receiver. The cone type loud speaker shown in this photograph, and exhibited at recent radio expositions, is the first of its kind to be made of wood

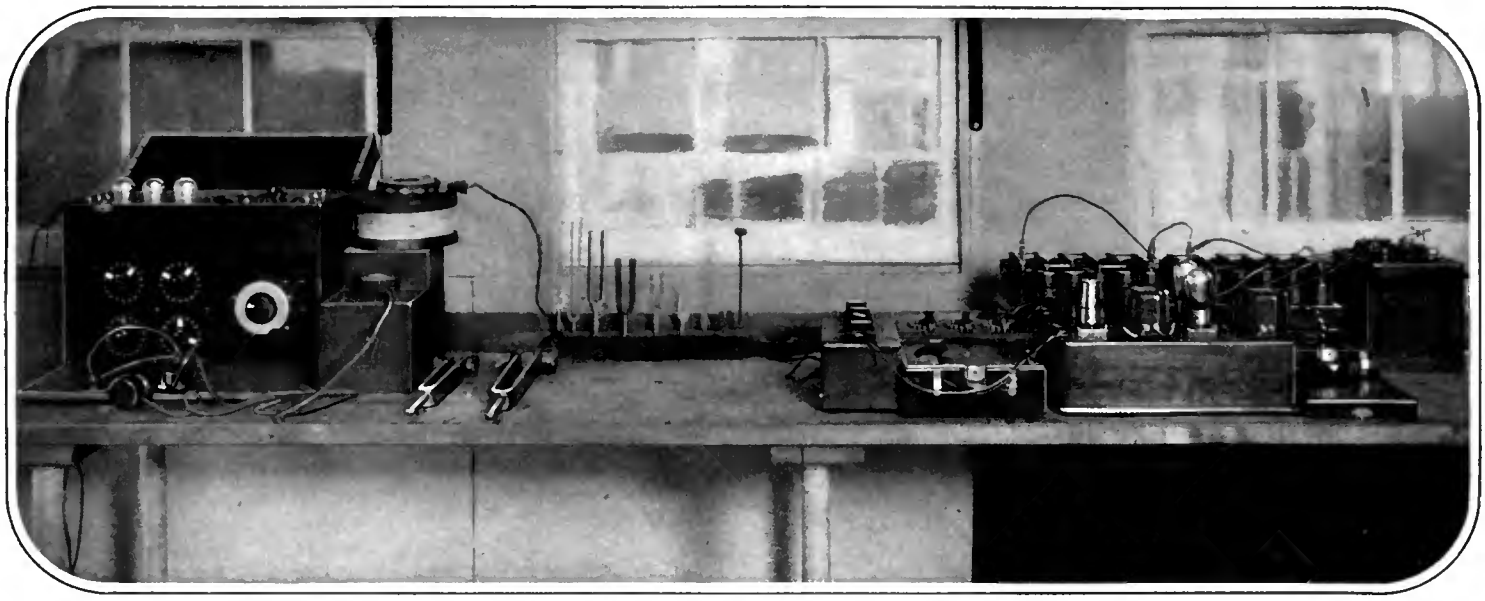


FIG. 1

The set-up of apparatus which is required to take accurate readings of audio transformer amplification over the audible frequencies. At the left is shown the audio oscillator which grinds out the signal whose frequency is known. In the center of the picture may be observed several sizes of tuning forks which, when struck, produce an audible signal whose frequency depends upon the mechanical make-up of the fork. At the right of the picture is the recording apparatus for measuring the degree of amplification of the audio transformer under test

The Requirements for Better Audio Amplification

How to Tell a Good Transformer by Its Curve—Comparing Resistance and Transformer Coupling—The Right Tubes to Use

By KENDALL CLOUGH

Research Engineer, Electrical Research Laboratories

IN SPITE of the fact that the audio-frequency amplifier is one of the oldest units of radio and telephonic reception, it is still the subject of much controversy, and conflicting ideas are just as prevalent now as they ever were. The purchaser of coupling units for the audio amplifier is confronted with a variety of products to choose from, which are accompanied by as many different curves taken under as great a diversity of conditions. Then, after examination of the characteristic curves, he decides on a particular transformer, resistance unit, or choke, and installs it in his own receiver where it operates either to his pleasure or dissatisfaction.

There is just one sad thing about the whole affair and that is that he is usually satisfied with his arrangement, chiefly because the theory of the thing is right. The ear is rather untrustworthy to some minds and even though things may not sound just right, the unsophisticated listener is apt to recall the curves that he has seen on the device, or some particular theory that he has heard regarding it, and conclude that the theory must be right and that his ears are wrong. As a consequence, too many of our homes are blessed with radio melodies of a nature that would make the composers as well as the artists blush with shame.

One of the first applications of the audio amplifier was its use in telephone systems for the amplification of the voice frequencies. In this capacity, it was considered necessary that the repeating devices used between tubes should handle with equal facility all frequencies between 200 and 2000 cycles per second. It has been recognized that the transmission of music requires a still greater frequency range, but how much greater, the manufacturers' curves do not seem to agree. It seems that, to date, few of them have considered the performance of their transformer or other devices below 100 cycles per second, and in some cases not that low. On the upper range, we see some carrying their curves up to 3000 cycles and some to as high as 8000 or 10,000 cycles.

The chart shown in Fig. 2 may shed a little light as to how great this frequency range actually should be. Here the piano keyboard is shown in full lines corresponding to actuality, while an additional octave, which will be discussed later is shown dotted. The heavy lines opposite the names of the various instruments are indicative of their frequency ranges.

The important point of this chart is the fact that the piano notes involve frequencies as low as 30 cycles. In addition, such instruments as the bass viol and the tuba have their entire ranges in the lower frequencies thus making it imperative that the audio amplifier be capable of magnifying such frequencies if it is to be properly designed. There are a few instruments, such as certain kettle drums and organ pipes, that sound at frequencies lower than those shown on the chart, but these notes are so exceptional that it is hardly necessary to consider them for the average broadcast program.

In the upper range of frequencies, the piano continues to represent the extreme, having a frequency of more than 4000 cycles at the highest note. It might appear on first thought that it would be unnecessary to measure amplification at higher frequencies, although, as mentioned previously, some transformers will amplify efficiently at considerably higher frequencies.

It is a fact well known to musicians and physicists that when an orchestral instrument is sounded, there is emitted, not only the fundamental note, but also frequencies of double, triple, etc., the frequency of the fundamental. These are ordinarily called overtones by the musicians, and harmonics by engineers. For example, suppose that the note C, frequency 256, is struck on the piano. Frequencies of 512, 1024, 2048, etc., together with combinations of these frequencies, will be present in the resultant note. In general, the intensity of these overtones will decrease in the order named, but for a given instrument they will bear a definite amplitude relative to the fundamental note played. It is the number and intensity of these harmonics that enable the ear to distinguish between the violin and the piano playing the same note. These harmonics aid the highly trained ear to tell the Stradivarius violin from others. In other words, the harmonics and their relative intensities determine the tone quality or color of the individual note. Experience has shown that in order to retain with fidelity the characteristics of the upper notes that at least one harmonic must be provided for in the design of the amplifier. For that reason we will need to consider certain notes that are not actually on the piano keyboard although they are heard. They are shown in the chart by the dotted line portion and by the notes of the staff above.

So the first point that we will want to assure ourselves of in the purchase of amplifying devices is that the characteristic is desirable from 32 to 8192 cycles or more.

WHAT CURVES AND CHARTS MEAN

THERE is a considerable variation in the appearance of response curves according to the type of coördinate paper that is used in plotting the results of tests, so that it is well when reviewing curves to note what type of paper is used. To illustrate this point, curves on two different transformers have been plotted on three different scales, such as have been used by various firms. The full line in each chart is the characteristic of a very good audio transformer while the dotted line represents a poor instrument. It will be noted immediately that there is very little apparent difference between the two as plotted in Fig. 3a while a decided difference is shown in Figs. 3b and 3c. The first curve is plotted in the usual regular coördinates and the third in what is called logarithmic scale. The second, Fig. 3b, is a combination of the two, frequencies being plotted on the logarithmic scale and the response or amplification in regular scale.

There can be no doubt but that the scale of frequencies should be plotted in logarithmic scale. The "C's" of the musical scale have been marked off on the three charts to show the absurdity of the use of regular coördinates for this purpose. Note in the curve, Fig. 3a, how the octaves are crowded at the lower end of the scale and spread out at the upper end. In logarithmic scale, however, the various octaves of the musical scale are each given equal importance and are actually illustrative of physical fact.

There is yet some doubt as to the proper scale to use in the plotting of amplification in these characteristics. While the semi-logarithmic scale is capable of differentiating between the good and the poor in transformers, it would seem that the double logarithmic paper gives a more accurate picture of what may be expected in the actual performance of the instrument. This opinion is based on Fechner's Law which states that "physiological response is proportional to the energy involved in the phenomena." This means simply that a sound pressure of 1000 dynes, for example, will produce only three times the sensation to the ear as would a sound pressure of 10 dynes, 1000 being the cube or third power of 10. It would not produce 100 times as great a sensation as might be expected. Hence a full logarithmic scale in the plotting of representative characteristics is considered best.

Now, unfortunately, a given transformer does not show the same characteristic under a variety of conditions. Thus, not only will the characteristic be altered by a change in tubes but also by changes in grid and plate voltages with the same tube. Furthermore, tubes of the same type do not have the same characteristics at the same voltages, so it is important that curves for purposes of comparison bear a notation of the types of tube used, the voltages at which it was used in the test, and the amplification factor and the plate resistance of the tube at those voltages.

This variation of amplification characteristic with change in tube constants is a subject that holds remarkable possibilities for the listener who is striving toward perfection in reproduction.

The characteristic of a given transformer is influenced by the amplification constant of the tube only in the matter of degree. That is, the amplification is high or low in proportion to the amplification factor of the tube provided the plate resistance of the tube is unchanged. This explains the fact that greater volume is obtained from the use of the 201-A type tube, with its amplification factor of 7.5 than from the 199 type with a factor of 6.0. It should not be thought that the use of some of the new

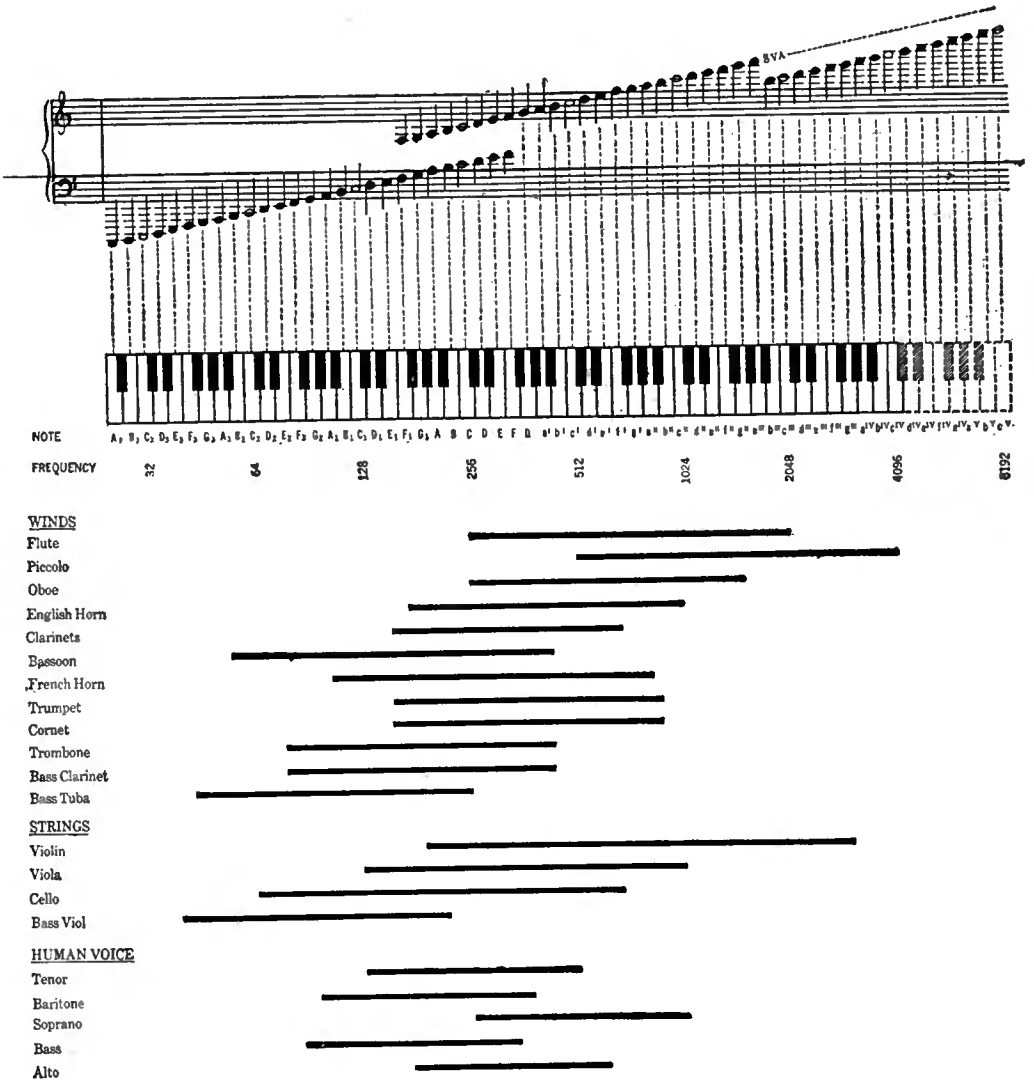


FIG. 2

A most interesting graphical comparison of the frequency range of a piano and other musical instruments. Even though there is overlapping of the ranges covered by these instruments, the particular tone by which a certain type of instrument may be identified is produced by a combining of the overtones emitted with the fundamental tone

high-Mu tubes would be desirable with transformers on this account, however, for there is another consideration in the case.

That consideration is the plate resistance of the tube. It is a difficult if not impossible thing in vacuum tube design to produce a tube having a high amplification constant and a low plate resistance. Hence we find that the high-Mu tubes have an almost correspondingly high plate impedance which produces an exaggeration of the effect illustrated in Fig. 4. Here are shown curves of the transformer previously referred to with a tube having an amplification factor of 7.5 and values of plate resistance of 5000, 10,000, and 15,000 ohms as marked. This instrument has a remarkably high primary inductance which causes it to produce high amplification at

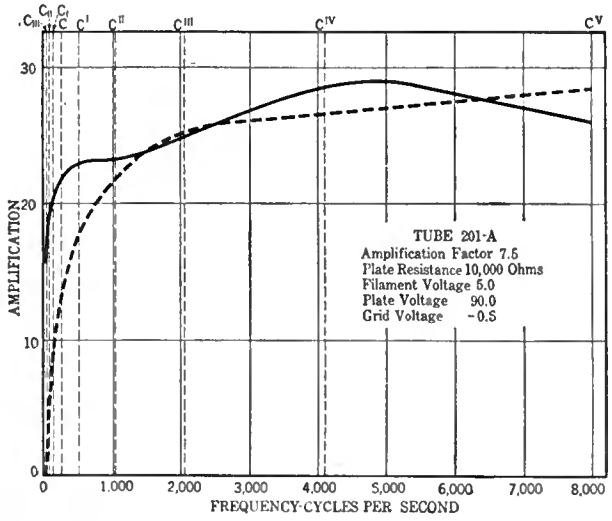


FIG. 3-A

the low frequencies, but note that the amplification falls off at these frequencies as the plate resistance increases, due to lack of balance between the plate resistance and the transformer impedance at those frequencies. This slump of amplification on the low notes would be aggravated with the high amplification tubes and, while the over-all amplification would be very good at the high frequencies the low notes would receive almost no amplification with consequent unnatural reproduction.

Our particular interest in these curves lies, however, in the fact that they represent particular possibilities in regard toselection of tubes. The curve, Fig. 4, marked 10,000 ohms would be indicative of the performance of this transformer when used with a 201-A tube with 90 volts on the plate and a negative grid bias of half a volt. This tube and these voltages would be very satisfactory for operation in the first stage as the grid of the tube would never become sufficiently positive on moderate signals, to introduce the kind of distortion discussed by Mr. Crom in the October RADIO BROADCAST. If we were to increase the bias on the first stage to $4\frac{1}{2}$ volts, the curve would be modified to that marked 15,000 ohms, for we have increased the plate resistance to that value by the use of a high bias.

It would not be wise to increase the bias beyond $1\frac{1}{2}$ volts unless required to by the tests described by Mr. Crom, for we would only be impairing the quality at the low frequencies.

On the other hand we might decide, after listening very analytically to our speaker, that the low frequency instruments cannot be heard with quite the volume relative to the other instruments that we would hear them if actually in the studio. In this case, unless the loud speaker has a decided discrimination against the low frequencies there will be some advantage in operating two 201-A tubes in parallel as shown in Fig. 5. The combined plate impedance of the two tubes would be reduced to 5000 ohms and we would obtain the curve shown for that figure on the chart. Or, we might use a single 216-A tube with some sacrifice in amplification (amplification factor 5.6) but with the same quality. The grid bias in the second stage should not be omitted due to the risk of the grid becoming positive and drawing current as described in Mr. Crom's article. Here, however, the use of semi-power tubes is desirable, for the output signal from the first stage has reached such proportions that a single 201-A will not handle it without some tube distortion. Therefore, the low plate resistance of two tubes or of a power tube in the last stage will allow the plate circuit to deliver more energy to the loud speaker at the low frequencies.

RESISTANCE-COUPLED AMPLIFICATION

CONSIDERABLE material has been published on the improvement of reproduction at the low frequencies together with various means for attaining it. Among these the claims of the various manufacturers of resistance couplings are predominant. While it is true that the theory of the resistance-coupled amplifier attributes to it the property of uniform amplification at all audible frequencies it can be shown by test that the average resistance-coupled amplifier, as merchandised, does not do very well with the low notes. This is due principally to the low capacity of the coupling condensers advocated in such amplifiers, whose impedance at 30 to 60 cycles becomes so high as to prevent an effective transfer of voltage to the succeeding tube. The only remedy for this condition is in the use of larger condensers of from one half to one microfarad, and even then there are often certain limitations that make it nearly impossible to obtain the quality of reproduction possible in a well designed transformer-coupled amplifier.

FIG. 3

Here are three curves, A, B, and C. They are all for the same two transformers. It is evident that by using one kind of cross section paper, the curve can be made to look as though the transformer measured was very good and amplified well over the frequencies desired. From an inspection of the three ways in which a transformer curve may be indicated as presented here, it is obvious that the curves in Fig. 3A are not honest in comparison to those shown in B and C. In Fig. 2 we saw that the tones and sounds we are most interested in ranged from about 32 to 4000 cycles. Yet by presenting a curve as in A, attention is subtly centered upon the flat portion of the curve which deals mostly with the high notes. The amplification at the lower frequencies is negligible compared to the higher frequencies. In B this condition is corrected somewhat by the use of logarithmic cross section paper where the frequency is plotted on a logarithmic or octave scale. However, the amplification indication is not of the same scale. The scale employed in C is favored by many as the true way to represent response curves for audio transformers. Here the frequency increases on the logarithmic or octave scale, as it is played on a musical instrument. Also the amplification in 3C is plotted logarithmically which is probably the way in which the ear hears sounds

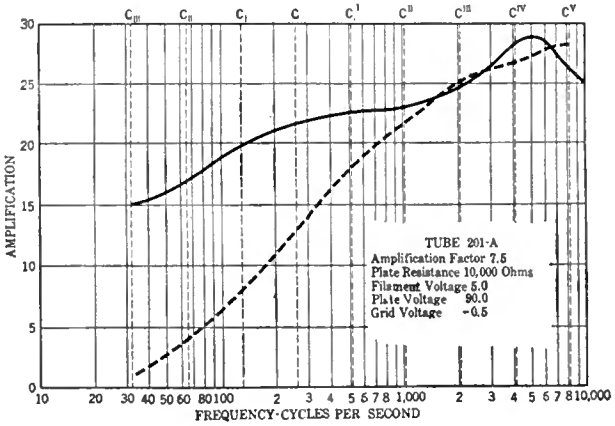


FIG. 3-B

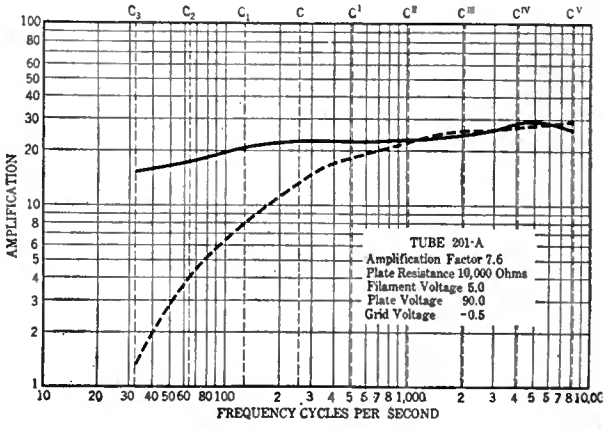


FIG. 3-C

The principle of these limitations is the inability of the resistance amplifier to overamplify the high frequencies. It has been the writer's experience that the average loud speaker discriminates against the high frequencies in such manner as to make it desirable that the amplifier supply a little more energy at these frequencies than at the low or medium frequencies.

In addition, in the more selective receivers the detector output shows a falling characteristic, that is the low frequencies are louder than the high, due to the tuned circuits of the radio amplifier cutting the sidebands of the transmission. This effect is illustrated roughly in Fig. 6, showing the output characteristic of a regenerative detector. Hence the desirability of being able to amplify the high frequencies to a greater degree than the low tones.

It is not the contention of the writer that all transformers are good in this respect. The majority of the transformers on the market show such ineffectiveness at the low frequencies that it is impossible to offset their characteristics. One particular transformer on the market is very poorly designed as evidenced by the fact that at 125 cycles it ceases amplifying entirely and from there down is actually nullifying the amplification obtained from the tube. From 30 to 60 cycles, an octave in the bass of the piano, it actually attenuates the signal to a greater extent than the tubes' ability to amplify, so that any note in this octave would actually be louder at the detector output than at the output of the amplifier. Unfortunately there are several transformers on the market that have similar characteristics, so the necessity of knowing the characteristics of a transformer over the entire frequency range of the piano becomes very evident.

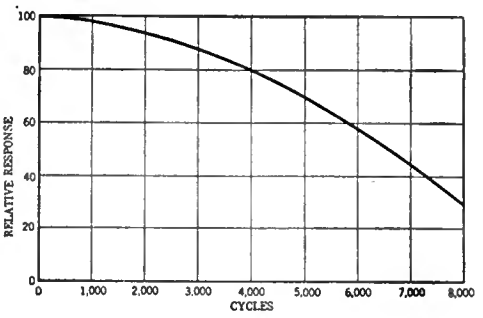


FIG. 6

Briefly, this curve shows that as regeneration is increased the response on the higher frequencies is reduced

There are several transformers on the market suitable for low frequency reproduction and among these is the transformer whose characteristic is shown by the solid line in Fig. 3c. The extremely good amplification obtained at the low frequencies is made possible by the use of a novel core construction known among power engineers as the cruciform.

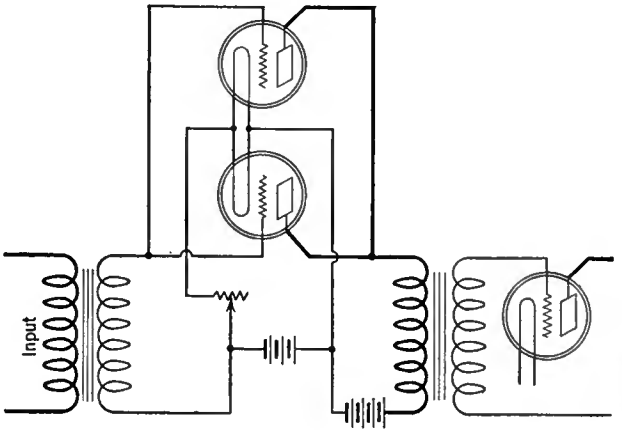


FIG. 5

By paralleling the elements of tubes as shown, the effective plate impedance is reduced to one half the value of one tube. However, this arrangement does not increase the amplification but does increase the power output of the amplifier

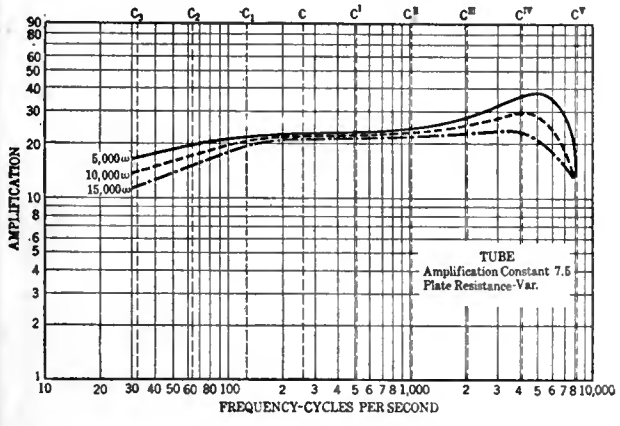


FIG. 4

Simply because a tube is called high-mu it does not follow that better amplification will result. It is difficult, in high-mu tubes, to obtain a low plate impedance. As the value of mu, shown here, increases, the plate impedance increases. From the curves shown above it will be observed that as the plate impedance is increased the amplification falls off correspondingly. However, when high-mu tubes are used in a resistance audio amplifier, the story is entirely different

The advantage in this type of construction is the fact that the magnetic flux developed by the windings is almost completely confined to the iron core, with the result that the primary inductance obtainable with a given amount of iron is higher with consequent better transformation at the low frequencies. Fig. 7 shows the manner in which the flux leaks out into the surrounding space with the more usual core construction, while with the cruciform construction the coil is so completely surrounded by iron that the leakage is negligible.

EDITOR'S NOTE

IN THE October, 1925, RADIO BROADCAST, an article by George C. Crom reviewed certain considerations of audio frequency amplification which are quite fundamental. Some of the readers of this article may not have seen Mr. Crom's remarks, and so, reprinted below are several paragraphs dealing with the requirements, as Mr. Crom sees them, for distortionless amplifier operation. These conditions apply to the amplifier tube itself:

First—The filament of the tube must be operated at a temperature high enough to supply all the electrons resulting from the sum of the direct plate current and its audio frequency component. The majority of good tubes give this necessary electron emission at low temperatures such as that resulting from 4.5 to 5.5. volts across the filament of a five-volt tube.

Second—The plate circuit should have sufficiently high impedance. This high impedance straightens out the curve which is usually referred to as the operating characteristic, and is explained in Paragraph 60 of *Thermionic Vacuum Tubes*, by Van Der Bijl. The discussion there is too involved to be detailed here.

Third—The grid must be maintained negative with respect to the filament so that at the positive peaks of the signal-voltage wave, appreciable current does not flow to the grid. If current does flow to the grid, it pulls down the plate

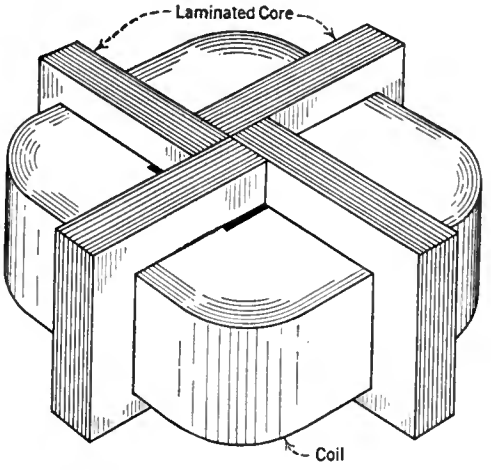
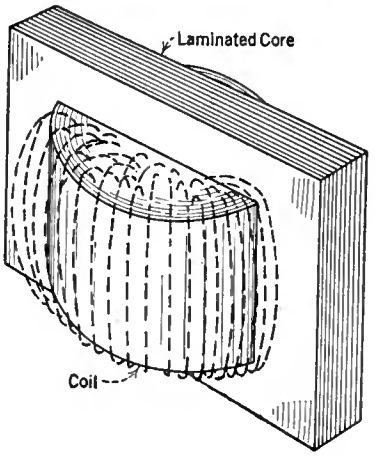


FIG. 7

The lower illustration shows the flux leakage prevalent in most transformers. This condition can be remedied by the intelligent use of iron cores situated as shown in the upper sketch



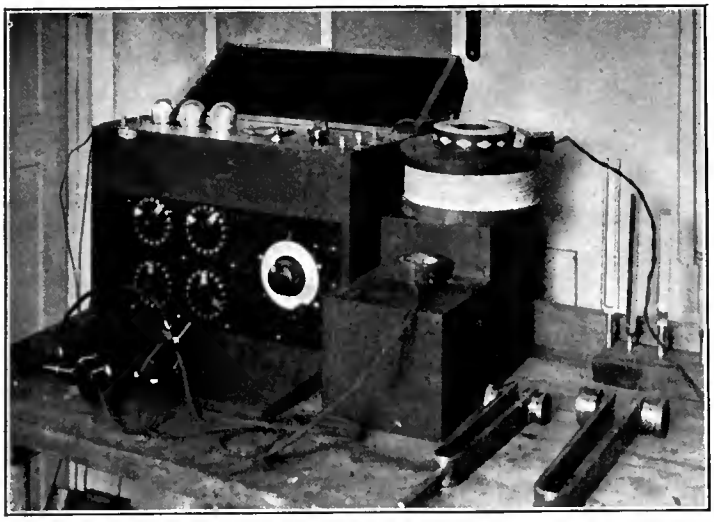


FIG. 9

This is a detailed view of the audio-frequency oscillator. The dial and switches on the front of the panel allow the adjustment of the instrument to frequencies ranging from 30 to 100,000 cycles with three inductance coils. The large white coil at the right is the coil for the medium range frequency. Note the phones attached to the small pick-up coil used for picking up the tone of the oscillator for comparison with the standard fork. The large fork at the left has a pitch of 32 cycles and near it is a fork of 64 cycles

current and causes a bend in the operating characteristic curve, that is, the positive peaks of the plate current waves are cut off. As current flowing to the grid must pass through the transformer secondary with its many turns, it may saturate the transformer core, pull down its amplification, and thus cause distortion in the transformer. The value of the C battery necessarily depends on the structure of the tube used and upon the signal voltage. This is not necessarily true, for individual tubes vary widely.

Fourth—the plate voltage must be high enough so that the plate current can faithfully follow the grid voltage. The plate voltage must force the plate current through the resistance of the apparatus in the plate circuit and still apply enough voltage to the tube, so that on the maximum negative signal voltage on the grid, some plate current will still be flowing. In other words, the negative peaks of the plate current waves must not be cut off.

These conditions sound complicated, but they are not when stated simply. The first is: use good tubes and keep your A battery charged. The second is: use good transformers. The third and fourth are: use the proper value of C battery for the signal voltage at the grid of each tube, and a plate voltage which corresponds to this C voltage.

The most satisfactory method, and also the easiest, for determining these last two conditions is to put a milliammeter (d. c., of say, 0-15 milliamperes range) in the plate circuit of the amplifier tube under investigation and observe the plate current while the strongest signal that is to be received is going through the amplifier. If the C battery voltage is not high enough and positive peaks of the plate current are cut off (and current is flowing in the grid circuit), the plate current will decrease with a strong signal. Increasing the C battery will prevent the grid from going too much positive.

If the plate voltage is too low (in the opinion of the writer, it usually is) and the negative peaks of the plate current are being cut off, the current will rise on a strong signal. Increasing the plate voltage will remove this difficulty."

In an early number, we expect to publish an article about audio frequency transformers which should be of deep interest to everyone in the radio field. We shall show many curves of the electrical characteristics of audio transformers, taken in RADIO BROADCAST'S Laboratory. This feature alone should be very interesting because with so many transformers on the market, it is difficult for the untutored buyer to know just what transformers have the characteristics he wants. The article will explain how the transformers are measured. Some needed light will be cast on the disputed effect of the use of shunt condensers and resistances in audio transformer circuits. The effect of the C battery on transformer operation will be carefully covered.

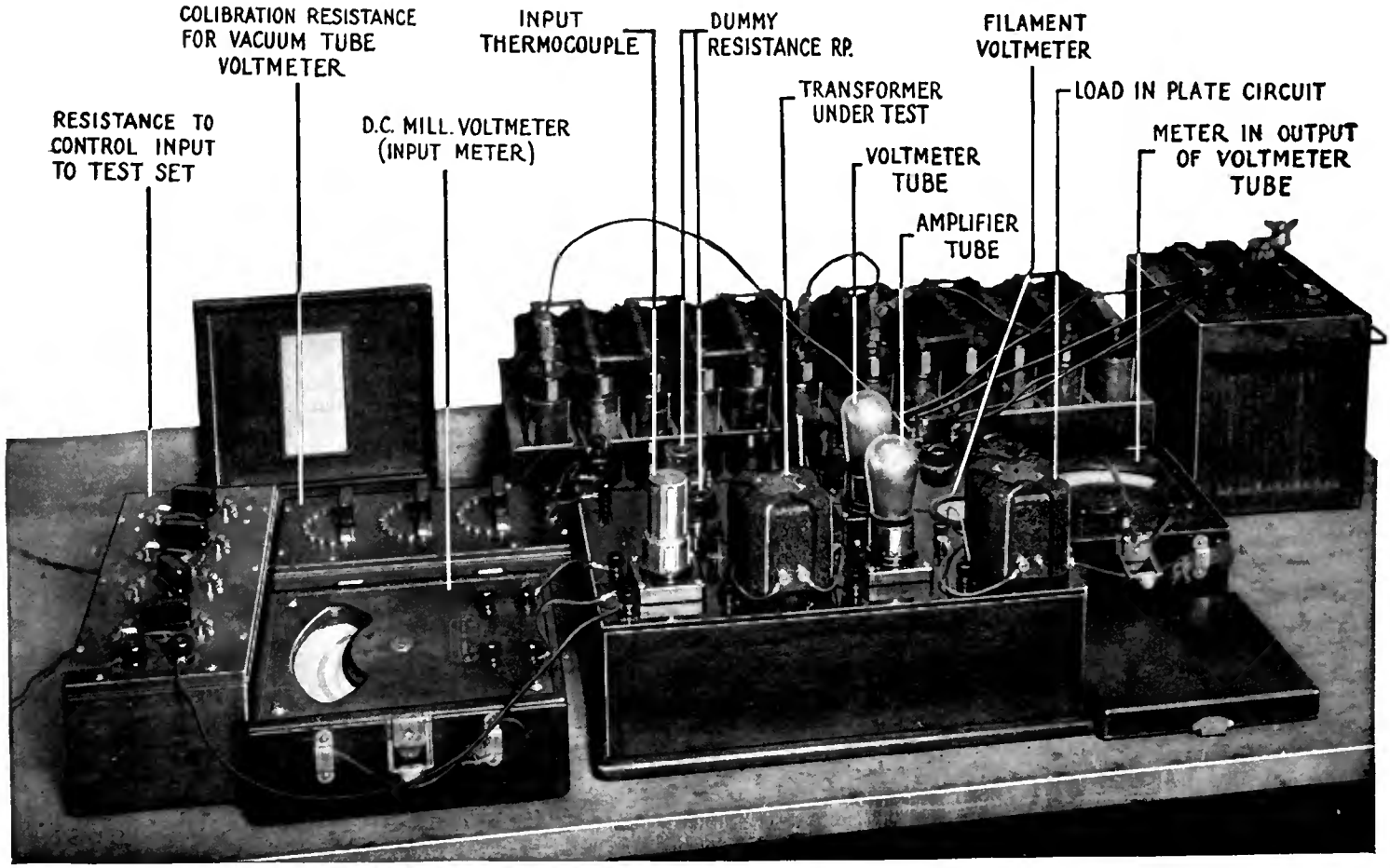


FIG. 8

A close-up which is self-explanatory of the recording apparatus

Additional Notes on the Model 1926 Receiver

How to Employ Impedance- or Resistance-Coupling in the All-Wave Receiver—How Quality in the Loud Speaker Can Be Bettered by Coupling the Output Tube to the Speaker Through an Auto-Transformer

By ERNEST R. PFAFF

THIS year we find attention concentrated upon the improvement of the reproducing quality of the radio receiver, rather than upon its sensitivity and selectivity as in past years. There is very little reason why this problem should require any very great concentration or experiment upon the part of the enthusiast or listener desirous of building his own, since equipment is available upon the market for audio amplification purposes which will permit of nearly perfect reproduction.

In the November, 1925, RADIO BROADCAST there appeared a description of a receiver developed by McMurdo Silver which possessed ample selectivity and sensitivity, and consequently was admirably fitted for the incorporation of any type of audio frequency amplification desired by the individual builder. In this article, a standard two-stage transformer-coupled audio amplifier was considered, while in the present article, methods of improving this amplifier, the use of resistance and choke coupling, and the application of the new power tubes are considered.

THE ORIGINAL AUDIO AMPLIFIER

IN THE November article, the receiver was shown with a two-stage audio amplifier using Thordarson 3½:1 audio transformers. These transformers are remarkably satisfactory, though they do not wholly satisfy one condition necessary for distortionless amplification—which is that the primary impedance of the interstage transformer should exceed by three times the output impedance of the tube feeding into it at the lowest frequency to be handled. The primary impedance of the 3½:1 Thordarson transformer at 50 cycles, which may be considered as the low limit of frequencies to be reproduced is a bit less than 10,000 ohms, while the lowest frequency at which the condition stated above is satisfied will be in the neighborhood of 175 cycles, since the tube impedance for a UV-201A is approximately 12,000 ohms. Therefore, it is obvious that above 175 cycles, substantially distortionless amplification will be obtained, while below this frequency the gain will fall off rapidly, until some of the lower notes below 50 cycles suffer badly.

The reproduction from practically any audio transformers used in an amplifier can be very appreciably improved by careful and judicious attention to small details, such as by-pass condensers, proper operating voltages for the tubes used, shunt resistances and shunt plate feed arrangements. A most excellent discussion of such features will be found in Mr. Crom's articles in the October, 1925, RADIO BROADCAST.

A point not stressed by Mr. Crom is the use of shunt resistances across audio transformers secondaries, as well as small by-pass condensers across these windings. Grid leaks of from .05 megohms on up to .5 megohms shunted across audio transformer secondaries will invariably help to stabilize an amplifier, and at times will tend to improve its quality of reproduction. Small condensers ranging from .0001 to .0005 mfd., shunted across the secondaries of audio transformers will tend to bypass some of the higher frequencies, with the net result that in many cases the reproducing qualities of the amplifier for low notes seem materially improved. This, however, is only apparent improvement since it amounts to decreasing the high frequencies to the same volume as the low notes. A combination of resistance and capacity shunt is also frequently helpful.

Where a high plate voltage is used on an audio amplifier, the last stage should not include the loud speaker directly in the plate circuit of the tube. This is because the normal direct plate current would flow through the speaker, to which would be added the alternating signal component. In many cases the handling capacity of loud speakers is decreased to one-half or one-quarter what it would normally be by this arrangement. A much more satisfactory arrangement is to feed the plate supply directly to the plate of the tube through a high inductance choke, such as a Thordarson autoformer, and then shunt the loud speaker in series with a .5- or 1.0- mfd. condenser from plate to filament. In this way, the direct current component is fed through the choke and kept out of the speaker; only the alternating signal component reaching the speaker windings. Thus, the value of signal required to saturate the speaker is that normally required, instead of, with the usual connection, the normal value minus the direct plate current—often several times the alternating component.

If it is desired to use a shunt feed system in several different stages of a receiver, the choke and condenser can be permanently connected to the speaker and set, and one side of the speaker plugged into the different stages at will. Fig. 1 illustrates a mode of connection which can be applied to any amplifier.

In this case, the join between the choke and conden-

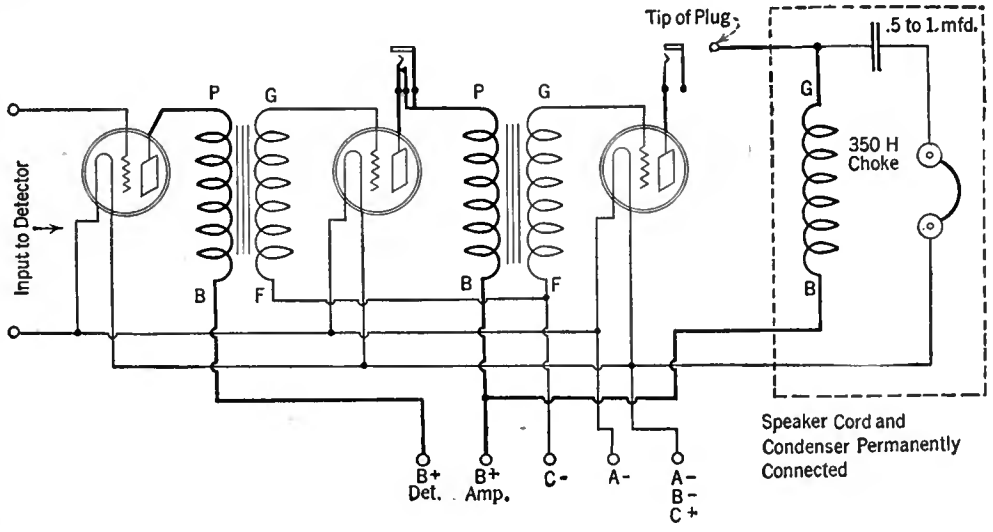


FIG. 1

The circuit of a transformer-coupled audio amplifier showing how the output coil and condenser constitute a separate unit which insures correct functioning of the loud speaker

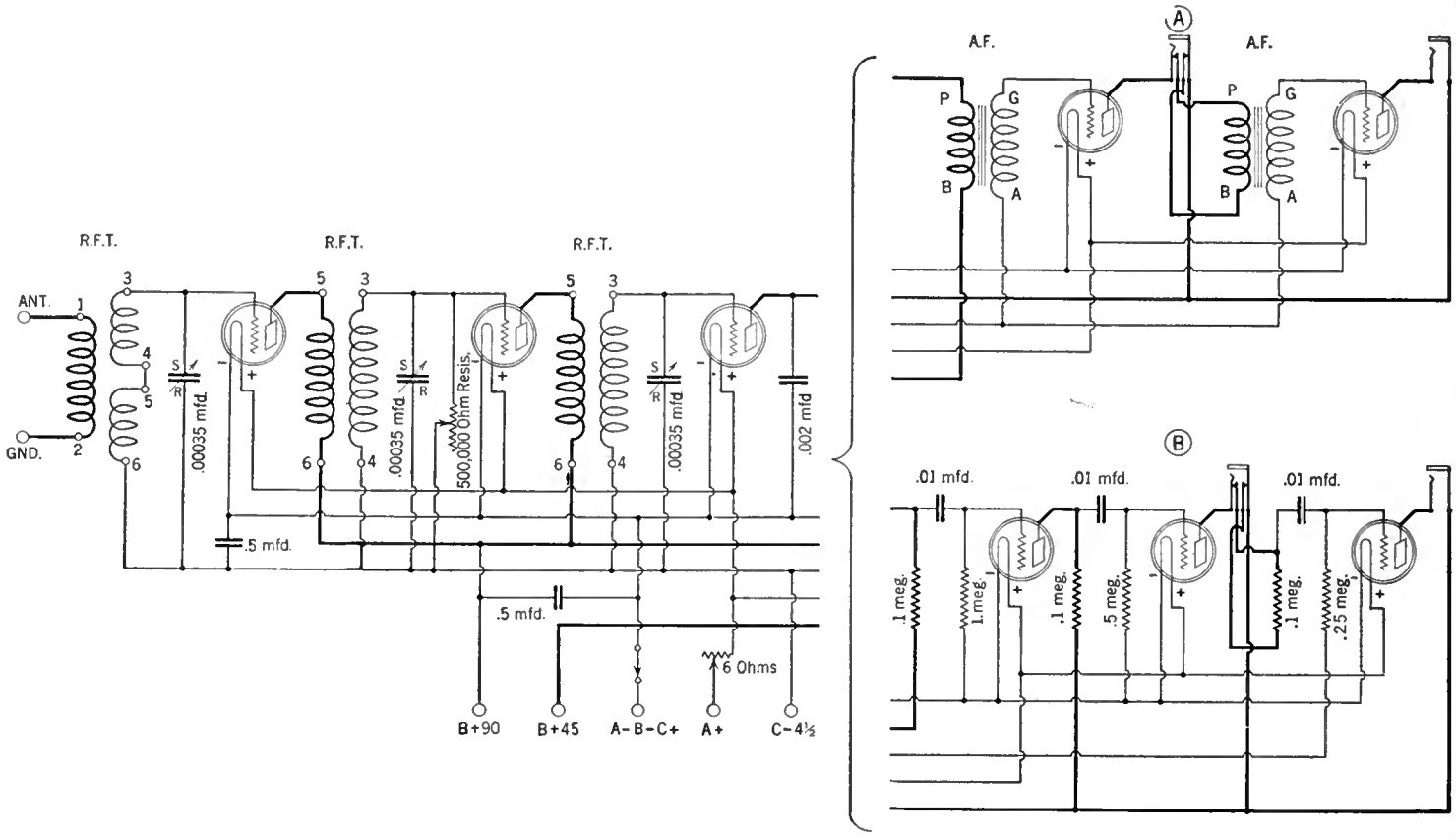


FIG. 2

That part of the circuit to the left is the tuner section of the receiver described by Mr. Silver in November RADIO BROADCAST. To the right is shown two types of audio amplification, the lower is resistance coupling while that above is the regular transformer audio amplification described last month. This circuit shows how one may be substituted for the other

ser connects to the tip of a phone plug only, the sleeve being left free. The arrangement will be found quite helpful.

RESISTANCE COUPLING

WHILE resistance coupling has been popular for quite some time, this is the first season where indications point to a general appreciation of the merits of this system by the listening public. Unquestionably, resistance-coupled audio amplification will give as fine quality of reproduction as it is possible to obtain, and contrary to general opinion, it is not extremely wasteful, either from the power consumption standpoint, or the quantity of apparatus necessary to render this system the equal of a good transformer amplifier so far as voltage gain per system goes.

A three-stage resistance-coupled amplifier made up of standard parts, operated on 135 volts, using proper tubes, will give about the same amplification that may be obtained with two transformer stages operated on 90 volts. The actual B battery consumption figured over a period of time is no greater than that of the transformer amplifier, though it is true that the initial battery cost is higher by 50 per cent.

Mr. Silver's six-tube receiver with a resistance amplifier is at its best, for the quality of reproduction is truly splendid.

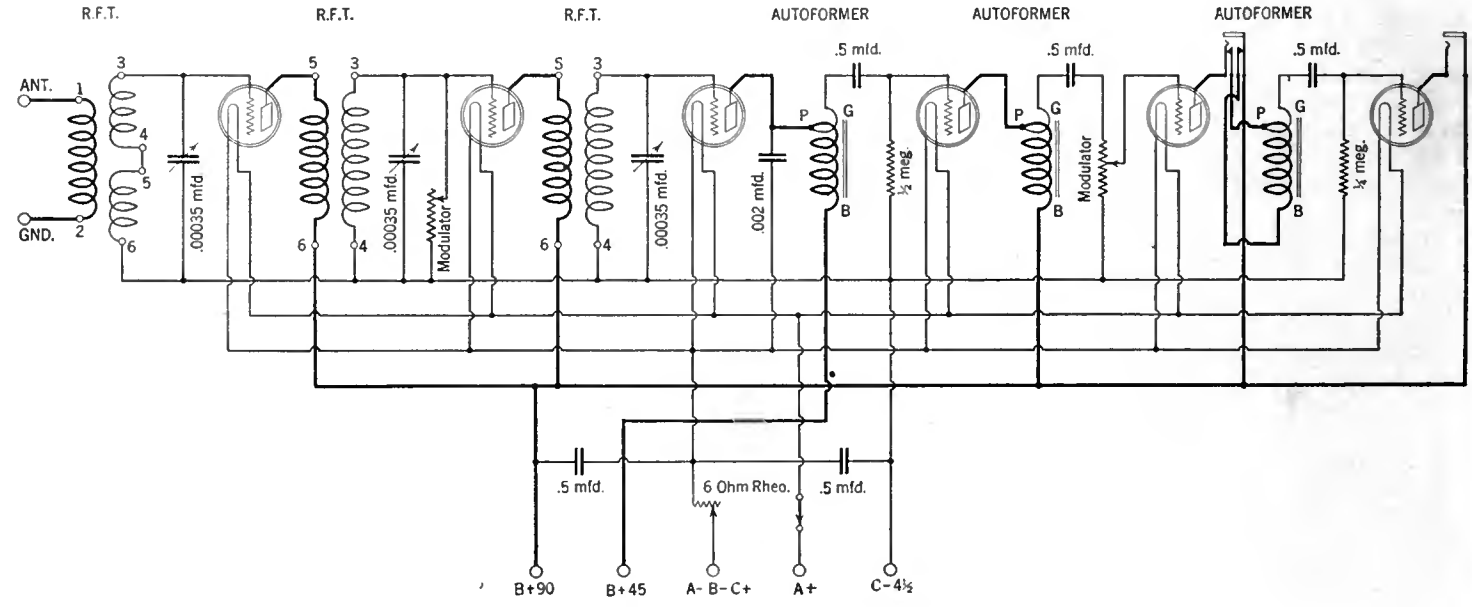
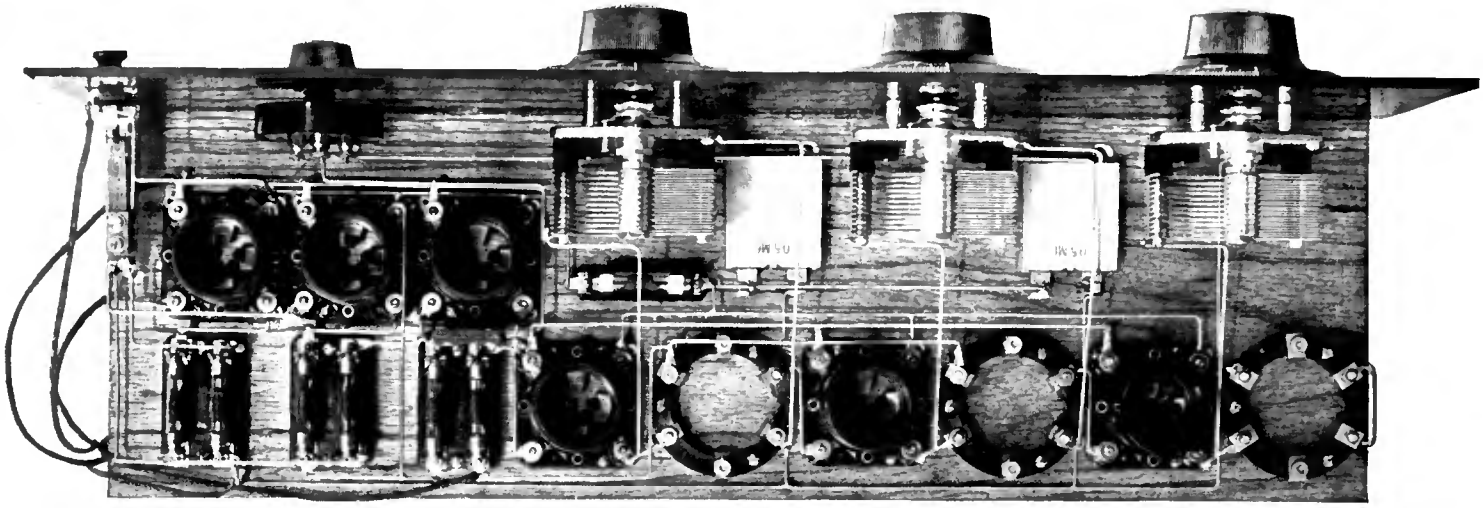


FIG. 3

A complete circuit diagram of the receiver employing impedance-coupled audio amplification. The various features described in the text, such as modulation control on the r. f. secondary and impedance amplifier coil, are brought out here prominently



RADIO BROADCAST Photograph

FIG. 4

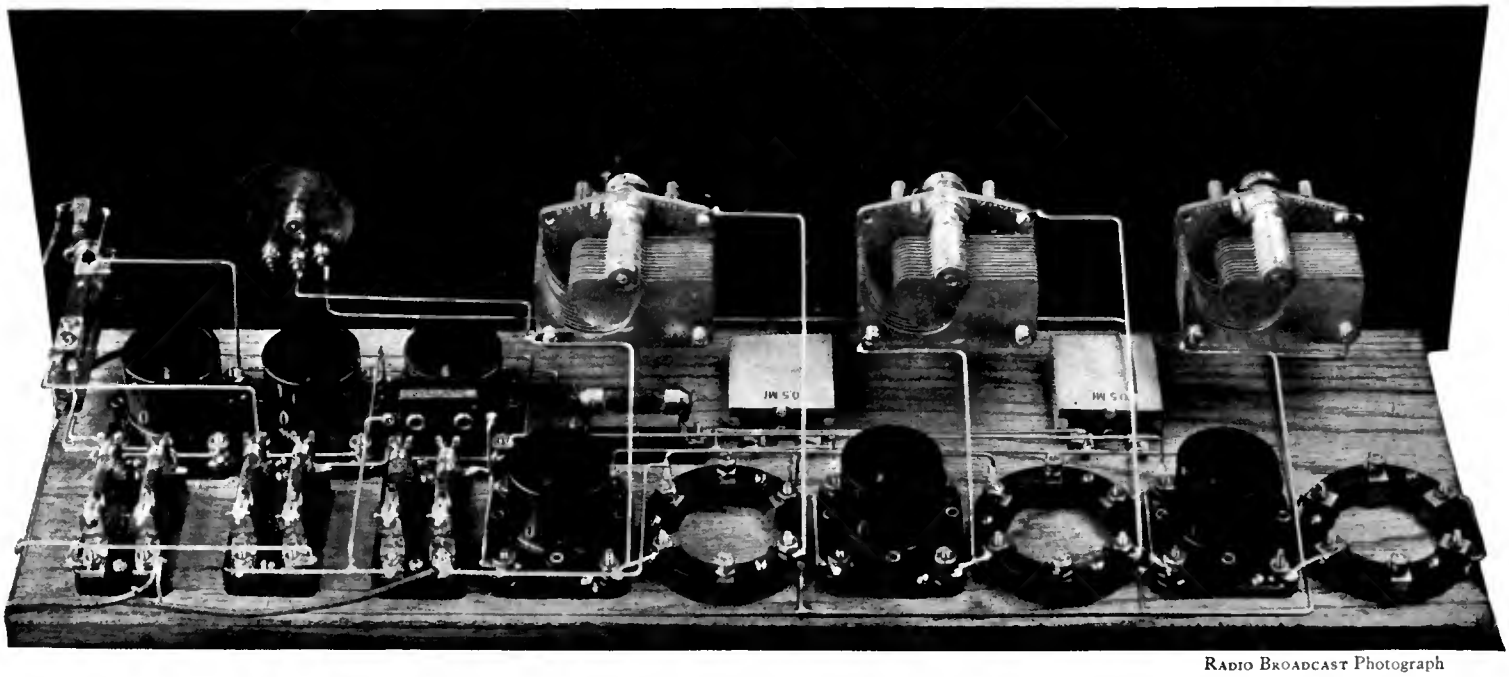
A view of a model showing the disposition of the resistance coupling units. In all three types, the audio amplifier occupies the same location

and the ease of tuning is surprising considering the extreme sensitivity and selectivity of the set. However, in incorporating this type of audio amplifier, there are a few cautions to be observed.

The detector of the set operates with a negative grid potential of $4\frac{1}{2}$ volts, which is substantially correct in order to obtain satisfactory rectification using a plate potential of 45 volts. This assumes that in series with the B battery is a transformer primary winding of only one to two thousand ohms resistance—so low as to have hardly any effect upon the actual plate potential. However, with resistance coupling, a resistance of about 100,000 ohms will be in this plate circuit. If the detector plate voltage is increased to 90, rectification will still occur in an efficient manner with a $4\frac{1}{2}$-volt negative grid potential. Since the resistance amplifier requires 135 volts, two B battery positive leads will come out of the set—one 90 volts plus, for the r.f. amplifiers and detector, and one, 135 volts plus for the three a. f. amplifiers. Due to the low actual operating potential of the first two resistance amplifiers because of the high resistances in their plate circuits, no C battery will be required for these two tubes, their grid leaks terminating directly in the negative filament line. The last audio stage has only the loud speaker resistance in its plate circuit—a matter of several thousand ohms, and so should have its grid biased for 135 volts. With a UV-201A this bias would be about 9 volts, although $4\frac{1}{2}$ will be satisfactory as a basis for test observation.

Coupling units are available made by Muter, Daven, Brach, Dubilier, Polymet, and others, which provide clip mountings for grid leak, plate resistor and coupling condenser—thus but one unit is required to a stage. With UV-201A tubes, the coupling resistances should be 100,000 ohms, the first grid leak one megohm, the second one half and last one quarter. In no case should the coupling condensers be below .01 mfd., or distortion will be evident, and all the advantages of the system will be lost. Going to the opposite extreme will provide better quality, up to the point where the time constant—the discharge period of the condenser and resistance combination—becomes so low as to interfere with reproduction and cause blocking of the amplifier—.5 mfd. is a satisfactory maximum capacity, though for convenience and general practicability, the writer prefers .01 mfd. at least.

A circuit and layout drawing showing the substitution of three resistance-coupled stages for the transformer-coupled audio amplifiers accompanies this article. See Fig. 2. It might be well to mention the matter of sockets. Those are combination UX or UV sockets—that is, either a UV-201A or a UX-201A tube may be used in them, or for



RADIO BROADCAST Photograph

FIG. 5

Another view of the resistance-coupled receiver. The wiring of such a set is very easy as can be attested by close observation of the above

that matter, any other type of UX tube. With the UV bases, the tube pins are inserted in holes in the socket, with the bayonet pin over a corresponding mark on the socket. With other makes of UX sockets, UV-201A tubes may not be used—that is, UX or UV tubes may not be interchanged at will, except in a few cases. Therefore, the builder, if he uses UX sockets, should be sure that his tubes are UX bases.

IMPEDANCE AMPLIFICATION

DURING the war, "choke" or impedance amplification was quite popular, and was used in various airplane, ground and ship low powered telephone transmitter stations where quality of reproduction was important. The first practical chokes available are the Thordarson autoformers. which are inductances of 350 henrys, tapped so that there is a voltage step-up of 1:1½. These chokes satisfy the impedance requirements of a distortionless amplifier very nicely, and will give greater amplification per stage than a resistance-coupled amplifier but not quite as much as a transformer amplifier. They require but 90 volts for their operation, in this respect being similar to transformers.

A three-stage choke amplifier added to a receiver described by Mr. Silver in the November issue is shown in the circuit diagram, Fig. 3. While .5- mfd. coupling condensers are shown, those of .01- mfd. will probably be more practical, due to the tendency of the amplifier to block with higher capacities, for reasons previously given. One interesting feature of this amplifier is the use of the modulator to control its volume. Instead of the conventional shunt resistance which is not entirely satisfactory for audio volume control, the modulator consists of a 500,000-ohm resistance across the output circuit of the second stage. The grid of the tube into which this circuit normally feeds is then tapped in at any desired point on the resistance, thus giving a smooth even volume control from zero to the maximum available. The modulator may be used on an amplifier, of any type, and is to be recommended as a volume control instead of the conventional jack arrangement. It also serves, in this instance, as a grid leak.

POWER TUBES

THE use of UX-112 tubes in both stages of a transformer amplifier will improve quality considerably, since, in the case of the Thordarson 3½:1 transformers, at 50 cycles, the tube impedance is about one-third that of the transformer primary. However, it is doubtful if any increase in volume will result from the use of UX-112 tubes instead of UV-201A's. Other than improved quality, increased handling power will be obtained. This means that with a very strong signal, the UX-112 will function only without distortion, whereas a UV-201A would probably overload and distort. This is true, provided the proper C battery voltage is used.

UX-112 tubes should really be used with 135 volts plate potential, and about 9 volts negative grid bias. They will function moderately well at 90 volts plate potential with the conventional bias, however.

For resistance amplification, Daven and Cleartron make high-Mu tubes which are ideal for interstage use, and both make a power tube which is excellent for use in the last audio stage. The use of these tubes cannot be too highly recommended, as they will do much to bring resistance amplification into its own, for the improved volume resulting from the use of two high-Mu and one output tube is surprising when compared with the output of three standard tubes.

If Daven tubes are used, no rheostat will be required for them. Thus, the rheostat or ballast resistor if used would be connected in the filament circuits of the first three tubes, while the last three, being Daven tubes designed for 6 volts, would connect directly across the battery.

UX-199 tubes may be used throughout the set if it is intended to operate it on dry cells. If this is done, the UX-120 should be used for the output stage, or entirely in the audio amplifier if transformer coupling is used.

OPERATION

IT APPEARS that in preliminary operation, builders have experienced some difficulty in getting distance until they were familiar with this receiver's operating peculiarities. It might therefore be well to go over the mode of operation again.

Assuming locals to be received properly, the antenna coupling coil should gradually be turned out until the desired degree of selectivity on the first, or left, dial is obtained. This setting will react on the volume control, and may be found by tuning-in a high frequency (short wave) station, setting the volume control so that the arrow points straight to the right, and gradually loosening the antenna coupling until the set breaks into oscillation. This is a proper operating position for the antenna rotor, where it may be left permanently set. If the volume control is then turned counter-clockwise, the set will stop oscillating and it may be tuned as one would a neutrodyne—that is, all three dials will be set about alike for a given station.

If maximum sensitivity is desired, the volume knob should be turned clockwise until, with all three dials set in resonance, i. e., in a position where a station would come in, the set breaks into oscillation. Then, if one dial is moved, it will click out of oscillation, but if both dials are moved after the first a corresponding amount, oscillation will start again.

In this fashion the three dials may be moved up the entire scale in hunting for a station in steps of one or two degrees at a time. Using this method, a station will come in as a squeal. To tune-in properly, the first and third dials should be set right on the squeal—that is, so moving either one in either direction will cause the pitch to increase. Then, with the middle dial set dead on the squeal, the volume knob should be retarded until the squeal stops and the signal is audible.

No squeals will be heard if tubes or batteries are not good, or if too long an antenna is used. In some cases it may be necessary to add two or three turns to windings 5-6 of the radio frequency transformers. They were described in the November, 1925, RADIO BROADCAST.

In case too short an antenna is used, it may have to be connected to point 4-5 of the antenna coil socket, with the ground to the minus filament line. If one stage of r. f. amplification is to be cut out, the antenna connects to No. 5 of the middle socket, with the ground to the filament, and the antenna coil removed.

To use a loop, the antenna coil is removed and the loop connected to points 3 and 6 of the coil socket.

SINGLE OR DUAL CONTROL

SINGLE control will not be found entirely satisfactory in this receiver, but dual control will work quite nicely. This is because of the extreme selectivity of the outfit, which renders each circuit so sharp that minor variations which cannot be overcome cause trouble. The second and third controls may be connected so that they will work together if only one knob is turned by tying a piece of heavy braided fishline around the pulleys on the two condenser shafts. The ends of the line should meet in a light coil spring which can be gotten from a hardware store, and which serves to take up any play. It also allows either dial to be turned independently by loosening up whenever pressure is applied to either dial separately. With this arrangement, only the first and second dials need be manipulated for tuning, and operating the set becomes a real pleasure.

The Listeners' Point of View

Conducted by ..... John Wallace

The Design of Receiving Sets

THE one phase of the radio industry which, as far as we have observed, has received no adulation in the public prints, and which, we are convinced, is the one and only phase of the whole phenomenon that is worthy of unstinted praise is the astounding excellence of design of receiving sets.

Almost every new invention has spent its infant years decked in the most ugly of habiliments. It has been the good fortune of radio to be swaddled from the start in a manner to make Velasquez' Infantas look dowdy.

The early talking machines were ungainly looking eye-sores, with great oversize cranks, and hideously decorated and uncouthly proportioned horns.

The first automobiles were a laugh. They strove valiantly to keep up the appearance of their horse drawn predecessors, and succeeded only in being a silly travesty on the same.

The history of automobile design in America, if we may digress, has been an interesting one, and a supreme testimonial to the Great American God, Standardization. After its shamming days were over and the automobile had decided to "be itself," there was a constant and rapid improvement in its appearance. This improvement continued until a very few years ago, when disaster suddenly overtook it.

In their endless struggle to go their competitors one better, the manufacturers called in Professional Designers to supervise their coach work. Now, designers worthy of the name simply do not exist in America. The fact that the United States was the only great nation of the world that found herself unable to participate in the Industrial Arts exhibit lately held in Paris, would seem to support this contention.

What the Professional Designer did to the automobile body can be only too quickly perceived by a casual glance toward the nearest boulevard. Past us they ooze—a flock of elegant black seals—as diversified in appearance as the well known peas in the pod—sleek and elegant, but with no vestige of individuality.

The error into which they have fallen is one of over-refinement. All accessories are concealed in one svelt ensemble. Refinement is desirable but, gosh, not so much of it! Structural lines may be emphasized or subordinated, but they cannot be annihilated if the result is to be design in good taste. The Packard's design seems to have been the goal of the imitators. Cadillac held out nobly, but it, in its last edition, succumbed and now is as characterless as the rest of them. The old game of "What make of car is that?" has ceased to be a game and reduces itself into a guessing contest. Certainly the automobile was more fortunate when its body was designed by one of the plant engineers in his off hours.

In fact probably the best, and certainly the most American, design in this land at the present day is the work of the engineer. The engineer goes directly and efficiently to his goal, makes his designs to suit his purposes, and having attained them, adds no superflous and meaningless adornments, nor attempts to cover up what he has done with sham work. So his products are inevitably beautiful—beautiful in their simplicity and in their adaptation to their purpose.

Certain radical French artists, notably the late, unlamented Dadaists, have been so obsessed by the beauty of mechanics that they have smeared vast quantities of canvas with their interpretations of turbines, and girders, and egg beaters, and what nots. A pretty tribute indeed; if hardly a justifiable procedure in a supposedly creative art.

It is improbable that the radio engineer when he set about devising a container for his half bushel of parts, had in mind the making of a definite and important contribution to industrial art. He simply went ahead and made the most practical and efficient case he knew how.

But, whatever his intentions were, he succeeded in creating a "thing of beauty." We know of few merchandise displays out of which we get a more definite and legitimate aesthetic kick than a window full of first class radio receiving sets.

DR. S. PARKES CADMAN

Pastor of the Central Congregational Church, Brooklyn, New York. Doctor Cadman's afternoon talks before the Bedford Branch Y. M. C. A. Brooklyn, every Sunday at 3:45 P. M., are broadcast by WEAF, WEEI, WTAG, WCAE, and WSAI. In addition to his very large following, gained by the sheer force of his preaching in his own church, his broadcasting activities in the past few years have made him one of the most popular preachers ever to appear before the microphone

All are housed in simple wooden cabinets of pleasing proportion. And their panels are enough to make any one with any sensitivity to design whoop with joy. The regular arrangement of gleaming dials, with here and there smaller circles artlessly placed, is an application of one of the fundamental principles of good design—the repetition with variation of geometric forms.

Now please don't reduce this eulogy to absurdity by suggesting that if that's the way we feel about it, we forthwith whitewash our Rembrandt and cover its gilt framed canvas with assorted radio dials neatly glued on. It's the fact that the dials have a *raison d'être* on the radio panel that makes them beautiful. The same set of dials applied to the front door would be meaningless and ugly.

Some of the cone type loud speakers are as pleasing in form as a Greek vase (as to the goose neck horns, we'll never admit them to be other than unsightly). And an outside loop never ceases to delight us with its concentric, diamond-shaped wiring.

The innards of our set we likewise find intriguing (though we confess here and now we don't quite know what they are all about). Anyway we like the way those wires run around in neat little parallel lines, dodging tubes, and coils, and miscellaneous gadgets.

More power to the engineer! Would that his kind made up the membership of our lamentable "Civic Art Commissions."

But, alas and alack! even as we write, the so-called Designer is getting in his dirty work in the field of radio, and we are more and more frequently being pasted in the eye by receiving sets masquerading as Chinese pagodas, lamps, canary cages, electric heaters, fish bowls, and Louis XVI medicine chests.

What Sort of Fellow Should the Announcer Be?

SEATED in the theater awaiting the rise of the curtain on what was declared by all the critics to be the best show in town, we were presently brought to our feet by the arrival of a portly gentleman accompanied by his multitudinous family. We hitched in a reluctant patella and they squeezed through to their seats. Following them, the usher's hand, laden with programs, brushed by our nose. These were distributed to everybody down to little Willie, and all immediately buried their noses in them. At once a buzz of indignation began.

"I don't think much of the picture on the cover," growled Pa.

"There aren't any beauty hints or fire rules," whined Gerty.

"Shucks, where are the jokes?" wailed Willie.

"The program is rotten," said Pa with finality, "Let us depart!"

We hitched in a willing patella and they filed out, doubtless to seek some theater which presented a program of more attractive format and content.

* * * *

But what we started out to say before we got side-tracked on the above fable was: Why the importance attached to radio announcers? Why are their photographs continually staring us in the face in the public prints? Why have their names become household words?

Announcers are—or should be—simply substitutes for the printed program. How they part their hair or what they thought of the last selection is of no concern to us. We will not lament with little Willie if they offer no jokes.

The announcer *par excellence*, in our opinion, is the one who is only slightly more human than an automaton; who conveys the desired information in the minimum of words and intrudes no more of his personality than would a column of 8-point Caslon.

And, while we're on the subject, do they say "This is *radio station* XYZ" to keep us from falling into the error of suspecting it to be Post Hole Factory XYZ, Cumulus Cloud XYZ, or Choir of Angels XYZ?

From Ten P. M. to Two A. M.

IF EVER the disciples of Mercury crave substantiation of their suspicion that this is a nation eighty per cent. moron, they have only to plug in on the air any time between 10 P. M. and 2 A. M. Shades of Euterpes! What manner of cacophony greets the ear? You, little boy in the back row? Correct!

Now this department hereby declares it has no quarrel with jazz as such. But what does make it stand up on its hind feet and yowl desolately is the insufferable punkness of present jazz.

Popular music always was and always will be, and we contemplate no diatribe against it. In fact, to give it due credit, it should be remembered that the serious music of the present owes considerably more to the popular music of the past times than, say, to the classic polyphony of the church.

But the rhythmic caterwauling that is spewed forth by a hundred-odd (very) dance orchestras every night can only by courtesy be called popular music. "Popular" no doubt; but "music" . . . no!

If memory serves us right, we used to have a rather respectable brand of dance music in this country five or ten years ago. The tango brought with it no end of delightful pieces of melodic interest and colorful Spanish trimming. But melody and color have been consigned to the puppies. The only goal of present terpsichorean thrumming seems to be the maintenance of a rhythm. And this a hundred banjos do every night, with dogged and monotonous persistance. The result may be satisfactory for dancing but is far from delectable to the listener-in who is not, at the moment, imitating a kernel of corn in a popper.

Imagine, if you can, the music lover of a couple hundred years hence, collecting the "quaint old fox trot melodies of the twentieth century" as we do the charming old gigues, sarabandes, minuets, and polkas.

The trouble with modern jazz is not that it is jazz, but that it is poor jazz. Our high-hat friend who comes out flat-footed with the statement that he cannot bear popular music in any shape or form can, nine times out of ten, be labeled a four-flusher. Of course there is that rare tenth person who really understands music, and, understanding it, realizes that popular music is a very hollow echo of the real thing. But even an epicure occasionally enjoys a fried egg.

The line of demarcation between popular and serious music is not as exactly defined as some would have us suspect. At last reports the savants had not yet voted a unanimous ballot as to which rank claims M. Igor Stravinski. But, even as jazz can approach perilously near to being music, so it can likewise move a long way from it. Jazz, as is, has retreated to the limit. The tom-tomery of the aboriginal head hunter must have been less obnoxious than that which delights the present day sheik, if for no other reason than that the savage had fewer instruments—and no saxophones—with which to perpetrate it.

Popular music has been defined as differing from the serious by a diminution of the intellectual content. If the entire intellectual content of the see-lections that pollute the air from 10 P. M. to 2 A. M. were stood on end it would about equal the intellectual content of the third act of *Abie's Irish Rose*—or, if you must have your statistics stated graphically, it would be slightly higher than the grasshopper's instep.

In the aforementioned epic of the American stage, not an event transpires which can not be anticipated twenty minutes in advance by any normal fourth-grader. So in our modern dance music, the unexpected never happens. One piece is the Siamese sister of the other. The tunes are the same; the orchestration is the same; the banality is the same. You, gentle reader, could sit down at the piano now and write something better, and—so could the jazz composers!

But if the dance music that clutters up the long suffering ether from 10 P. M. to 2 A. M. is about as entertaining as a game of three handed bridge played with isinglass cards, what can be said of the songs that adorn those sad four hours? They are all cut from a pattern: either riotously "peppy" or lugubriously sad. Of the two, we most abhor the latter. "I want some bah-ha-dy. . . ." we hear a sacharine barytone imploring from XYZ at a speed of $2\frac{1}{2}$ miles per hour. And from ZXY, a tearful and flat soprano wails: "Like a rose-uh, I'm all, alone-uh!" And

QUIN A. RYAN

Director of WGN, Chicago. He reported the Big Ten football games. Mr. Ryan's sports reporting is exceptionally graphic and manifests a very complete and thorough preparation of material. He also reported the Kentucky Derby, Indianapolis Auto Races, and World Series. Inclined to rhapsodize poetically—but the stuff *is* poetical!

GRAHAM MACNAMEE

of WEAF, who, with Phillips Carlin, reported several important games played in the East. Among them were the Chicago-Pennsylvania, Yale-Army, and Cornell-Penn games. The cup Mr. MacNamee is gazing at is a popularity trophy awarded him some moons ago. Inclined to improvise comically—but the stuff *is* comical

we are all but overcome by a wild urge to call up their respective stations and arrange for a get-together. Continuing with our statistics: if all the sickly, sentimental ballads broadcast of an evening were placed end to end they would reach from Athol, Mass., to the Pacific Ocean. That statistical end attained, we would place ourself at the eastern end of said column and push.

"But," it is protested, "that is what the pee-pul want, and what the pee-pul want they should have!"

With both these propositions we take exception. In the first place, we are not convinced that such a large number of individuals as is imagined want this juvenile sort of musical substitute. There exist a goodly number of persons who are satisfied with this tasteless diet because they have known no other, but who, nevertheless, are capable of gustating something at least a little more meaty.

Take some ignorant looking yokel in the lowest ranks of the army of listeners-in. Suppose it is discovered that he has assembled his own receiving set. Then, say we, if he has brains enough to know what is inside that mysterious box that brings him in his radio entertainment, he, by that sign, has brains enough to appreciate to some extent the content of music. IF he gets a chance. If, for instance, we were to ask him: "The song of what small bird, frequently found in clocks, furnishes the motif of *Japanese Sandman, Carolina in the Morning* and Berlin's *Pack Up Your Sins?*" we will wager he could discover the answer, and in so doing he would have, after a fashion, discovered some of their "content." But it is to the second proposition—"what the pee-pul want they should have"—we take the most violent exception. Let them, say we, go without it!

A cursory glance at this mortal coil discloses it to be populated by two principal classes of beings: the common pee-pul, and those existing to serve the common pee-pul.

"Pity the poor masses!" we hear constantly reiterated. Pity, rather, the poor "classes," we shout. They are the ones who are getting the rotten deal in this age of the proletariat.

Everywhere the low-brow turns, he finds someone waiting to serve and entertain him, to supply at a moments' notice his slightest want. While the poor high-brow searches about taking his scant pleasures where he may. What's more, the high-brow's entertainment comes high (unless it be communion with books) and more often than not he has less money than his slanty-domed, ditch-excavating neighbor.

With half the world catering to the masses' whims, we often wonder why existence does not become a surfeit and a bore to said masses. If *Fuzzy Wuzzy Baby* played on a tomato can is the *summum bonum* in music to them, imagine how constantly they are surrounded by art! Imagine a world in which every open cafe door emmited strains of Brahms and DeBussy, and passers-by whistled airs by Palestrina (are they whistleable?). A world in which every billboard bristled with El Grecos and Titians, and every vaudeville skit displayed the artistry of a Strindberg or a Synge!

Well now that we've quite completely disposed of the issue—whether the public should get what it supposedly wants, let's get back to the subject, which, if we remember, was jazz.

A little jazz is relished by the best of men (now and then) but there's no relish in the variety on the present market. Even the redoubtable Paul Whiteman is dishing out the same monotonous

THE RADIO PLAYERS AT KGO

A presentation of William Archer's "The Green Goddess" before the microphone of KGO, at Oakland. This is the way the radio villain loses his life—under protest (his own)

stuff as the rest of them, the while riding on a reputation created by mob hysteria and which he has long ceased to deserve.

In conclusion: give us jazz, Oh Mister Popular Music Composer! We can stand our share of punishment. But, frevvens sakes, give us a better brand of it. We will trade seventeen *Yes, Sir, That's My Baby's* for one *Allah's Holiday* . . . or what have you?

Broadcasting Funeral Services

AS ONE of the outstanding examples of bad taste in broadcasting that has come to our attention during the past month, we submit the broadcasting by a Mid-Western station of funeral services for one of its departed minstrels.

Certainly the man was a most excellent entertainer and his death was regretted by those who had come to know him through the air. But we question whether their grief was so sincere as to justify their being, not merely invited, but forced, to attend his obsequies. And of course thousands of listeners-in had never even heard of him before. It is a doubtful mark of respect to the deceased to intrude his funeral eulogy into what may be a dancing party, a convivial dinner, or a poker session.

Assuming that the whole nation was genuinely "bowed in grief" over the death of some great statesman or outstanding leader, a radio funeral service might be not only appropriate but almost imperative. In the instance cited the service was given an importance out of all proportion to the importance of the deceased.

Broadcast Miscellany

DOUBTLESS ere this appears in print the results of KOA's aërial battle, "Jazz vs. Classical Music" will have been published. And the statistical lore of radio will have been enriched by an impressive array of figures tabulating the judgment of the populace as to which was the winner.

But as to the possibility of this musical debate having lured the army of jazz lovers over to the enemy camp, or vice-versa, we are inclined to believe that the prophetic utterances here appended will have been realized:

—AND MAKES NIGHT HIDEOUS—

Jazz and classical music are to fight it out in the air. KOA will stage the battle in Denver on November 6. The ringside is the continent—or where you will. Seats are free. The betting is heavy on both sides.

The ethereal, soul-stirring sonata will spar with the sole-tickling slide of the trombone. The thunder of the Mountain King's Ball will roar defiance at the comic saxophone simulating a psychic jackass extemporizing during the vernal equinox. The graceful minuet pirouetting on the gossamer of imagination must hurl the lance at the primitive pom pom moving to fleshly ecstasy the "fat black bucks in a wine-barrel room." The flute, capturing bird notes still fresh with the dew of morning, must fence with the piccolo harmonizing feline infelicities at 2 A. M. Faust, meditating divinely on Margarita's dwelling, must come to vocal blows with a "gent" in rainbow linen and checkerboard socks snapping out "Yes, Sir, That's My Baby."

Beethoven, Bach, Handel, Gounod and all the other masters who are doing their harmonizing among the celestials will descend as an awful nightmare upon the living hip-wigglers and will utterly demolish Polasek's "Spirit of Music." The boys in the pool-room will say "That was some jazz." The girls in the School of Music will buy tickets for the Spring Festival. That's how the world of music will be changed.

News—Index
Evanston (Illinois)

LET the calamity howlers take note: radio has added several things to the credit side of its somewhat unbalanced ledger since last writing.

First and foremost on its list of achievements we place the broadcasting of the autumn's football games. Here is radio at its best—performing a unique service that no other existing agency can do. Music we can get, after a fashion, on records; speeches can well wait perusal in the morning paper; but a football game to be properly enjoyed has to be lived through. Certainly the broadcasters made us feel as though we were right down on the sideline bench with the water boys and the coach's relations.

A close second on the list is the epochal undertaking of WEAF—the weekly broadcasting of first rate artists. And *paid* artists at that! Not pluggers for Whoozis Garters or Whatzis Shaving Cream.

Mr. A. Atwater Kent is the sponsor of this concert series, which has been broadcast by WEAF, and connected stations, Sunday nights since October 4. The list of singers and musicians who have already been heard and those yet to come reads like a roster of Who's Who in Musical America.

Other isolated instances of genuine musicians performing via radio could be mentioned. Station KGO's Tito Schipa concert, and KFI's program by Mme. Schumann-Heink come to mind.

And all these events presage a brighter future for radio programs. A small beginning, perhaps. An hour of music is a small drop in the bucket of several hundred hours of mediocrity. But vastly important because it is a beginning.

FORD AND GLENN

Ford Rush and Glenn Howell; which is which we don't know. As entertaining a pair of comedians as have ever been heard by radio. They were recently broadcast by WFAA, Dallas, to whom they were loaned by WLS. They are versatile humorists appealing to domes of all dimensions

A Universal Short Wave Transmitter

How to Build a Five-Watt Transmitter of Extraordinary Range and Steadiness which Can Be Used with Receiving B Batteries as a Source of Plate Supply—The Cost is Not More Than Fifty Dollars

By NICHOLAS HAGEMANN

Station 2 KP, Mitchel Field, Long Island

ANY one who has listened to signals on the very high frequencies, on the so-called amateur 40 meter-band, for example, will know that strange things occur there. In the first place, signals do not stay put, but they wobble around, fading in and out, changing in frequency and strength. It is one of the discouraging things about high frequency transmission—but on the other hand it is one of the joys, for one never knows what is going to happen next. The next signal may be from China or Indiana, no one knows. And no one can tell whether the station will sign before he fades out.

Once in a great while a station can be heard that in a steady, unvarying pure note pounds away, perhaps not very loud, but unceasingly. Among the medley of notes that fill the 7-megacycle (7000-kc.) band, notes of all sorts, some coarse and raw, practically all of them varying, a clean steady note is like a beam from a lighthouse on a thick night. It gives the receiving operator confidence, for he knows that the signal will not leave him in the middle of a message.

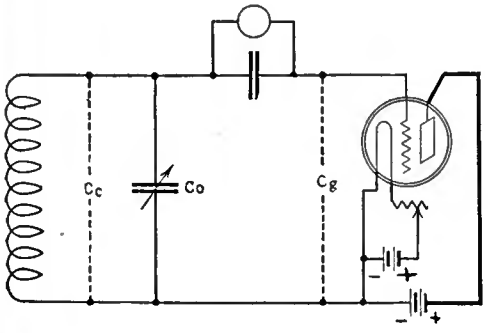


FIG. 1

A conventional input circuit to a vacuum tube wavemeter. The frequency to which such a circuit will tune depends upon the inductance and three capacities as indicated. The resultant frequency is a function of $L \times (C_o + C_g + C_c)$

There are several reasons why signals of this sort vary. One reason is fading; no one yet knows how to conquer that natural phenomenon. Another is a swinging antenna, sometimes fifty feet from the ground, at other times nearer or farther from earth. This swinging changes the antenna capacity and naturally changes the emitted frequency. Another reason lies in a transmitter whose filament or plate supply is not steady. With every change in the conditions under which the tube is operating, the frequency emitted changes.

A transmitter whose frequency is independent of filament or plate voltages is a great boon, and if attached to it is an antenna that is rigidly fixed, unvarying signals will be emitted that will attract any receiving operator's attention at once, especially if it is battery operated so that a pure steady d. c. note is emitted.

The transmitter described in this article has several noteworthy features that should appeal to any constructor of amateur equipment, whether he already possesses a transmitting station or whether he is about to enter this fascinating field.

The great advantage of the present circuit lies in its stability with regard to the frequencies it turns out to an antenna or other load. A little of the history behind its development will reveal its possibilities in this direction.

In connection with other precision radio instruments developed by the Signal Corps for the various branches of the United States Army, a need arose for a frequency meter whose calibration would be independent of many factors, notably tube capacity, differences in plate and filament voltages, etc. In other words, the Army needed a heterodyne frequency meter that could be calibrated with one tube and at certain filament and plate voltages with the certainty that this calibration would not differ materially when other tubes or voltages were used.

Fig. 1 shows the usual tuned circuit that is used in a vacuum tube frequency meter (wavemeter). The apparatus consists of a coil and a condenser, which is usually variable, the tube, and a grid milliammeter. There are three capacities as shown in this Figure, all of which must be accounted for in the tuning. The coil capacity Cc is small, of the order of a few micro-microfarads, the condenser capacity Co is usually quite large, and the tube capacity Cg is of the order of several micro-microfarads. Naturally a change in any of these capacities affects the frequency to which the circuit will tune.

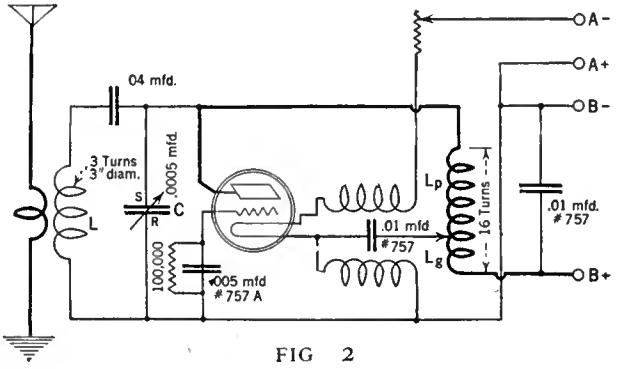


FIG 2

The circuit diagram of this new transmitter. It is distinct in that the inductance in the tuned circuit is very small and the capacity is very large. For this reason small variations in grid-filament capacity will have little effect upon the resultant frequency. The key is inserted in the B battery negative lead

The task of developing a new type of frequenty meter was undertaken at the Signal Corps Radio Laboratories, Fort Monmouth, New Jersey. The circuit described in this article is based upon the results of the work there. This meter was remarkably stable as regards frequency, due chiefly to the fact that the small grid-filament capacity of the tubes used was bridged across a very large capacity so that variations in the small capacity had little effect upon the total capacity in the circuit.

The circuit performed so creditably as a frequency meter, and it was found that such high voltages and currents existed

THIS article will primarily interest those who already have a short wave receiver and are anxious to build a good transmitter for the high frequencies. This set has the great advantage that the note produced is unwavering and very steady. It should appeal strongly to the amateur experimenter located in the country, where it is difficult to get a dependable source of current supply. The set described here is entirely operated from batteries, an unusual design in short wave transmitters. For those who are interested, a short description of the short wave receiver at present in use at our station 2 GY is shown. We expect to describe a good short wave receiver in an early number. The author has used the term megacycle in referring to transmission frequencies because it simplifies terminology. A megacycle is one thousand kilocycles. It is customary to refer to the frequency of broadcasting and short wave stations in kilocycles, but in short wave work, where the frequency is often of the order of 10,000 kilocycles, the term megacycle is more satisfactory. A government license is, of course, necessary before this transmitter can be used.—THE EDITOR.

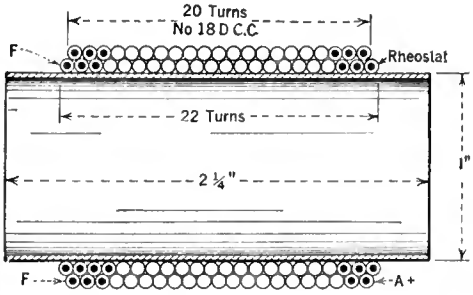


FIG. 4

Details of the filament choke coils. There is no trick whatever about the construction. Both coils are on this tube, one to be inserted in each filament lead

in the tuned circuit, that its value as a transmitting circuit soon became evident. It was then designed to operate at 3748–2998 kc. (80–100 meters), on low power. At these frequencies, a change of 150–400 volts on the plate of the tube produced no greater change in frequency than 800 cycles and corresponding differences in grid-filament capacity and filament voltage produced very little difference in the frequency of the tuned circuit.

AN EXCELLENT TRANSMITTER CIRCUIT

ANY one who has listened on the high frequency amateur bands 3.5, 7, and 10 megacycles, (3500–10,000 kc., 80–30 meters) will appreciate this advantage. With a d. c. plate supply, say from B batteries, a pure unvarying note will arrive at a receiving station and where is the amateur who would not pass by a dozen powerful but fluttering notes for one that is steady though not so powerful?

As actually designed for transmitting service, the coil in Fig. 2 is a single loop of heavy wire and, with a five-watt tube, currents as high as eight or more amperes were obtained in the loop. As designed here for amateur use, the coil L consists of a few turns of heavy wire coupled to an antenna-counterpoise system. With medium power, large currents are induced in the antenna, the actual value of course depending upon the relation between the fundamental frequency of the antenna and the actual frequency used for transmission, as well as upon other factors.

As constructed by the writer, a consistent day range of 800 miles was obtained in the so-called 40-meter band with a UX-210 tube with 350 B battery-volts supplied on the plate. The currents and voltages in the loop circuit are so high that higher powers require great care, and at the present time, the writer is not prepared to give dimensions of the parts to be used if more than 50 watts input to the tube are employed.

The constants of the various condensers are shown on the diagram of connections in Fig. 2 and the general layout of such a transmitter may be seen from the photographs accompanying this article. The tuning condenser must have wide spacing between plates and have a large capacity, since the inductances used in the set are quite small. The larger this condenser C, the smaller will be the detuning effect of varying tube capacities. The by-pass condensers and .04 mfd. stopping condenser in the L-C circuit must be able to stand

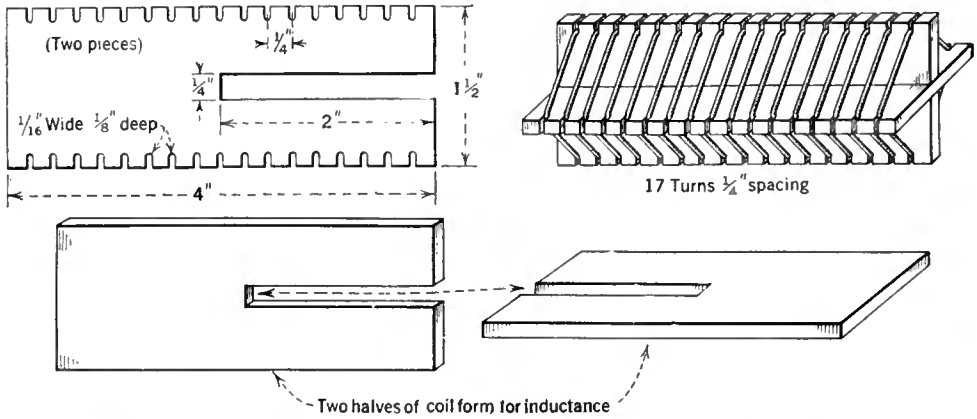


FIG. 5

Details of the Lg-Lp coil and its construction. This is somewhat different from the usual transmitter inductance. A good view of it is shown in Fig. 3 and in Fig. 6

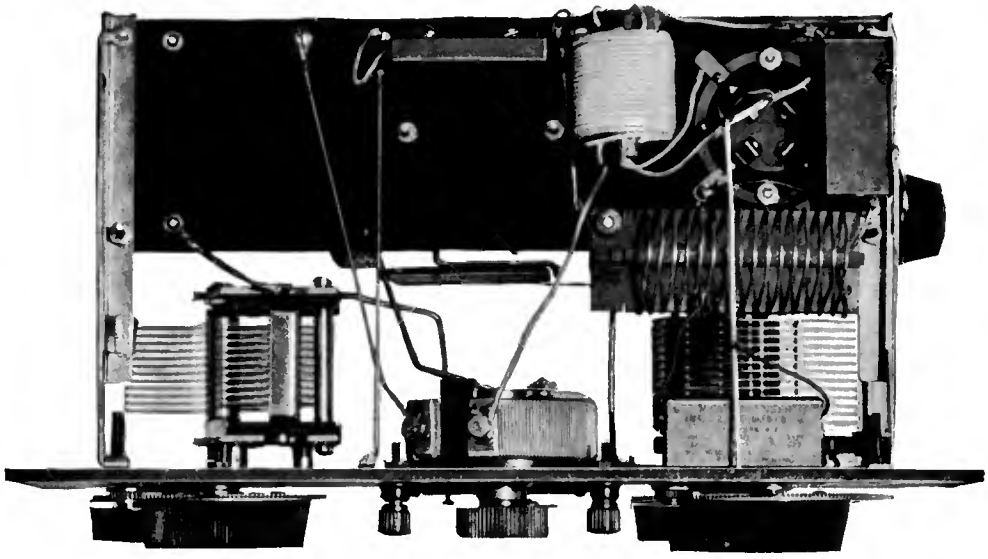
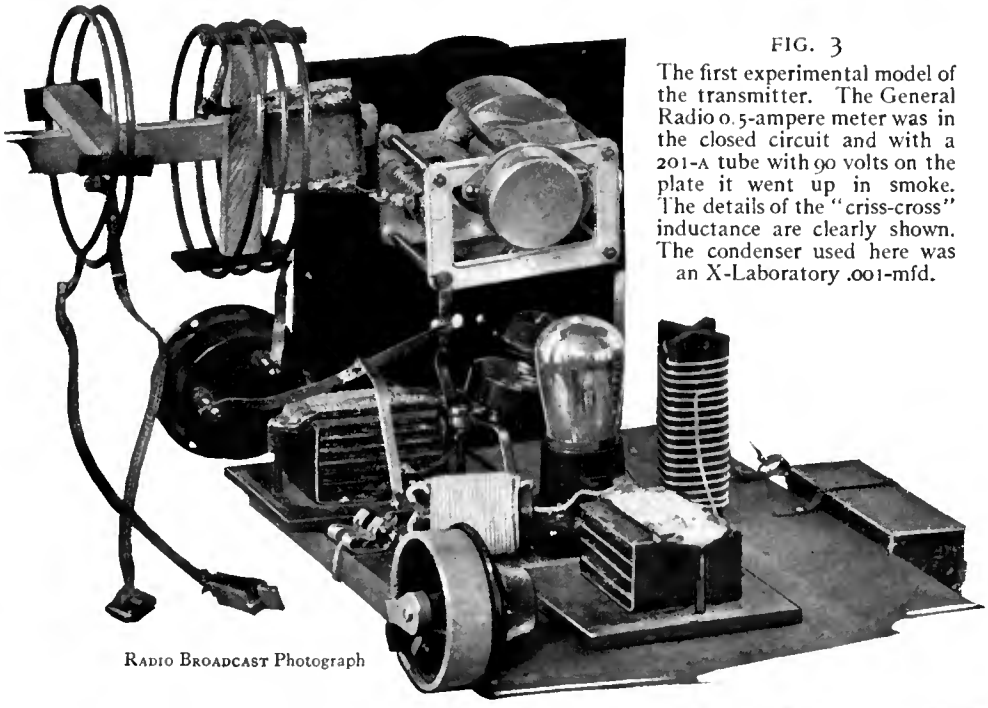


FIG. 6 RADIO BROADCAST Photograph

A view of the transmitter from below the sub-panel showing the disposition of the choke coil and the criss-cross inductance. The short, direct, and heavy leads for the radio frequency paths are clearly shown. The variable condensers shown are a General Radio 247 .00044-mfd. and DXL .0005-mfd.



RADIO BROADCAST Photograph

FIG. 3

The first experimental model of the transmitter. The General Radio 0.5-ampere meter was in the closed circuit and with a 201-A tube with 90 volts on the plate it went up in smoke. The details of the "criss-cross" inductance are clearly shown. The condenser used here was an X-Laboratory .001-mfd.

at least 1000 volts, and for this reason transmitting condensers, are suggested. In the writer's opinion it always pays to buy good by-pass condensers since the life of tubes frequently depends upon them. Mica condensers of the correct capacity may be found in many automobile spark coils.

Coil L consists of three turns of No. 10 bare copper wire wound on the cardboard case of a dry cell and then allowed to expand until the diameter of the coil is about $3\frac{1}{2}$ inches. The antenna coupling coil is a single turn of the same wire and about $2\frac{1}{2}$ inches in diameter.

The filament choke coil is wound in two layers on a bakelite or hard rubber tube 1 x $2\frac{1}{4}$ inches. The bottom layer has 22 turns, the top 20 and any size of wire may be used, although No. 18 d. c. c. is about the best from the standpoint of resistance. One layer is wound on over the other as shown in Fig. 4 and the connections to the tube as illustrated in the figure should be short.

The other inductance, Lg—Lp, is constructed of two hard rubber cross pieces as shown in Fig. 5 and in the set illustrated about 17 turns are correct for the 7-megacycle (40 meter) band. Varying the tap along this coil controls the plate current taken by the tube and with a given antenna current, this plate current should naturally be as small as possible. The tap with a UX-210 tube should lie about six turns from the plate end. The actual construction of such a transmitter is remarkably simple. There are few pitfalls to avoid, the chief one being long, poorly made connections and condensers that will not stand the voltage.

Radio Broadcast Photograph

FIG. 7

The panel view of the completed transmitter

After the instruments are wired up, a receiving tube should be placed in the socket and about 90 volts used on the plate. Then the transmitter should be brought near a receiver that will tune to the frequencies to be covered by the transmitter and the latter tuned. It will be found that, with the constants used in the diagram in Fig. 2, that the entire 7-megacycle band can be covered with the tuning condenser C at from 80 to 100 degrees. This is purposely done so that the condenser will be used at its maximum value. If desired, a fixed air condenser may be made with a small two- or three-plate variable placed across it. Then the frequency band may be covered with more degrees of dial rotation.

The variable condenser, C, should be turned to maximum and the lowest frequency found by tuning the receiver to it, and then the condenser capacity decreased until the tube stops oscillating or until the condenser approaches its minimum capacity. The transmitter illustrated in Fig. 3 oscillated perfectly until 10 megacycles (10,000 kc., 30 meters), was reached. It is probable that a given set could be made to cover two of the amateur bands, either the 15- to 7-megacycle (15,000 to 7000 kc.,

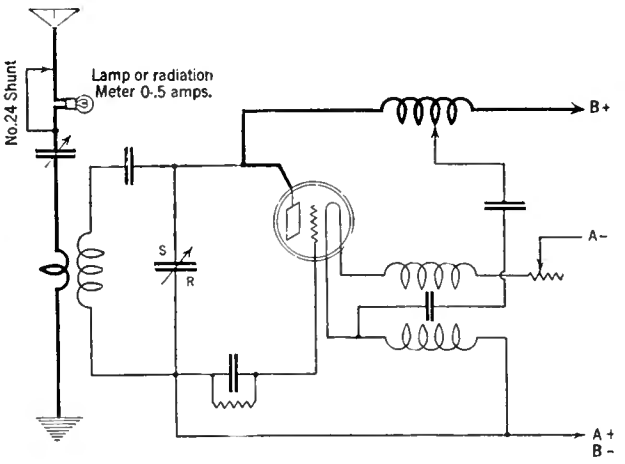
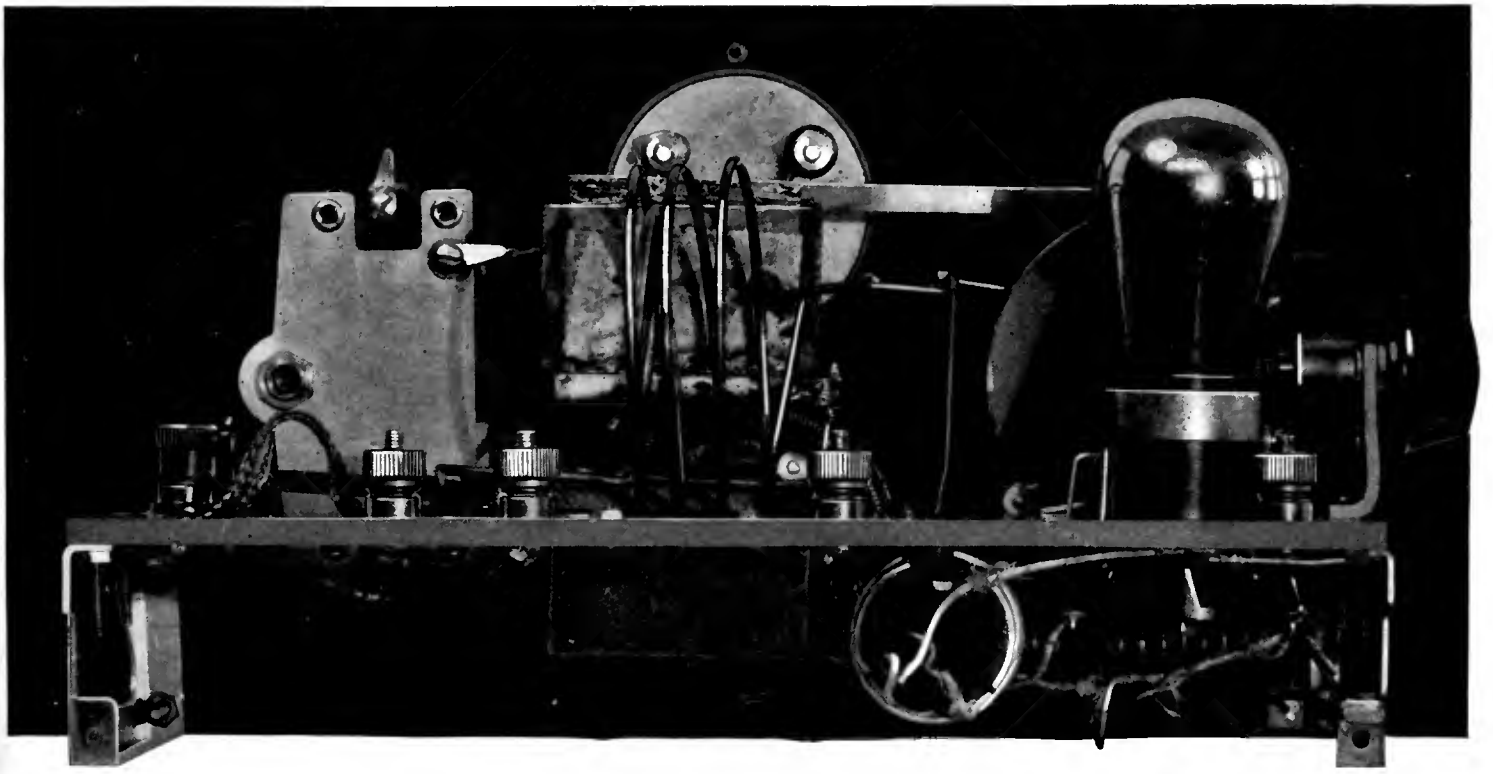


FIG. 8

A method of indicating when the transmitter is in resonance with the antenna-counterpoise system. The length of the shunt varies with the current passing into the antenna and with the amount of current that the indication device will stand without burning up. About one foot may be used and one point of connection made variable so that more or less antenna is included



Radio Broadcast Photograph

FIG. 9

Looking behind the panel of the transmitter, the three turn coil L and the single turn of antenna coupling inductance are very much in evidence

The Facts About This Transmitter

FREQUENCY RANGE: 6.5 to 8.5 megacycles
WAVELENGTH: 35 to 40 meters
ANTENNA: Single Wire, 35 feet long
COUNTERPOISE: Single Wire, 35 feet long, as near to the ground as possible
SOURCE OF PLATE CURRENT SUPPLY: Receiving B Batteries
Rectified a.c.
Motor generator

TUBES WHICH MAY BE USED

	A VOLTAGE	B VOLTAGE	SENDING RANGE (MILES)
UV-201A or similar independently made tube	6	200	50
UX-112	6	200	100
UX-210	7.5	400	800

If B batteries are used, so-called "heavy duty" cells should be purchased. This transmitter when properly operated, will have a current drain of about 35 milliamperes, which is about equivalent to the demand made by an 8-tube super-heterodyne. Owing to the fact that, in the transmitter, the keying of the circuit interposes an intermittent drain on the B batteries, the drain on them is not nearly as heavy as would ordinarily be supposed.

LIST OF PARTS USED IN CONSTRUCTING THIS TRANSMITTER

One panel, 7 inches by 14 inches by $\frac{3}{16}$	1.25
One General Radio condenser .0005-mfd. without gears (or other good receiving condenser)	3.25
Two General Radio dials with verniers	5.00
One Centralab 100,000-ohm variable resistance (Bradleyohm or Royalty B may be used)	2.00
Two Benjamin brackets,	.70
One .00025-mfd. variable condenser (any reliable make)	3.00
One socket for UX tubes	.65
Two Dubilier .01-mfd. condensers type 577	5.50
One Dubilier .005-mfd. condenser type 577	2.25
One General Radio or Weston radiation meter	8.00
One General Radio rheostat (or similar which will handle up to $2\frac{1}{2}$ amps	2.25
Eight heavy duty binding posts	.56
One sub base $3\frac{1}{2}$ inches by $11\frac{1}{2}$ inches	.75
Two hard rubber cross pieces	
One bakelite choke coil tube 1 inch by $2\frac{1}{4}$ inches	
One Dubilier .04-mfd., 1000-volt stopping condenser.	2.75
One plate milliammeter, range 0–100 (Weston or Jewell)	8.00
One UX tube	2.50-6.50
Total not over	$50.00

20–40 meters), or the 7- to 3.5- megacycle (7000–3500 kc., 40–90 meters) band.

After the maximum frequency range has been determined, the constructor can calibrate the condenser in megacycles, kilocycles, or wavelengths as desired.

THE ANTENNA

PROBABLY the simplest antenna to be used with this transmitter is a single wire 15 to 25 per cent. lower in fundamental frequency than the actual frequency to be emitted. A series condenser is then used to bring the frequency to the desired value. For example, on the 40-meter band, a single wire 12 meters (37 feet) long and a similar counterpoise will have a fundamental wavelength of about 50 meters which can easily be reduced to 40. The antenna current will be lower under these conditions than if the antenna were being excited at its fundamental frequency, but since the radiation resistance is higher above the fundamental frequency, greater efficiency is obtained.

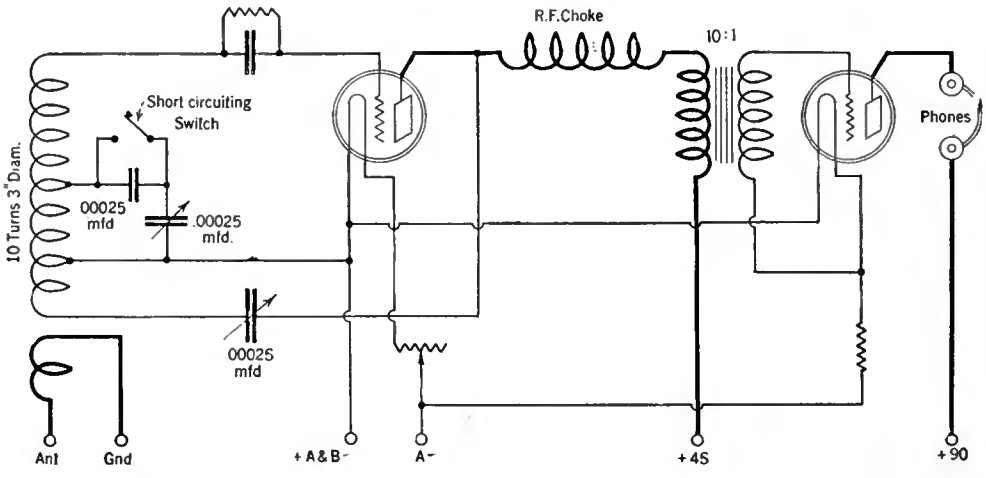
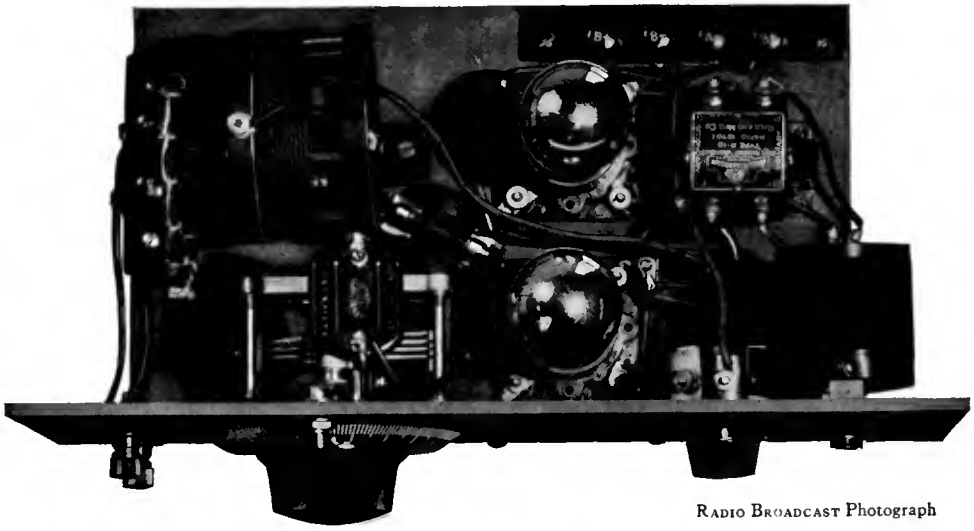


FIG. 11

The connections for the receiver. Interchangeable coils enable this receiver to cover all of the amateur bands



RADIO BROADCAST Photograph

FIG. 10

A photograph of a receiver now in use at 2 GY which employs the circuit familiar to all amateurs, known as the capacity feed-back. The condenser is a five-plate Bremer-Tully and the interchangeable coils are wound on Bruno forms. The transformer is an All-American, ratio 10: 1

Ribbon antenna wire will lower the ohmic resistance and if the wire is twisted, motion caused by the wind will have little effect on the frequency transmitted. Good copper ribbon may be obtained from an old Ford spark coil primary. It is highly important that the antenna be thoroughly insulated, preferably with Pyrex and that it be taut.

In the photographs illustrating this transmitter, a General Radio half-ampere radiation meter is shown. This will handle the output of a 201-A, a UX-112 or even a UX-210 type tube, unless a very small antenna or greater plate voltages are used. Then a copper wire should be shunted across the meter so that it will not be burned out.

In actually tuning the transmitter to the antenna, the antenna series condenser

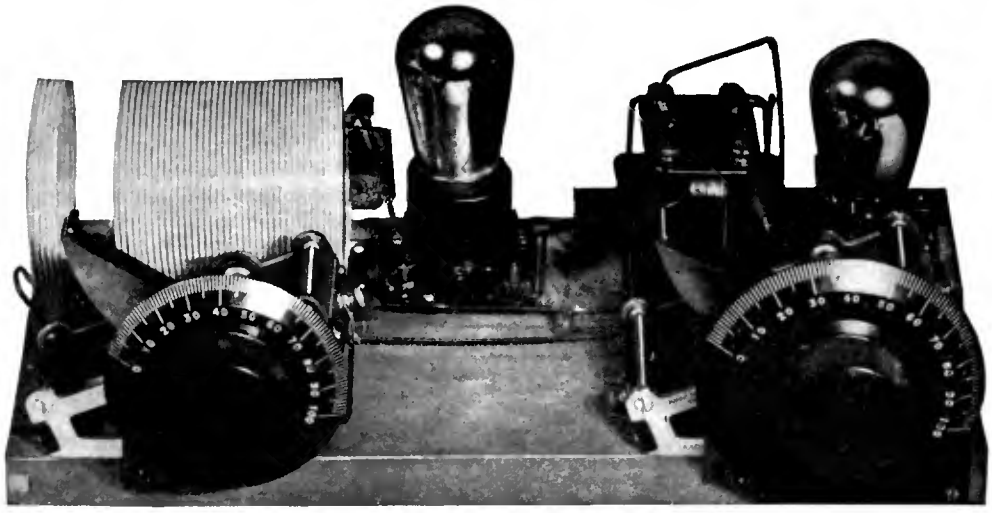
and the tuning condenser C should be varied until the greatest radiation on the desired frequency is secured. At this point, the plate current should be adjusted by varying the tap on the Lg–Lp coil until it is smallest, consistent with good radiation.

If the constructor desires only one meter, and only one is really necessary, he may use a plate milliammeter with a range of 0–100 and a flash light bulb. The milliammeter is placed in the negative B battery lead, and the flash light is placed in the antenna-ground lead. When maximum current flows in the antenna, the lamp will be brightest. Here, again, care must be taken not to burn out the indicating device. A 6-volt lamp or smaller with a shunt wire may be used for this purpose. Fig. 8 shows the proper position of the indicating device.

After the constructor is thoroughly familiar with the operation of the transmitter, greater power may be applied to the receiving tube, or a power tube can be employed. It must be understood, however, that the voltages in the tuned circuit are very high and that as soon as heavy currents begin to flow, both condensers must be able to stand up. If the mica condenser passes more than five amperes it will probably get hot and then trouble begins. The remedy is to use more condensers in a series parallel arrangement—but before that time, enough distant stations should be worked to satisfy any one.

In the writer's station 2 KP at Mitchel Field, Garden City, Long Island, and at 2 GY, located in the Radio Broadcast-Eveready experimental station, no difficulty at all has been had in maintaining schedules with stations 800 or more miles away. On several occasions, a 201-A tube has been used, and with 180 volts of standard receiving B batteries on such a tube, successful transmission of several messages to Philadelphia, 100 miles away, has been accomplished. This represents a power input of less than one-half watt! At the Mitchel Field station, a standard input of 19 watts has been used on a five-watt tube and all districts in the United States have been worked.

The transmitter illustrated in this article is now operating at 2 GY, and the operators there would appreciate reports on signal reception.



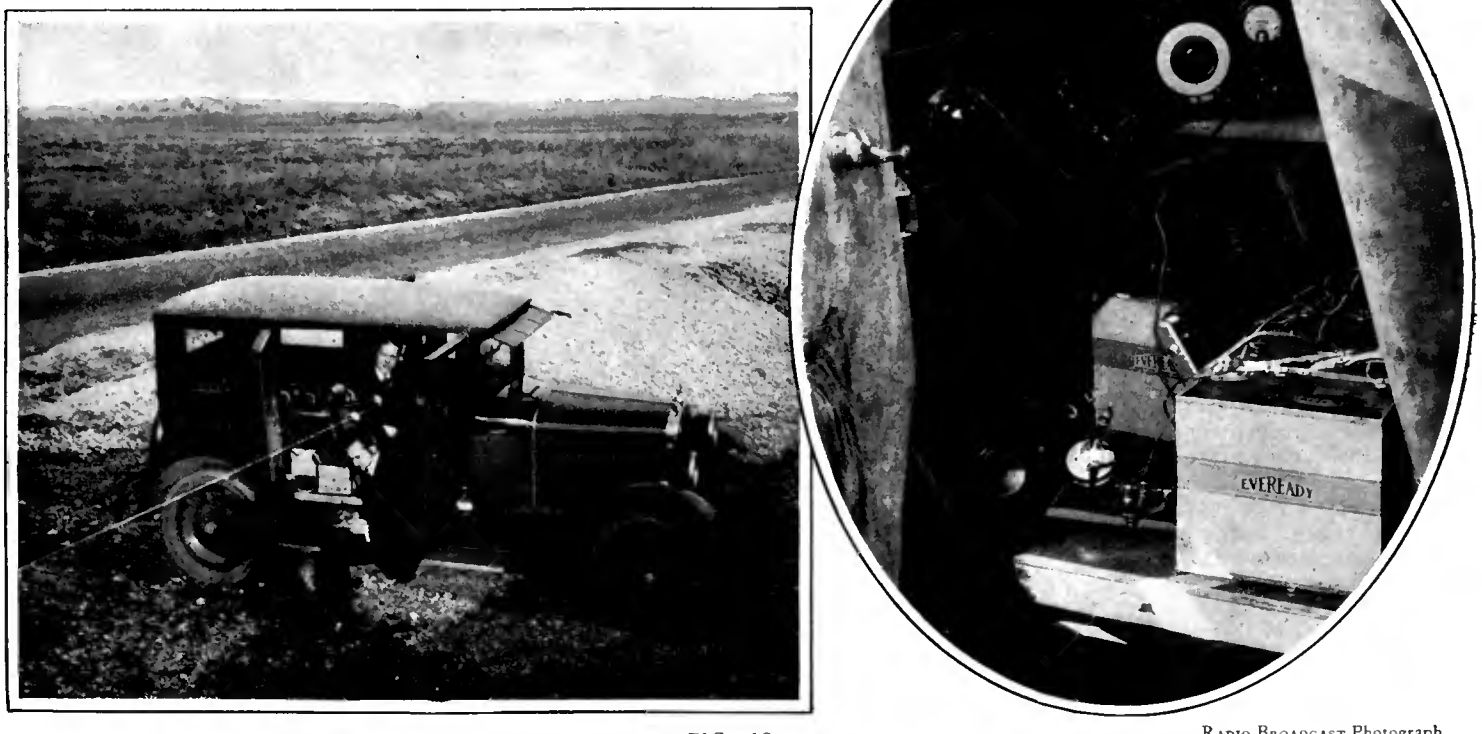
RADIO BROADCAST Photograph

FIG. 12

A short wave receiver used at 2 GY on the so-called 80-meter band. Karas orthometric condensers are used for both feed-back control and for tuning. The coils shown are made by Hammarlund Manufacturing Company. Other coils may be quickly inserted in the circuit so that higher or lower frequencies may be received

THE RECEIVER

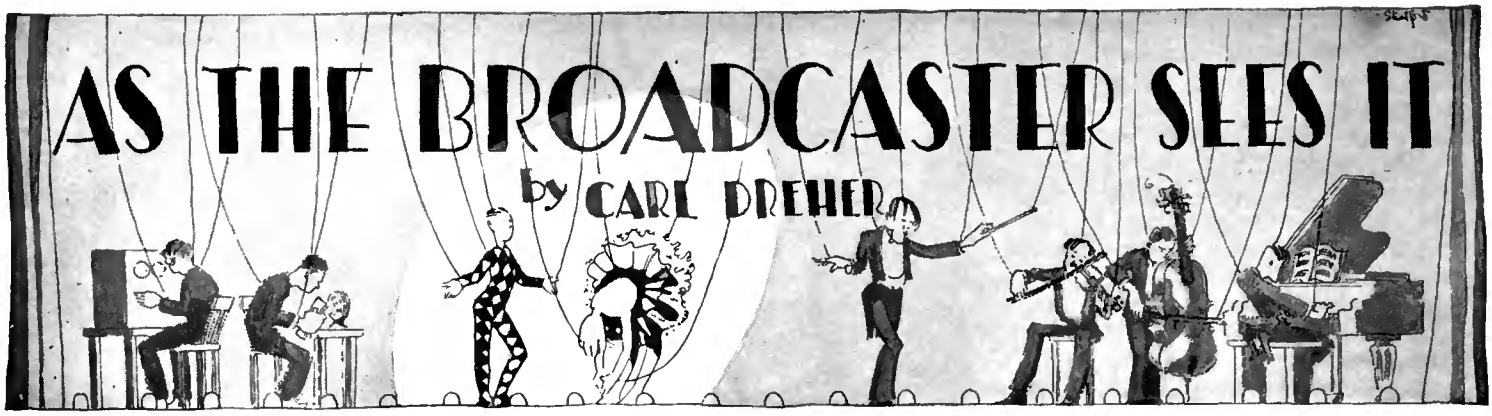
THE receivers used at 2 KP and at 2 GY are very simple and are fashioned according to the well known amateur capacity-feedback circuit shown in Fig. 11 and illustrated in Figs. 10, and 12. Complete description of such a receiver will be included in the Radio Broadcast-Eveready short wave experiments series of articles. The photographs and circuit diagram show enough detail so that the home constructor should have little difficulty in actually constructing such a receiver. A fixed condenser is placed in series with the tuning condenser so as to spread out the stations over a greater number of degrees on the dial. This may be shorted when not wanted. The switch is shown in Fig. 12.



RADIO BROADCAST Photograph

FIG. 13

Twelve miles from the home station 2 GY. This transmitter with an input of about 6 watts on an antenna 7 feet above ground put strong signals into the receiver at 2 GY. The oval insert shows a close-up of the automobile installation, operated from B batteries



Drawings by Franklyn F. Stratford

Who Shall Judge the Quality of Our Broadcasting Stations?

AS THE years of broadcasting reach a dignified sum, and similarly the money expended on programs, the question, "Who shall be responsible for the musical quality of the station output?" is being raised at more than one station. That is, who shall say that there is not quite enough cello in this trio or that quartet, or that the woodwinds are a trifle too prominent in some symphony orchestra (as broadcast), or that the accompaniment to a vocal solo might be a little less prominent without injury to the pianist or his relatives. Shall it be the operators, who have been doing it heretofore? Or shall the job be handed over to professional musicians?

The opinion among the best informed and forward looking broadcasters seems to be that this responsibility should be loaded on to the shoulders of the musicians, rather than the operators, but with certain qualifications. Not to any old musicians, but to men trained in both music and broadcasting. And to these, with reservations as to the no man's land between the program side of an event and the technical aspects of transmission.

For example, when carbon microphones are used, there is always liability to blasting. This phenomenon is a technical matter. (See "Microphone Placing in Studios," September, 1925, RADIO BROADCAST.) The operators and engineers of broadcasting stations know more about it than the average musician does. Furthermore, they have instruments (d.c. milliammeters in the battery circuits of carbon transmitters), which afford an additional check, showing up both incipient and severe blasting. Some microphones are more susceptible to this difficulty than others. Clearly, therefore, this is a matter wherein the musical critics in the studio need the aid and counsel of the technical experts.

As a matter of logical expectation, skilled musicians should be better able to balance an orchestra to the utmost nicety, and to perform similar delicate musical tasks, than men who grew up with voltmeters and R. M. S. voltages and curves of tube characteristics. That is, as a class. There will be exceptions, of course. Some broadcast operators with exceptional musical taste or experience are capable of turning out a better job on the air than all but a few musicians. The ideal combination is a first-rate engineer who is also a first-rate musician, a sort of fusion of Charles P. Steinmetz and Jean De Reszke, for example. Try and get him. Having done that, try to make him work in a broadcasting station for $3000 a year. When we poor devils who, for our sins, have been set to running broadcast stations—when finally we have completed our penance, and the last milliampere has quivered through our nerves, then, operating the broadcasting stations of heaven, we shall have paragons like that working with us. Oh for those celestial studios and control rooms, where sopranos shall never shriek, where the "mikes" shall cease from blasting, and the grid milliammeter be at rest! But here on earth we must take men and materials as we find them, and there is no use looking for such engineer-musical genius combinations as those we have been dreaming about. Their very qualities are antipathetic.

"IF MISS AMERICA ARRIVED, HE WOULD NOT STOP LISTENING"

The basis for employing musicians in this phase of radio transmission is simply the old motto: Shoemaker, stick to thy last. But in citing that phrase—and I do so with approval and have thrown what influence I have toward the musicians in this friendly controversy—I want to add that I am proud of the part engineers and operators have played in the musical development of radio broadcasting. Lifted abruptly, most of them, out of the purely technological and non-artistic labors of radio telegraphy, they quickly adapted themselves to unfamiliar conditions, learned what was needed, developed new aptitudes, and turned out a good job in many cases, and a brilliant one in some. And a rotten job in other instances, it must be added, but to the custodians of the tin horn and dishpan stations I refuse to grant the name of radio operators and engineers. It was a fine example in adaptation. Radio men are not a stationary lot and they move fast when necessary. If they ever have to do it again, in some other connection, depend on it that you will not find them lacking. Those of us who live to see the complete development of radio motion pictures may view a similar incursion of radio men into the field of pictorial art. But inherently such in-

vasions are self-limiting in their nature. Invariably the investigators and research men improve the equipment to such an extent that the most artistic interpretations become possible, and the aid of men with an artistic background becomes essential for the best possible results And in broadcasting we are not going to be satisfied until we get to the point where a man listening to a loud speaker will not be able to tell for the life of him whether he is hearing the original performance or a reproduction. That point we may not be able to reach, but we shall certainly aim at nothing less. And anybody who can help us, whether he is a musician or a street-cleaner, is welcome.

The musician who undertakes work in broadcasting should realize, on his part, that he must add something to his technique, as the operators have added something to theirs. I have myself seen competent orchestra leaders and soloists —competent, that is to say, as leaders of orchestras or performers on special instruments—whom I would not trust on the musical end of a 10-watt station with an audience of two dozen. They were incapable of listening closely, in the first place. Have you ever seen a good broadcast technician listening to the output of some piece of equipment? He goes into a kind of trance. If Miss America came and pirouetted before him in a one-piece bathing suit, it is doubtful if he would pay any attention to her. Frequently he stops breathing. With such concentration one is likely to know what one is hearing, These musicians I am writing about did not go to all this trouble. They would listen for a few seconds, snatch the phones off their ears, rush over to the orchestra, and make some change. After touching the telephones to their ears once more, they found it necessary to alter something else. With the third trial, the orchestra—the men by now in active rebellion, was returned to the first position. This was now pronounced, "Excellent!" "Wonderful!" which it was not. After a few minutes the virtuoso realized this, although he was quite incapable of making the correct diagnosis. Once again he began making changes. By this time every man in the ensemble was ready to come to blows with him. In another minute the tension would have risen to that point, but at this juncture the operator took charge, moved the microphone a foot back in the right direction, getting rid of the violin blasting which was causing all the trouble, and ended the argument.

Why should some musicians, who are perfectly competent to read a score, give their individual interpretation, control an orchestra, and play a few instruments, be unable to listen to a loud speaker giving a fairly faithful reproduction and tell how it can be improved? I don't know, but presumably they overlook the differences between even the best reproduction and the original in the present state of the art, and, in an unfamiliar situation, they are unable to concentrate to the necessary degree. There are also temperamental obstacles. I am not one of those who look on all artists, writers, poets, and musicians as subjects for the psychopathic ward; I believe that as a class they do not go crazy much oftener than manufacturers of corrugated ashcans and cheese-paring machines, and that in any state they are more interesting to talk to. But I presume that the average musician is somewhat more nervous than the average engineer, because in his profession nervousness is not discouraged as much as in engineering. And there is not much room for nervousness in broadcasting. The business itself contains enough tension without any contributions from the participants. One needs sharp ears and a cool head.

It is to be hoped that no personal rancor will enter into any readjustments that must be made. It is merely a matter of doing the best possible job. There is room enough for everybody involved. If it were not for music and musicians there would be little use for radio broadcasting, and if it were not for broadcasting some musicians would be out of jobs. There is also dignity enough to clothe everyone, it is to be hoped. The operator's function can never be relegated to a place of unimportance. Some people seem to think that the term "operator" is applied only to persons of no great consequence or skill. This is a mistake. The term is a very broad one, applied to a variety of workers. Some are unskilled and others must be extremely intelligent and capable. It is not generally known that in medical literature the surgeon who performs an "operation" is referred to as the "operator." If a man who daily holds the lives of other men in his hands does not mind being called an "operator," surely there is nothing invidious about the expression. But why dwell on such trivialities? Radio men are more interested in radio.

Credit Where Due

MANY a time and oft I have felt called upon to comment sourly on the contents, make-up, and editing of the newspaper supplements devoted to radio, especially those in New York, which meet my dour eye most often. As a whole, they seem to me to foster superstition, sensationalism, and questionable information, to emphasize all that is transitory, childish, and unoriginal, and to neglect the substantial and scholarly elements in the art. There are, of course, some exceptions. Mr. Zeh Bouck's weekly column, "What Are the Air Waves Saying?" in the New York *Sun*, stands out in this group. But it is an oasis in the desert. Most of the sheets are dull, obvious, full of unchallenged press agents' concoctions, and perhaps dubious advertisements. Heaven knows I have a lot to learn about radio, but, with my right hand raised and my left laid solemnly on a copy of Zenneck, I declare that I have never learned anything from newspaper radio sections, with lamentably few exceptions.

"I SWEAR—WITH MY HAND ON A COPY OF ZENNECK"

It is with the more pleasure, therefore, that I would call attention, somewhat belatedly, to the New York *Times* Sunday Radio Section of September 13, 1925. It was a first class journalistic job. It was brought out during the week of the two big radio shows in New York, with, presumably, the same fundamental objects as those of other radio sections and supplements. But this one set about its task by filling the space not occupied by advertisements with useful information, authoritative articles, and good sense. Among the authors who contributed were Orrin E. Dunlap, Jr., A. Hoyt Taylor, E. F. W. Alexanderson, E. E. Free, J. A. Holman, David Sarnoff, Alfred N. Goldsmith, Kolin Hager, C. B. Popenoe, E. H Jewett, Lee De Forest, J. H. Dellinger, E. C. Mills, Martin P. Rice, H. P. Davis, W. H. Priess, David Grimes, J. D. Freed, and J. H. Morecroft. I spent several hours reading it, and they were profitably spent. I have never met the editor of the *Times* weekly radio section, nor does the paper subsidize me, but, having knocked radio newspaper supplements in general, I feel bound to congratulate that editor and that paper for their achievement

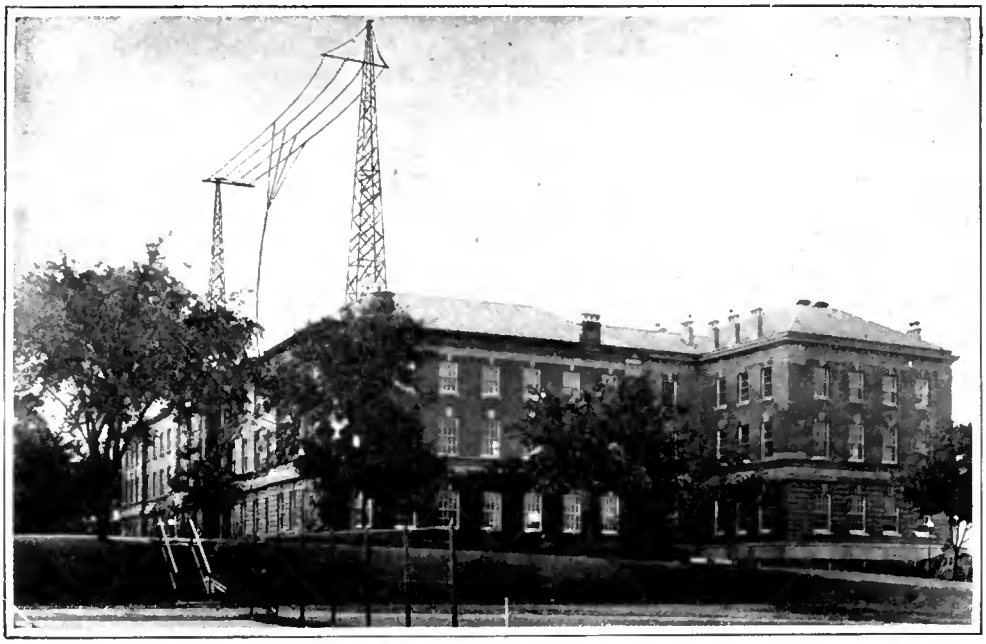
Among the Broadcasters

WHAZ

ACCORDING to all accounts and evidence on hand, WHAZ, the broadcasting station of the Rensselaer Polytechnic Institute at Troy, New York, has started its fourth year on the air without showing the effects of age. WHAZ, it will be remembered, is under the direction of Prof. W. J. Williams, who defended the low power side in the super-power debate which lately raged in these columns. Mr. Rutherford Hayner is program director and announcer.

Station WHAZ is housed in the Russell Sage Laboratory of the Institute, with the towers on the roof. The location overlooks the Hudson River at the head of tidewater navigation, 150 miles north of New York, and it appears to have electrical as well as scenic advantages, for the station has attained enviable ranges for a standard 500-watt installation. No doubt a part of this is also due to the operating personnel and management, which, in an engineering school, may be expected to turn out a top-notch technical job. As early as February, 1923, the station was heard in New Zealand, two-fifths of the way around the earth. It has also been picked up repeatedly in France, Belgium, Scotland, England, Alaska, Panama, South America, the Pacific Islands, the Far East, and of course all over the United States and points near by.

The R. P. I. station is on the air but once a week, on Monday evenings. It is the gift of the Roebling family to the Institute, and is operated naturally, on strictly, non-commercial lines, in contrast to the blatant advertising of some of the smaller and irresponsible stations in the state. There are popular monthly programs by the students' symphony and dance orchestras, and musical clubs. The first minstrel show is said to have been broadcast from WHAZ's studio. One of its programs that is well and favorably



THE ANTENNA AT STATION WHAZ

remembered is the commemorative Joseph Henry broadcast, in honor of the American electrician and physicist, whose work in electromagnetism prepared the way for many later developments of the telegraph, telephone, and radio. Other educational broadcasts have found a place in the programs, including practical and non-technical talks by members of the faculty on subjects of current interest in the scientific and engineering field.

Of course Rensselaer does not limit its radio activities to the operation of WHAZ on its frequency of 790 kc. (379.5 meters). As an engineering college in which electrical and communication engineering are among the major courses, the school employs numerous transmitting and receiving sets covering a very wide range of frequencies. Among the curiosities are a DeForest radiophone set which Professor Williams demonstrated to the students in his courses as long ago as 1910, and a Marconi wireless telegraph set dating back to 1902, containing one of the original coherers.

Many radio amateurs both in this country and abroad are familiar with the call letters of the Rensselaer experimental stations, 2 XAP, 2 SZ, and 2 CDC.

WIBO

NEWSPAPER reports tell of an accident in the generator room of WIBO in Chicago, when L. G. Rasmussen came into contact with a high tension wire during the evening program on September 17th, and was severely injured. He was taken to St. Francis Hospital in Evanston.

The operator's injuries were sustained when the gold frame of his eyeglasses came into contact with a live lead. The frame of the glasses fused immediately and the resulting arc burned the face, hands, and chest, of the victim. The station had to be shut down before he could be released.

This unfortunate occurrence should be a warning to other broadcast operators who have so far escaped. Familiarity breeds contempt, and men who handle high tension machinery every day are apt to forget that contact with it at the wrong time may prove fatal. Particularly with the higher powers and voltages which are coming into use in broadcasting, additional precautions are the order. One good trick is to work on the equipment, where possible, with only the right hand, leaving the left in the hip pocket on that side. The logic of that is the fact that if one is caught, the current will pass down the right side of the body to ground, instead of through the relatively low resistance arm-to-arm path which includes the heart region, the great splanchnic ganglion, and other primary nerve centers and organs. Secondly, never lay a hand heavily on a portion of a circuit which may be alive, without first flicking it lightly with one finger, which will give you a chance to disengage if there is anything wrong. The same precaution should be used in connecting two wires which may cause a short-circuit. Incidentally, the arc following a short circuit, if the potential difference is not too high, may be blown out with a puff of breath. Thirdly, every station should contain red fibre signs "Man working on this circuit—do not close," or some similar formula, to be attached to open switches when an operator is working on a "killed" circuit. These tags should be signed, and the rule is that no one but the man who attached the tag may remove it. Fourthly, keep away from the sets when there is a local lightning storm. And finally, all operators should be familiar with first-aid practice and methods of resuscitation, and in the larger stations it is a good thing to have a drill along these lines once a month.

KFI

ACCORDING to somewhat vague reports which have reached us, the engineers at KFI have been experimenting with varying amounts of acoustic damping in the studio. They started, it seems, with the usual idea that a studio should be made as "dead" as possible, the ideal studio being one with entire absence of reverberation. This opinion is now being modified, and the object of the experimentation at KFI is to ascertain how much reverberation is to be allowed for best results on the air. This quality seems to be like salt; you don't want much of it in the goulash, but a little is almost indispensable.

KGO

STATION KGO in San Francisco tackled a big job at the Municipal Auditorium, broadcasting the oratorio "Creation," given by the city of San Francisco with a chorus of 300, 65 players in the orchestra, and three soloists This was possibly as big a pick-up undertaking as any one in the West has tried. There was also an organ, we must not forget to mention.

The space occupied by the chorus and musicians was 48 by 80 feet, and the organ pipes rose 50 feet in the rear. The solution of the pick-up problem was found in the use of condenser microphones, which have no hiss or internal noise, when they are in proper working order, and can be used to pick up sounds within an extreme range of volume. One of these mechanisms, about three inches in diameter and ten inches long, was suspended twenty feet over the heads of the performers, carrying most of the orchestral and choral tone. A second condenser was used for the soloists, about five feet in front

"HIGH TENSION EQUIPMENT . . . MUST BE HANDLED GINGERLY"

of them. As the soloists stood in front of all the other performers, this microphone was well removed from the rest of the musicians and singers.

By all accounts the transmission was first-class. Even the slight rustling sound as the audience turned the pages of the programs in unison, while reading the words of Haydn's masterpiece, was distinctly heard on the air.

Some years ago WEAF broadcast the "Messiah" oratorio from Carnegie Hall in New York, also turning out an excellent piece of work. And WJZ in the same city did Beethoven's Ninth and Verdi's "Requiem" last summer, outdoors, with an orchestra of 110 men, five soloists, but with a smaller chorus—200 in number. We should like to hear from other broadcasters regarding large pick-ups they may have tried, and their estimate of the results.

CKCO

DR. G. M. GELDERT of Ottawa, the president of the Ottawa Radio Association of 600 members which operates CKCO out of pure interest in broadcasting, was in New York during the week of the radio expositions, looking over the field and visiting the metropolitan broadcasters. The Doctor is a prominent physician of Ottawa. If I knew as much about cyanosis and streptococci as he knows about microphones and audio frequency, I should feel proud of myself.

Studio Microphone Placing—Further Consideration

THE interest shown in the problems of microphone placing in the studio has been sufficiently marked to warrant interrupting the progress of our technical series for broadcasters to give further discussion of this important subject.

Among the letters received is one from Mr. Ralph S. Hayes, of Ardmore, Pennsylvania, reading as follows:

While I have never had anything to do with broadcasting, nevertheless, from a study of speech, music, and acoustics, I would like to submit some ideas relevant to the article, "Microphone Placing in Studios." (In the September issue.)

1. I notice the basses and percussion instruments are placed comparatively far from the microphone. Should it not be just the opposite on account of the fact that the bass tones are invariably attenuated more in their transmission through the station amplifiers and receiver amplifiers?

2. It is a proved fact that the basses carry much of the pleasant roundness of music—as well as the energy.

3. The excess of energy in the lower pitches—isn't it the usual cause of the "blasting" mentioned?

4. Wouldn't a better placement be—
   (a) microphone farther away from orchestra;
   (b) basses closer to microphone than trebles.

5. A possible objection to such an arrangement would be carbon frying, but it either need not be carried to such extremes, or a condenser transmitter could be used. At any rate shouldn't you aim toward "basses front" instead of "basses rear?"

As to Mr. Hayes's first point, I believe the general feeling among broadcast engineers is against trying to compensate for losses of essential frequencies in the audio channels of transmitters and receivers, by exaggerations in the pick-up or elsewhere. As far as the transmitter is concerned no such losses should be tolerated in any considerable degree. Plenty of stations find it possible to send out their stuff flat between 60 and 6000 cycles, and those who haven't learned how, should acquire that ability quickly, while they still have an audience. As for receivers, what degree of deficiency is to be taken as a criterion? In some cases the loss of low frequencies is so complete that a slight gain in bass at the start would not help appreciably. Again, just as many receivers lose the higher frequencies as well as the lower, passing only a band of three octaves or so in the middle. Following out Mr. Hayes's theory, there is just as much reason for emphasizing the violins at the start in order to retain the natural quality of the treble strings with their wealth of overtones. This brings us to the second point. It is true that loss of bass notes makes music sound "tinny," "canned," and disagreeably sharp, and strident. But dropping the band from 3000 cycles up is quite as bad. All the instruments merge into a dull, soft, lifeless harmony, like a bad organ heard with one's ears stuffed full of cotton. Finally, receiving sets are now on the market which are capable of reproducing sounds sensibly as they are broadcast, and the number of these sets will naturally increase. They are the only safe criterion. It is obviously a saner procedure to work with a horizontal frequency characteristic all along the line.

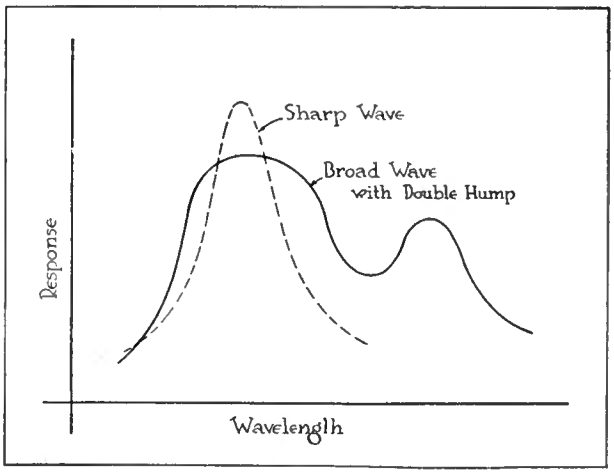


FIG. 1

Answering the third point, I believe that blasting is most frequent with instruments possessing a steep wave front. The cornet is about the worst offender. Cutting off the higher frequencies tends to reduce blasting. One type of carbon microphone, which cuts off on the high end at about 2500 cycles, is relatively free from blasting, but the loss of intelligibility and tone brilliancy makes the net result undesirable in high quality work.

To point 4a, I should answer "No," for reasons well stated by Mr. Julius Weinberger, one of the leading electro-acoustic and broadcast engineers in the East. ("Broadcast Transmitting Stations of the Radio Corporation of America." *Proc. Institute of Radio Engineers*, Vol. 12, No. 6, December, 1924.). Mr. Weinberger writes:

It may appear that less work would have to be done with regard to proper placing of the performers if the microphones were not used relatively close up, being placed instead, for example, at the opposite end of the studio. In the latter case, the relative distance of the microphone from each of the several performers would be nearly the same and there would apparently be less of a problem so far as proper "balance" is concerned. However, it has been found that this cannot be done for a number of reasons. First, the farther away the microphone is from the performers, the greater is the proportion of sound which reaches it by reflection from the room walls, compared with that reaching it directly from the source of sound. These reflected sounds are generally distorted, since they not only are reflected in a variable fashion with respect to frequency, but interference phenomena occur between reflected sounds coming from various reflection points. Thus, it is found that the sounds as heard from a microphone located, say, twenty feet from the source, are more distorted than those heard when the microphone is placed relatively close.

Secondly, the sounds reaching the microphone must be strong enough to give an output far exceeding the hiss due to the use of carbon, and this again necessitates fairly close placing with all performers except orchestras or large choruses.

It will be observed that I am not attempting to controvert Mr. Hayes's idea that the bass instruments may advantageously be moved closer to the microphone. No doubt in some studios something might be gained by work in this direction. I do not believe, however, that some of the theories on which Mr. Hayes bases his conclusion, would work out in practical broadcasting.

There is no doubt that the carbon microphone is not the final answer to the pick-up problem. What is needed is an inherently hissless and noiseless transmitter, reasonably flat from say 50 to 6000 cycles, if not better, and insusceptible to blasting. Preferably, also, it should be a low impedance instrument, so that it can be used with a long, relatively high capacity lead. Finally, it should be capable of producing a voltage output comparable to that of a good carbon microphone, which is, incidentally, a fine amplifier in itself. Such an outfit would simplify many of our pick-up problems, and personally I pray for it night and day. If someone will invent it, I hereby offer $25 in gold, out of my own pocket, toward a statue of the great man, to be erected at the site of his labors, be it East Pittsburgh; 463 West Street, New York; Schenectady; Van Cortlandt Park South, New York, or any other place.

Radio Lingo, Past and Present

IN THE December issue of this magazine, the writer considered the source of some of the terminology of radio. In the group of figurative expressions we considered were phantom and dummy antennas, and the counterpoise.

Numerous figurative expressions along the same lines will occur to the reader. We speak of the "fading" and "swinging" of distant signals as they vary in strength in their journey over great distances. A reactance coil is termed a "choke" for alternating currents. Interrupted continuous wave signals are sent with a "chopper." A transmitting station has a "broad" wave or a "sharp" wave; it is violating the radio regulations if it has a "double hump" or "peak." These terms are derived from the curve of response of a wavemeter or receiver to such a transmitter, as shown in Fig. 1. The word "wave" with its combinations, as used in radio, is itself in the nature of a simile, for an electric wave is some sort of displacement or stress in a figurative medium, quite inconceivable to the non-mathematical mind, and the comparison with the waves of the sea and other material wave motions is simply a convenient but rather inaccurate means of tuition.

The same hydraulic analogy persists when we

refer to wave "filters"—networks of resistance, inductance, and capacity which allow only a certain "band" of frequencies to pass. But we are also familiar with wave "traps," used to eliminate a narrow range of frequencies, and here apparently we think of the wave as a small animal—a rat or mouse—while when we speak of "carrier" waves or "carrier" telephony the wave has become a beast of burden. The term "trap," incidentally, is one of those ubiquitous comparisons which can be found in almost every trade; the bend in a drainpipe to prevent gases coming back along the tube is called a "trap" by plumbers, for example.

The "regeneration" of Armstrong is a distinctly figurative term, carrying a theological connotation, although it was used in connection with gas engines and other prime movers long before the vacuum tube was invented. There is also a physiological reference in the name "tickler" applied to a "feed-back" inductance in the plate lead of the amplifier-rectifier tube of a receiving set. The early workers in this field must have been struck by the extraordinary increase in volume as the tickler coupling was brought up, and the sudden break into oscillation; and they compared these phenomena to the peculiar spasmodic reactions of human beings to a tickling stimulus. Nor must we overlook the word "feed-back" in this connection. Why should we speak of the oscillations in the plate circuit as being "fed" back to the grid, instead of merely saying "brought" back? This figure has a practically universal utility. It is used in transportation, in reference to railroads and waterways, as, the Morris Canal Feeder. In communication, as "feeder" telegraph offices. In electrical engineering—"feeder" conductors, generating stations, etc. In sport: basketball players speak of "feeding" a team-mate when he is in position to shoot for the goal. And it is all based on the nutritional instinct, of course, and the comparison is widespread because that instinct is shared by all living creatures.

It is hardly possible to go through the list of metaphorical expressions which have invaded the radio field, but a few more typical ones may be mentioned briefly. Electricians talk of "juice," apparently a survival of the early fluid theories of electricity. The flow of high frequency oscillations on the surface of a conductor is called "skin-effect." Irregular interference of arc transmitters on low wavelengths is termed "arc-mush." Transient interference with radio reception, both natural, as from lightning, and artificial, as from arc lamps, lightning circuit grounds, sparking commutators, etc. is referred to as "strays." We talk of "shielding" a panel with metal. Spark interference is "jamming," a graphic expression which originated in the English Channel, although familiar in a related sense to the riders in the New York City subways during the rush hours.

(To Be Continued)

Memoirs of a Radio Engineer, VIII

IN OUR last issue I gave a brief account of the *Titanic* tragedy of 1912. For some days after the disaster all was confusion. Commercial stations and ships interfered with each other, some of the amateurs, it was charged, interfered with commercial stations, and no reliable list of survivors could be obtained. As the *Carpathia* neared New York with the survivors, communication improved, and the names came through in the rescue ship's mournful 60-cycle spark. Most of the shore copying was done, I believe, by the Wanamaker station, WIH. The amateurs shut down voluntarily, setting a good example which they have followed on other occasions since that time, although now, with commercial and amateur wavelengths so far separated, the necessity for it has disappeared as far as SOS calls are concerned. They listened on their double-slide tuners and loose couplers to the long fateful strings of names. The commercial operators worked heroically, some of them standing continuous watches until they were ready to drop.

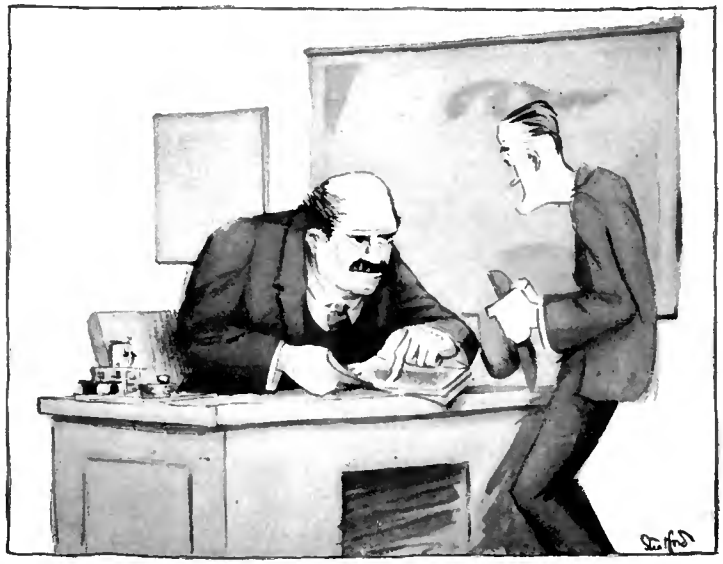
I have referred before to the anarchy which prevailed in the ether lanes in those days. Everybody transmitted on any wavelength which pleased him, or, for that matter, without knowing what his wavelength was or giving any signs that he cared. Amateurs interfered with paid commercial traffic, and refused to shut down when sworn at in code. Profanity on the air was the rule rather than the exception. The caution of Y. M. C. A. broadcasting phraseology was as yet unknown. Call letters were self-assigned, according to fancy; initials were used, or simply what was known as a "good" call—one that had a pleasing rhythm and lilt to it in the Continental or American Morse code. Both codes were used, with American Morse as yet more prevalent. The Britishers used Continental, and there was a strong prejudice against it among the Americans. Morse, with its spaced letters, such as *c* (two dots, space, dot) was harder to copy than Continental, but faster, and the Morse operators were very contemptuous of the newer symbols. The New York *Herald*, which maintained a wireless station, OHX, in connection with its excellent shipping news department, sent press every night at 9 o'clock, first in Morse, then in Continental, but traffic was generally sent in Morse, and my recollection is that the election returns of November, 1912, were sent in Morse only. All this confusion could not last. Soon after the *Titanic* catastrophe, the government took hold. In 1910 a law had already been passed providing for radio equipment on certain steamers. This was not taken very seriously until 1912, when it was amended to apply to all vessels licensed to carry fifty or more persons on the ocean or the Great Lakes, and to provide for auxiliary apparatus covering failure of the main set, continuous watches, and penalties in case of failure to observe the law. A little later, on August 13, 1912, the Senate and House of Representatives passed "An Act to Regulate Radio Communication," under which the present licensing system for stations and operators was instituted. By an international convention signed at London on July 5, 1912, and ratified by the United States Senate early in 1913, initial call letters were allocated to the several nations. Those two years, 1912 and 1913, were the great legislative years of radio. In fact, so much legislation went through that this country has not experienced any since, and has gone twelve years without altering the radio laws themselves. What adjustments have been made the Department of Commerce has taken care of by regulations under the administrative power which it was granted by the law of August, 1912.

These momentous changes percolated down to even the lowest strata of amateurs. Some of my friends lost their call letters. Such amateur calls as MHS, NSE, DSE, SU, JR, AY and, YF, became taboo. *M* calls belonged to British stations; *D* was allocated to the Germans; *N* to the American Navy. Amateurs were to be licensed, and to receive calls beginning with numbers, denoting the radio district in which the applicant happened to find himself. All stations, from the largest down to the most insignificant which might interfere with reception over a State line (the necessary limitation of Federal authority), were subject to the new régime. It was like the lines in the Agamemnon:

None who was mighty then, and none so small
But in the sack of doom is borne away.

All the amateurs, formerly so reckless and carefree, went about with worried faces, wondering if they could pass the examination, and trembling in fear of a new ogre, the Radio Inspector.

(To be Continued)



"THE AMATEURS . . . TREMBLED BEFORE A NEW OGRE—THE RADIO INSPECTOR"

Radio Broadcast's Universal Receiver

Being the Study of Several of the Most Popular and Most Efficient Circuits for Home Construction With a View to Adapting Them to Fit Our Individual Needs

By ARTHUR H. LYNCH

HAVE you noticed that within the past few months the new Flexes, Dynes, and Supers described in the radio press have been extremely conspicuous by their absence? For some time, the passing of the trick circuit and its capitalization by the crafty and sometimes not too scrupulous publicist and manufacturer has been considered, by those who really understood the radio business, as a foregone conclusion. In passing on this interesting angle of the radio business, some of the older readers of RADIO BROADCAST will recall Zeh Bouck's article, entitled "The Truth About Trick Circuits" which appeared in our March, 1924, number. Some others may remember that we defended ourselves successfully in a libel suit for $100,000 which was brought against us as a direct result of the publication of this article and our refusal to make public apology for the things we said. We hope that article was instrumental in bringing about the situation with which the radio parts business is now blessed. Certainly, it is in better shape now than it has ever been before, even though there are those who would have us believe that, because the business in completed receivers has flourished so greatly, there is little or no parts business going on.

And before going directly to the subject at hand, perhaps a few words about the parts business will be of interest to the home constructor and others. On the magazine, we are in direct contact with thousands of the listening public by mail who express their likes and dislikes to us in no uncertain terms. Through our short wave transmitting station in our Laboratory at Garden City (2 GY) we are in direct communication with amateur radio enthusiasts in all parts of the world. Many manufacturers avail themselves of our laboratory services and from them we learn much of what is going on in their particular fields. Then, too, our laboratory has been chosen to pass on the quality of the products radio manufacturers desire to advertise in *The World's Work, The Atlantic Monthly, Harper's Magazine, Review of Reviews, Scribner's Magazine,* and *Country Life.* From these contacts, we come in still closer contact with many sides of the radio business.

There has been a considerable slackening off of the general parts business and there is no contradicting that fact. There are far fewer varieties of parts now to be had than there were a year ago. Allah be praised for that! Much of the older kind of parts business was little more than traffic in junk. Much of the junk has now been cleared out and it will not be long before the rest will have found its way to the scrap heap. Many of the junk dealers, who, a few months ago, believed themselves to be in the radio parts business have gone broke or have gone back to their old jobs, whatever they were. The parts merchant of to-day and to-morrow is not the fellow who attempts to unload a lot of radio jimcracks on credulous but misinformed radio buyers, but he is rather the man who understands the reason for every part he sells and is able to render the home constructor the sort of service he is reasonably entitled to expect. If more dealers would study some of the existing radio circuits and determine from actual performance just which is suited to their particular needs and then have samples made, which could be displayed in their stores and operated if need be, they would

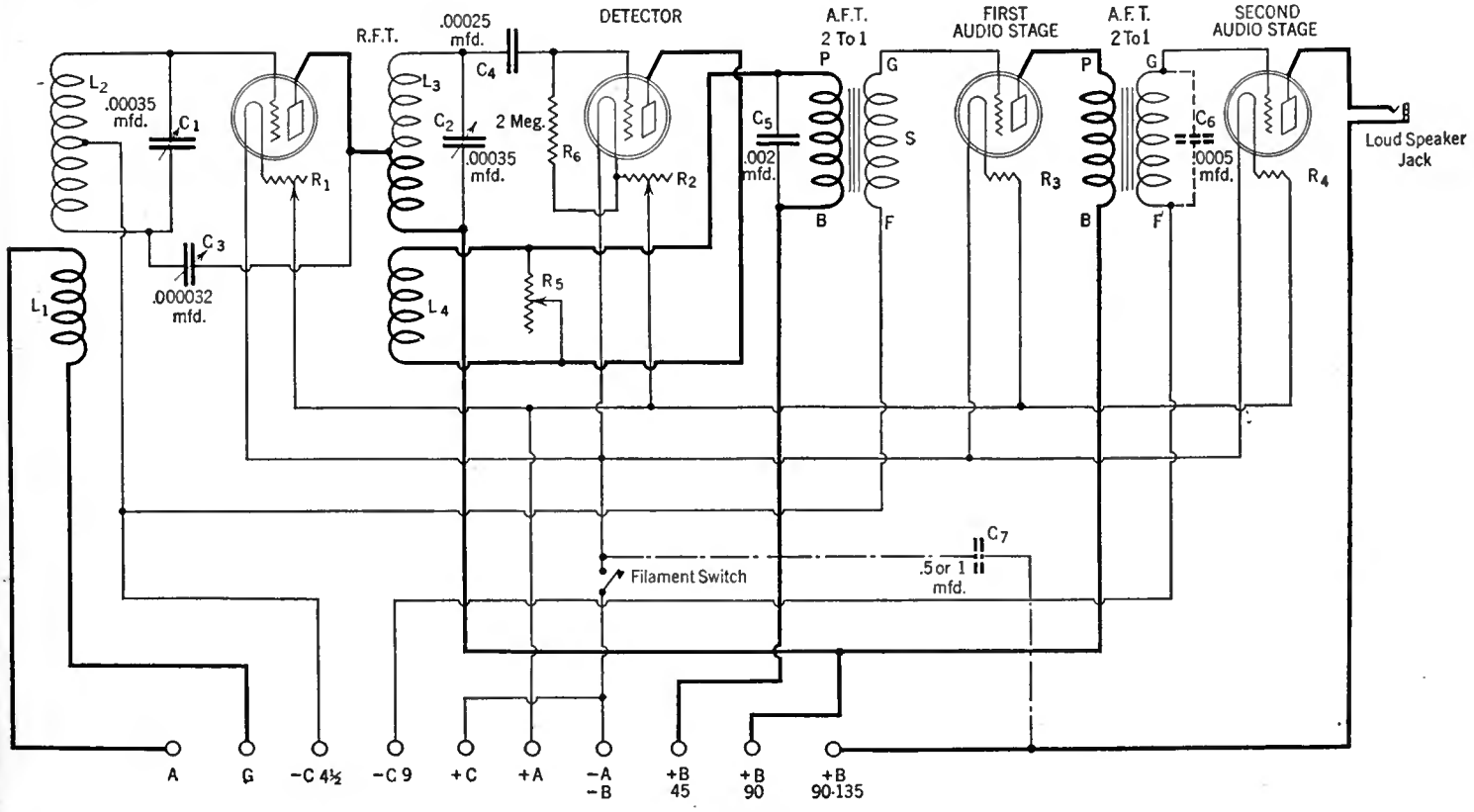


FIG. 1

This is the circuit diagram of the Universal Receiver. It consists of one stage of tuned radio-frequency amplification utiliz ing the Rice method of neutralization, a regenerative detector, and two low ratio stages of audio-frequency amplification. The wiring of the assembled receiver takes the same form followed in this diagram. For instance, the lower terminal of the radio frequency coupling unit is the lower end of L_4 in the diagram

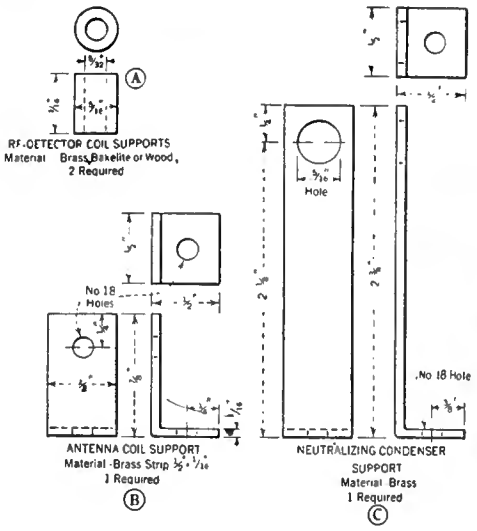
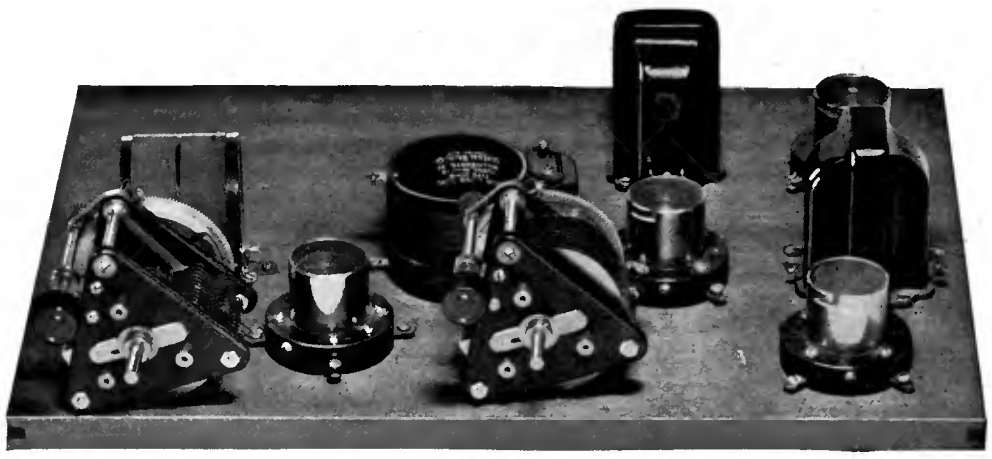


FIG. 2

The dimensions and other specifications for the angles and other hardware used to assemble the receiver are given here. In the case of the bushings, bakelite or wood will do as a substitute for brass



HOW THE SET STARTED . . .

The embryo "Universal." By laying out the parts on the base-board, it was possible to experiment with changes in location of the various coil and condenser units to observe any improvement in results obtained. This system of experimental construction is to be highly recommended

find a harvest in the parts business far beyond their most optimistic expectations. In fact, those dealers who are following this plan, and there are a great many of them, are finding the parts business to be anything but dead.

Every home constructor is actually a radio salesman in his neighborhood. If his receiver works well, and homemade receivers usually do, the builder generally proclaims from the housetops, first the wonders of his outfit and then the wonders of radio in general. Many of his auditors wouldn't give a red apple to duplicate his accomplishment, but many of them would like to be able to hear the things he hears and the rapid growth of the radio business to-day may well be credited to the home constructor.

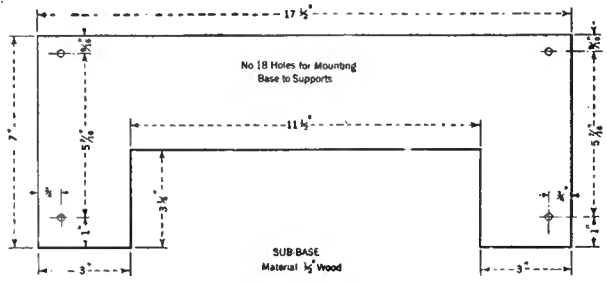


FIG. 3

The baseboard layout. Especial care should be exercised in cutting out the section to be removed so as to prevent splitting the wood. The use of this type of baseboard insures easy assembly and wiring

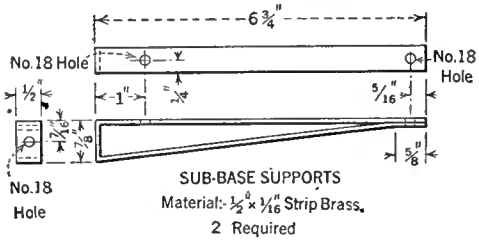


FIG. 4

Two brackets, made as shown here, support the baseboard assembly. Approximately 32 inches of ½ x 1/16-inch strip brass are required to make the two brackets

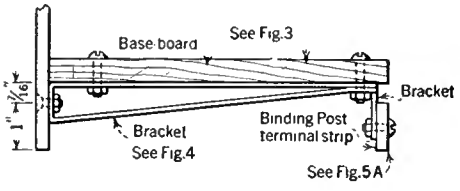


FIG. 4A

The baseboard is mounted on the brackets and panel in the manner shown above. Two brackets for the terminal strip are required. The vertical part is 1¼ inches long and the hole for the strip is located ¼ of an inch from the bottom

THE PROBLEM

ALL of the foregoing was brought to mind by a moment's consideration of the problem at hand and our reasons for dealing with the subject of the universal receiver. First of all it was necessary for us to determine on a particular circuit. It is almost impossible to think of circuits at all without thinking of all the dynes and whosits and so forth which were given so much free space in the newspapers a few short months ago. Most of them have met a natural death. There remain but a few tried and true circuits, so the matter of selecting the proper one for our individual use, is not such a difficult job, even for the uninitiated. There are many we could attack and use to good advantage, but when all the smoke has cleared away and the shouting is all over and we get back to a peace time basis, there is but one real type of circuit which may be called universal and that is the combination of one stage of tuned, neutralized radio frequency amplification, a regenerative detector and some kind of audio-frequency amplifier which will produce good quality. To explain the kind of a circuit we are describing, each time we have some variation of this circuit to contend with is indeed embarrassing and the name "Universal" is about as near the correct characterization as we have been able to find.

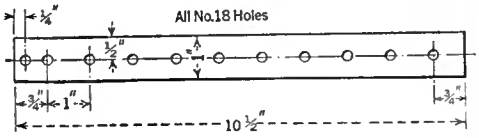


FIG. 5A

This is the layout for the binding post terminal strip. Bakelite, hard rubber, or formica 3/16-inch thick is satisfactory for use here

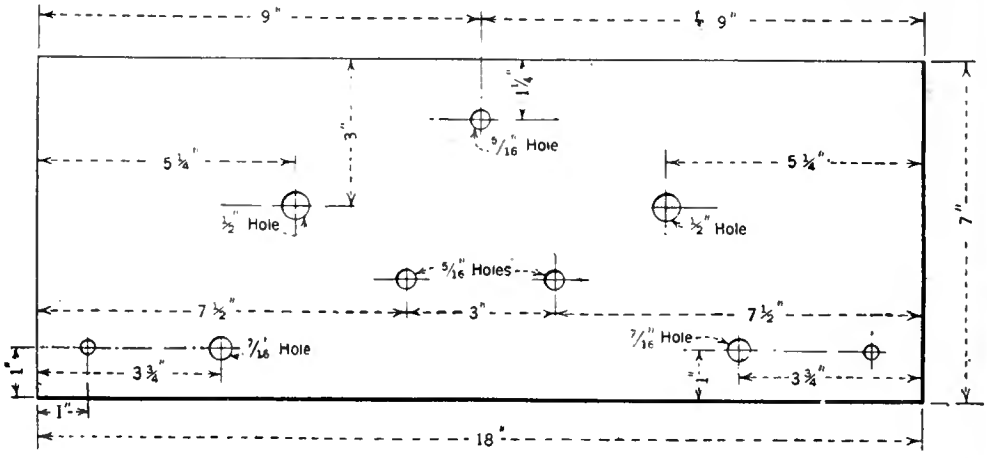


FIG. 5

The panel layout. Only center holes are shown so as to enable the builder to use parts that he may have on hand which differ in make from those recommended. In any case, before these center holes are drilled it is well to spot off the other mounting holes

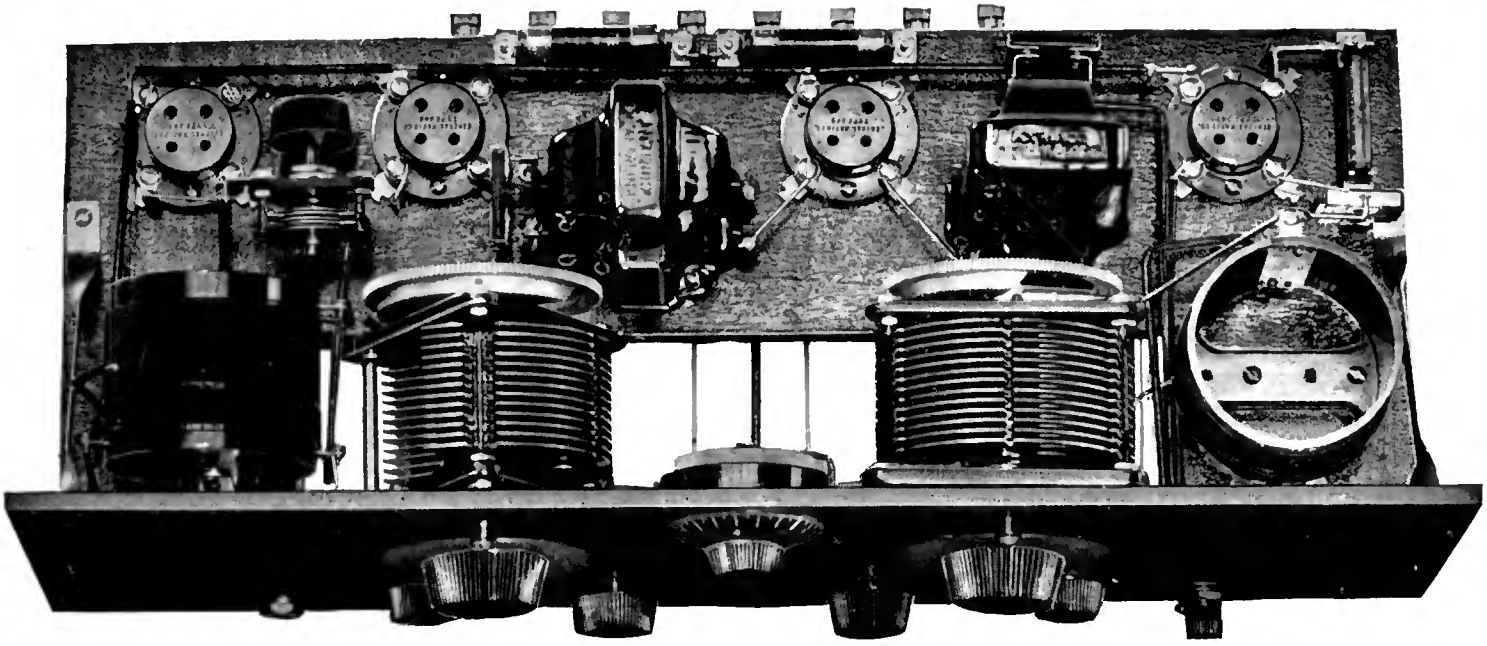


FIG. 7

Here is a view of the Universal employing the new UX sockets. With this arrangement there is a generous spacing of the parts and it is possible to employ any of the UX type of tubes such as the UX-199, UX-201A, WX-12, or UX-112 tubes in these sockets. The advantage of building the receiver with these sockets is apparent as there is not the necessity for using adapters when other voltage tubes are to be employed. Leads are short and direct, another obvious advantage

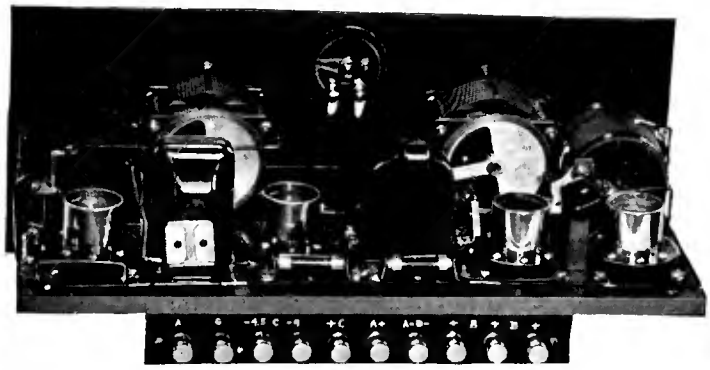


FIG. 6

This is a picture of the Universal receiver employing, in the main, General Radio Company parts. Standard UV type sockets are provided. This allows the use of either the UX or UV 201A type of tube in this set. Note the position of the neutralizing condenser between the first two sockets at the right. The grid leak and Amperite mountings are easily accessible if replacement ever becomes necessary. The binding post terminal strip serves also as a support for the rear of the wooden sub-base

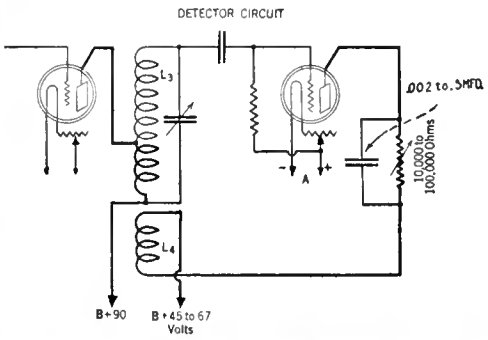


FIG. 9

Still another highly efficient way in which to control regeneration by a variable resistance. It is necessary to experiment with different values of capacity shunted across the resistance to obtain smooth control of regeneration. Such resistance units as the Bradleyohm No. 10, the Centralab, and the Royalty may be employed successfully

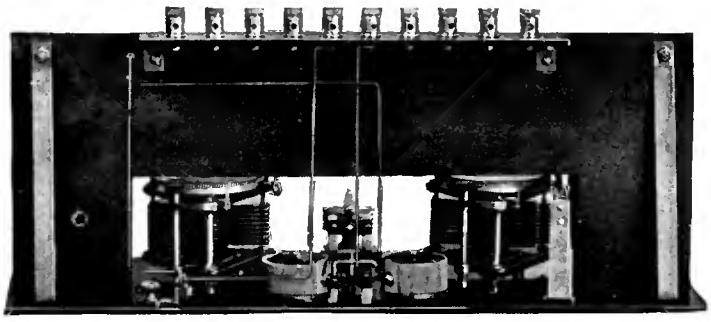


FIG. 10

With the use of the cut-out baseboard, the wiring and assembly of the parts employed in the construction of the receiver is made amazingly simple. Unlike a bakelite sub-base it is possible to screw down on to the wood the sockets, transformers, and other material without previously drilling it to admit the screws

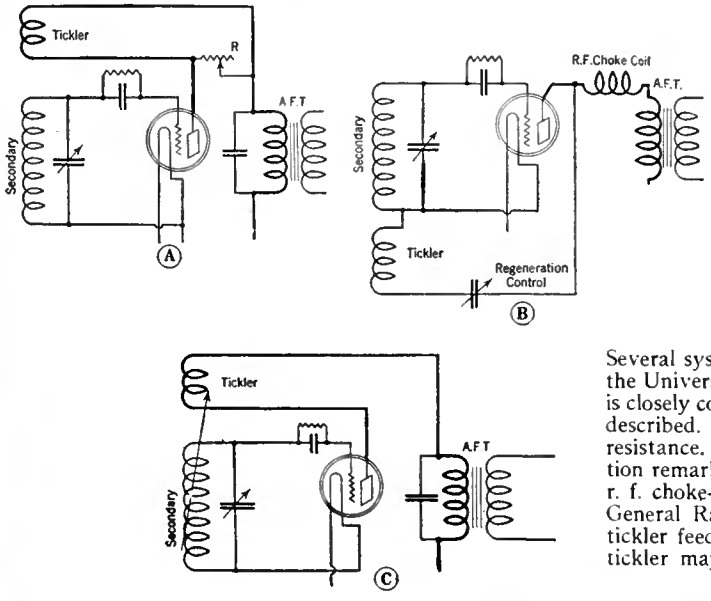


FIG. 8

Several systems of regeneration which may be incorporated in the circuit of the Universal receiver. In A, the resistance R shunts the tickler coil which is closely coupled to the secondary. This system is employed in the receiver described. Regeneration is obtained and then controlled by varying the resistance. In B, a condenser feedback system is employed which will function remarkably well when care is taken to include in the circuit a suitable r. f. choke-coil. In C is shown the usual tickler feedback system. When General Radio coils are used in the receiver and it is desired to employ tickler feedback, a mechanical arrangement must be provided so that the tickler may be coupled to the secondary of the detector coil unit. This puts another control on the panel

A circuit which would perform satisfactorily in city and country on dry cells or with a storage battery, without wasting B batteries, which would give more than ordinarily good quality of reproduction on a loud speaker over comparatively long distances, which was easy to build and easy to operate after it was built, and, last, but not least a circuit for which the parts could be procured in any town of any size in any part of the world; that was our notion of what the "Universal" should be. We believe we have found it. It is not a new circuit, by any manner of means. Fundamentally it was used in slightly modified forms in such popular receivers as the Teledyne, the Browning Drake, The Roberts, RADIO BROADCAST'S Four-Tube, Three-Tube, and Two-Tube Knockout Receivers. Hammarlund-Roberts, RADIO BROADCAST'S Aristocrat, the Samson T. C. Receiver and the Silver Knockout. But since the appearance of most of these receivers in RADIO BROADCAST, improvements have been made in the design of many of the integral parts and this improvement is particularly evident in the matter of tubes.

FIG. 11

A panel view of the Universal. Symmetrical layout has been one of the prime considerations in the construction of this receiver.

In order to show how various parts may be used in this circuit with satisfaction, we are illustrating with this article, a receiver employing just about the same circuit and sold in kit form by the Samson Company of Cambridge, Massachusetts, and another built to our design by the American Mechanical Laboratories of Brooklyn, New York. Other variations on the same theme may be seen by looking over the article by Allan T. Hanscom in our October, 1925, number and the description of RADIO BROADCAST'S "Aristocrat," by the present writer, in our November number. We are very anxious to have the fact understood that intelligent substitution of parts for those we have used will not detract from the performance of the receiver. It is impossible for us to list all those which can be used, but we wish to show no favoritism in the matter of recommending parts for the RADIO BROADCAST Universal Receiver.

So, then, as an example of what may be done, let us first consider the circuit and then the components of a single manufacturer which may be used to advantage in it. From a study of Fig. 1 it will be seen that there are two coil assemblies, one, a primary and secondary in the antenna circuit (L_1 and L_2; the latter tuned by the variable condenser C_1) the other, a tuned radio-frequency transformer of the auto transformer type and a tickler coil, which is fixed in position but adjusted electrically by means of the 500- to 50,000-ohm resistance, R5 shunted across it. These coils are indicated in the diagram by L_3 and L_4. By properly using the windings already provided on the General Radio Company's coils, No. 277D, both these coil units are instantly provided. No changes whatever need be made as the coils are of solenoid type with two windings on a single form. Two such forms are necessary. On each form there is a small and a large winding. The small ones are used for L and L_4 while the large ones are used for L_2 and L_3. The tap indicated on L_3 is easily provided by picking up a turn of the large coil, and scraping clean. It is merely necessary to solder the proper wire to it to carry out the correct circuit arrangement. In L_3 this tap is made 39 turns from the grid end and the tap on L_2 is made in the exact center of the coil. These coils may be used with .00035 mfd. variable condensers to cover the broadcast frequency range and the results obtained in our laboratory tests of the completed receiver indicate that they will go well below the lowest and well above the highest frequencies transmitted by the broadcasting stations now on the air. Let us now consider the remainder of the parts used for storage battery operation and once having done that we will study the few changes necessary for using the same circuit arrangement with dry cell tubes.

PARTS USED IN R. B. LAB MODEL OF THE UNIVERSAL RECEIVER

THE parts employed are: 1 Panel, 7 x 18, 1 Wood sub-base 7 x 17½, cut as shown in Fig. 3 and for simplicity of mounting and wiring we recommend the use of wood not more than ½ inch thick, 2 sub-base supports, made as shown in Fig. 4, from ½ x 1/16 inch brass strip (the approximate length of this strip required for the re-

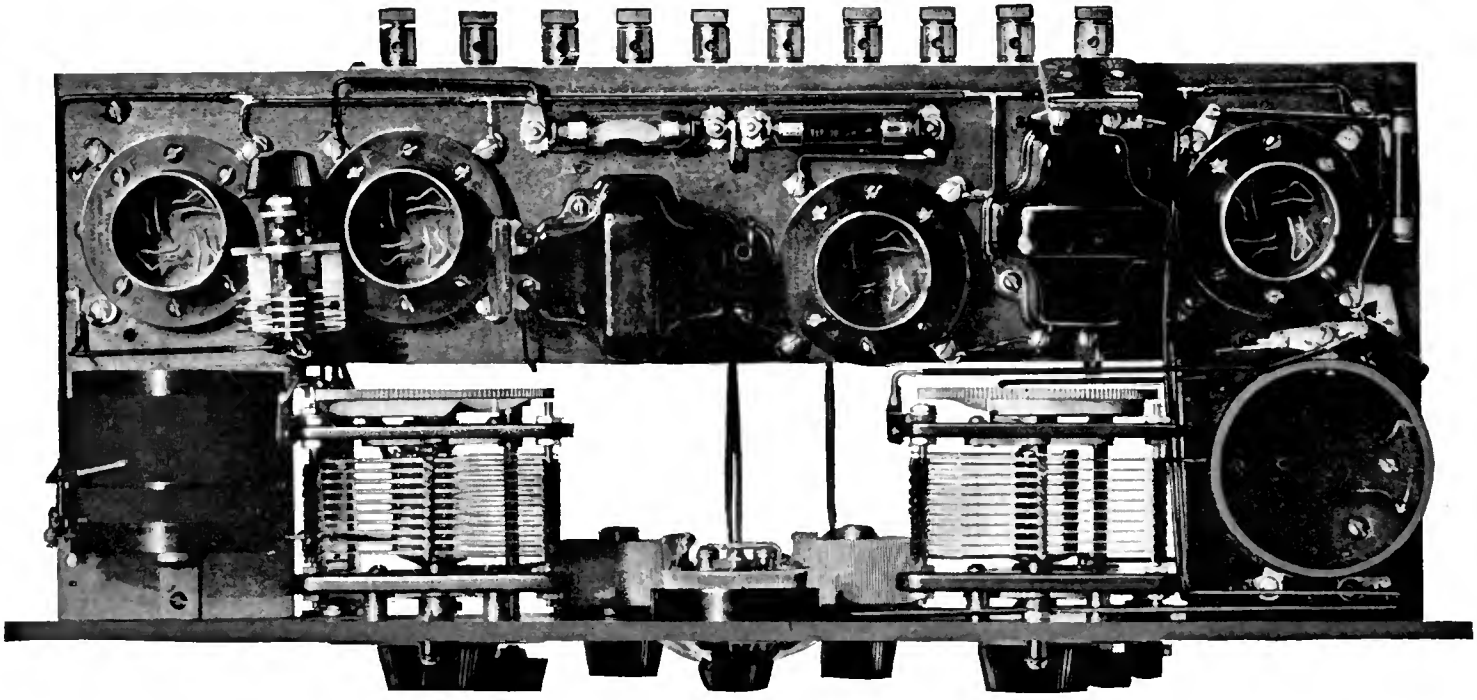


FIG. 12

A base view of the receiver. Note that the coil units are in line with and at right angles to each other. This is absolutely necessary for obtaining proper neutralization

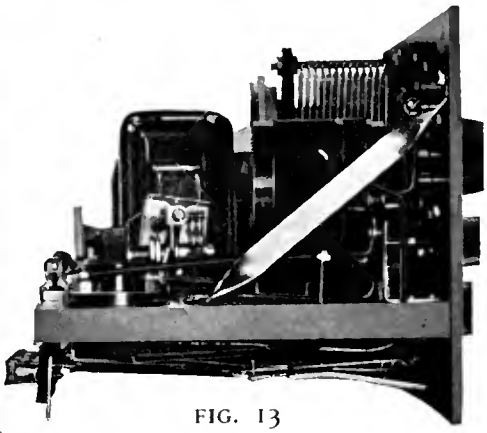


FIG. 13

In this end view the use of other brackets is shown. The builder may use either type according to his own desires

ceiver is 32 inches); 2 Detector coil supports, as illustrated in Fig. 2A; 1 Antenna coil support, as shown in Fig. 2B; 1 Neutralizing condenser support, as shown in Fig. 2C; 1 Royalty, 500- to 50,000-ohm variable resistor; 1 each Electrad, .00025-.002- and .0005-mfd. fixed condensers, and the following General Radio parts: 2 coils, type 277D; 2 variable condensers with vernier attachment, .00035 mfd. capacity, either S.L.W. or S.L.C., type 247P; 2 Dials type 310; 1 neutralizing condenser, type 368; 2 audio-frequency transformers, 2:1 ratio, type 285L; 4 sockets, type 156 for use with tubes having UV base, or type 349 UX sockets for tubes with UX bases, as explained further along; 1 binding post strip, with 8 posts, type 138Z; 2 rheostats, 10 ohms, type 301; 1 Yaxley filament switch and phone jack and one Electrad grid leak resistor, 2 megohm; and the large $\frac{1}{2}$ to 1 mfd. condenser across the B batteries is optional, but advisable. One each $\frac{1}{4}$ and $\frac{1}{2}$ ampere Brach or Amperite filament ballasts and mountings.

BEFORE BUILDING THE RECEIVER

TO BEGIN with, the combination which we have found to meet nearly every occasion, except where the storage battery is impossible for one reason or another, is the circuit in which 201-A type tubes are used in all sockets except the output of the amplifier and here we have found the UX-112 very satisfactory, when operated with 135 volts on the plate and a negative bias of approximately minus 9, as shown in the diagram, Fig. 1 With this arrangement, using the proper plate and biasing voltage (B and C) on the radio frequency tube as indicated in the same diagram the plate current consumption is in the neighborhood of five milliamperes and should not be above seven. The UX-112 will increase this figure somewhat. This sum is very low for a receiver of this general type and is one of the outstanding features of the RADIO BROADCAST Universal. If your receiver is to be located more than fifty miles from a broadcasting station, you may find that one low and one high ratio transformer will give you more volume and in such cases it is advisable to use it. It should not be more than 6:1, however. If this combination of transformers is to be used, be sure the high ratio transformer is used last and *not first* as is common practise. The reason for this change is well covered by Mr. Keith Henney, Director of RADIO BROADCAST'S Laboratory, in his article, *Tubes: Their Uses and Abuses*, in our last number.

The matter of sockets is a rather important one, in view of the great number of tubes already on the market and those which will probably follow. We have found that the standard socket is just about as satisfactory at the present time as any, because the standard tubes will fit in them and so will the tubes with the new UX bases. Where either the WD-11 or the UV-199 types of tube are to be used, they may be placed in the standard sockets by means of adapters. So much, for the receiver when the tubes to be used are those with which we have become quite familiar.

Now for the dry cell operation. We have found the combination of three 199 and one 120 tubes, or their equivalent, to be very satisfactory and, if you contemplate the building of this receiver without using any of your present stock, we suggest that you use the new type of socket because it may be used with any of the new tubes and it will be remembered that both these tubes are soon to be on the general market with the new UX bases, and by using the UX sockets, it will be possible to convert your receiver from dry battery operation to one which may be used with a storage battery by going to no greater bother than changing the tubes. Many of the independent tubes have been found to be very satisfactory and most of them will be on the market within a short time, probably before this article gets into circulation, with the new type bases. In order that you may have a direct comparison of the two types, we illustrate in Figs. 6 and 7, just how they will look when completed. The proper use of any type of tube in any receiver is one of the greatest factors in determining its performance and we can not urge too strongly the careful reading and then putting into application the instruction sheets which accompany the tubes now on the market.

BUILDING THE RECEIVER

AFTER procuring all the necessary parts and properly bending and drilling all the brass fittings and the wood subbase, the drilling of the panel can be undertaken and the layout shown in Fig. 5 will be found helpful in this connection. Next, all the parts which are to be directly attached to the panel should be put in place as should those which are to be attached to the sub-base. From this point on, the work of assembly is a very simple matter and it is but necessary to fasten the sub-base and the panel together by means of the brass supports and attach the binding post strip, which acts as the rear support for the receiver and then go ahead with the wiring. The dimensions of the entire assembly are such that the completed receiver will fit into a standard 7 x 18-inch cabinet and the use of a cable lead to the batteries is handy and is

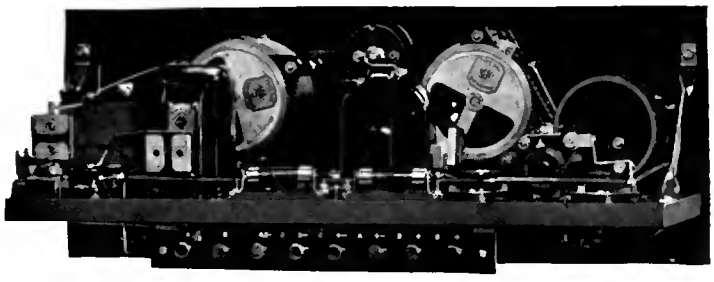


FIG. 14

This view of the rear of the Universal gives a pretty good idea of the disposition of the various parts. In this particular receiver, larger tuning condensers have replaced the .00035 mfd. variables. However, for the broadcast range the .00035's are entirely satisfactory

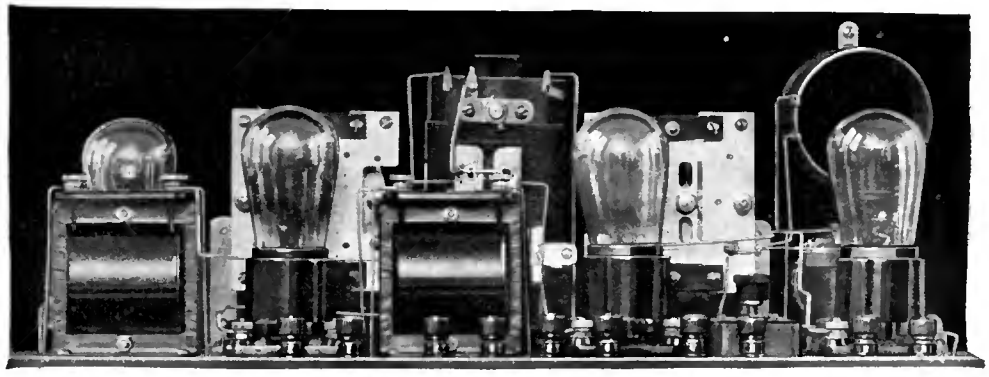


FIG. 15

So much equipment in such small space is, in itself, an accomplishment. This layout of the Samson TC Receiver is a little difficult to approximate but when you have it finished it's a real receiver. The tests run on it in our laboratory revealed it as one of the best receivers we have ever used. It is compact, easy to handle, economical to use and the tone quality is far above the average. On the second stage audio it performs very well with a cone speaker which is saying much for a transformer-coupled audio receiver

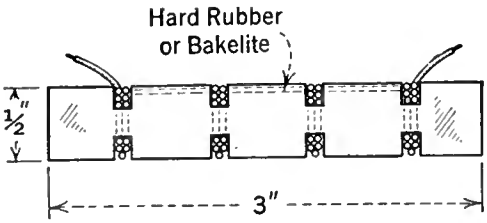


FIG. 16

To keep radio frequency currents where they are useful, a choke coil is shown in use in Fig. 8B. Such a coil is illustrated above and may consist of No. 30 wire wound 100 turns to the slot. With such a coil the feed-back condenser may be a small "midget" condenser

recommended. Furthermore, the dimensions on the sub-base are large enough to allow the use of any sockets or transformers now on the market, without making necessary any changes in design.

Perhaps there are those who would like to improve on the general design of this receiver in one way or another and the point which might well be expected to be attacked is the control of regeneration by the resistance across the tickler. Some of the attempts at this which were made in our laboratory, during the development of this receiver are indicated in Fig. 8, but for a number of reasons we have found the system finally employed here to be most practicable with the type of coils employed. Since the inductive relation of the tickler to the secondary of the radio-frequency transformer, that is coil L_4 to coil L_3, is always the same there is no change in wavelength or detuning in the radio frequency circuit, which is sometimes noticeable to a marked degree in receivers where a tickler of the rotary type is employed. Then, too, the number of moving wires and the breaking of connections they sometimes cause has been eliminated and with the proper detector plate voltage and the proper variable resistance, the control of regeneration is remarkably smooth, which is a distinct advantage.

CONDENSER FEED BACK

A VARIATION of the resistance control is the condenser feedback, probably due to Weagant and used commonly in the Reinartz circuit. A fixed coil is placed near the detector secondary and coupling to the plate is effected by means of a series condenser. The condenser and coil is then a shunt path for the radio frequency currents, and a choke coil may be necessary to keep these currents from escaping through the phones or amplifier primary. The circuit is shown in Fig. 8B and a drawing of a choke in Fig. 16. There should be no condenser across the output in this arrangement. This method of adding regeneration is particularly smooth in operation, and it avoids the movable tickler with its varying field.

And now there is little to do but the soldering and wiring. Wherever possible, the home constructor should fit himself out with a good soldering outfit, and a set of those small wrenches which comes in so handy in getting the nuts on and off transformers, tube sockets and such places. He should have a good supply of bus bar and spaghetti or flexible rubber-covered wire and a goodly supply of small sized lugs which may be directly fastened to the various units which go to make up the circuit and to which the soldering is actually done, rather than to the units themselves. By using this method of construction, it is possible at any later time to remove the holding nuts and off comes the wire with no fuss whatever. Then it should also be remembered that a good small screw driver is valuable in placing the soldering lugs under the heads of the screws in those units provided with screws instead of binding posts, and there are a great many of them on the market. That's about all there is to the building, and now we come to the point of putting our prize on the air.

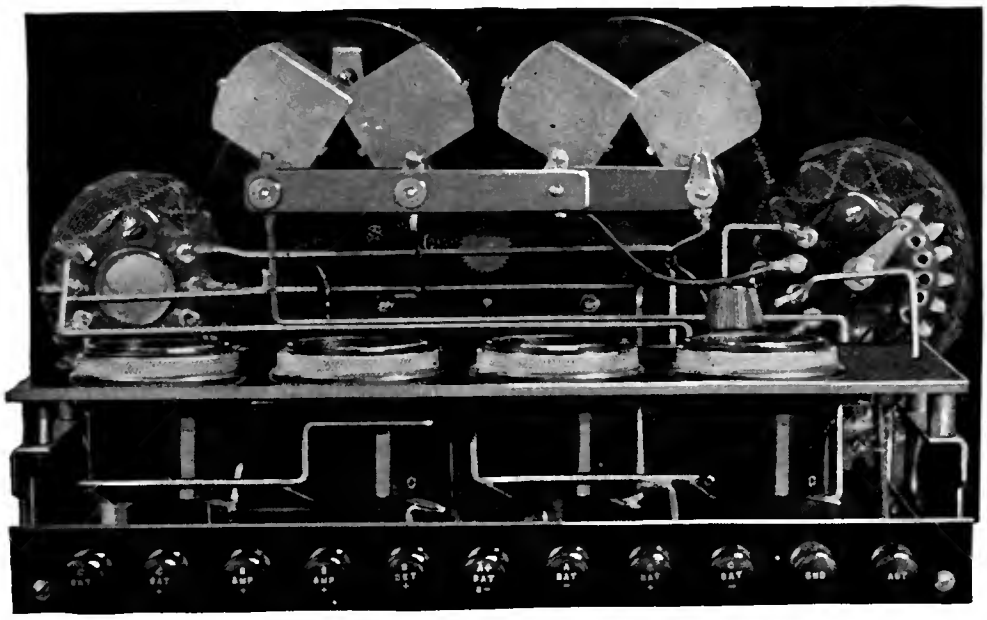


FIG. 17

A typical example of the Universal circuit worked into the small dimensions of RADIO BROADCAST's Phonograph Receiver. A Hanscom single-control unit with model 2 RK Clarotuner coils provides the tuning system, and the sub panel with special sockets was supplied by Osborne & Company of Boston to our dimensions. Note the freedom from visible wiring

OPERATING THE UNIVERSAL

THE antenna used with RADIO BROADCAST's Universal Receiver should be about 150 feet long, from the receiver itself to the outside insulator, including the length of the lead-in wire. With such an antenna, if you are located within 25 miles of a powerful broadcasting station you may find that the receiver is not selective enough to permit you to cut out the local station and bring in distant stations on frequencies near that of the local. This objection may be overcome by inserting a .0001-mfd. fixed condenser in series with the antenna or by reducing the length of the antenna a little. The former method is easier and usually more effective.

It will be found that the two dials will run just about even over the entire scale, if they are properly set when they are attached to the shafts. If the wiring is correct the receiver should respond as soon as it is put on the air, if there is any broadcasting going on. The only adjustment other than that which usually characterizes tuning is the setting of the neutralizing condenser and that is a simple matter, which once taken care of need cause no further worry. In order to set the neutralizing condenser properly, some broadcaster whose frequency is about 1000 kc. (300 meters) and whose volume is not very great should be tuned-in with the detector oscillating. The detector condenser should be tuned until the whistle from the station is quite loud. Then the first, or antenna, condenser, should be tuned. It will be noted that the whistle will change in pitch as this condenser is varied. When the set is exactly neutralized, this whistle will not change, and the problem is to adjust the neutralizing condenser until such a state of affairs exists. The neutralizing condenser should be varied a little at a time, each time noting the change in pitch of the whistle. On one side of the neutralization point, the pitch will rise in frequency; when the neutralizing point has been passed, the pitch will lower in frequency. By listening for these changes in pitch, the listener can tell on which side of the actual balance point he is.

The usual method of turning out the first tube and adjusting the neutralizing condenser until no sound is heard is not satisfactory. The grid-plate capacity of tubes differs by a large factor in the two conditions of tube unlighted and tube lighted. In other words, the tube will not be neutralized when it is lit if it is balanced with the filament turned out. It should be neutralized under actual operating conditions.

A more practical all-round receiver than RADIO BROADCAST's Universal will be hard to find.

MILES FROM ↓ TO →	BOSTON	CHICAGO	CINCINNATI	CLEVELAND	DETROIT	NEW YORK	PHILADELPHIA	PITTSBURGH	ST. LOUIS
Atlanta, Ga.	930	590	375	550	595	745	660	520	470
Baltimore, Md.	350	600	420	315	405	170	85	200	730
Birmingham, Ala.	1050	580	415	615	640	855	775	610	400
Buffalo, N. Y.	400	450	395	175	215	295	280	180	655
Calgary, Alta.	2060	1370	1620	1645	1555	2000	1200	1755	1950
Dallas, Tex.	1515	800	795	1000	990	1350	1280	1060	540
Davenport, Ia.	990	160	360	455	390	860	800	560	200
Denver, Colo.	1750	900	1080	1200	1140	1600	1550	1310	775
Des Moines, Ia.	1135	300	500	605	540	1010	965	710	265
Elgin, Ill.	870	35	280	335	260	740	690	440	255
Galveston, Tex.	1585	945	880	1100	1090	1400	1315	1125	690
Hastings, Neb.	1400	560	740	865	795	1265	1215	965	445
Havana, Cuba	1500	1315	1100	1250	1325	1300	1270	1215	1165
Houston, Tex.	1575	925	875	1085	1080	1400	1310	1120	660
Indianapolis, Ind.	790	160	100	255	230	630	575	325	230
Iowa City, Ia.	1045	200	405	505	435	900	860	600	210
Joliet, Ill.	870	35	250	330	260	730	680	430	225
Kansas City, Mo.	1225	400	545	690	640	1080	1025	775	230
Lancaster, Pa.	310	600	430	295	390	130	65	200	750
Lansing, Mich.	680	170	240	170	85	550	520	280	400
Lincoln, Neb.	1320	465	650	775	700	1175	1120	875	365
Los Angeles, Cal.	2560	1730	1875	2020	1950	2420	2360	2110	1565
Louisville, Ky.	815	270	90	300	310	645	570	345	245
Madison, Wisc.	925	120	370	405	325	800	760	520	300
Memphis, Tenn.	1120	480	410	620	615	950	870	655	240
Mexico City, Mex.	2300	1675	1600	1800	2120	2115	2035	1860	1420
Miami, Fla.	1280	1180	950	1085	1150	1100	1025	1010	1050
Milwaukee, Wisc.	840	80	320	335	255	725	690	450	325
Minneapolis, Minn.	1110	360	590	620	545	1005	980	750	465
Montreal, P. Q.	260	740	700	490	515	335	400	470	970
Oakland, Cal.	2650	1820	2000	2115	2030	2500	2490	2240	1705
Ottawa, Ont.	315	640	620	410	425	335	380	410	875
Providence, R. I.	40	825	700	525	585	150	235	450	1000
Rochester, N. Y.	340	500	450	240	280	250	260	225	720
Salt Lake City, Utah	2070	1245	1440	1550	1475	1950	1900	1650	1145
San Francisco, Cal.	2650	1820	2020	2140	2065	2540	2500	2240	1715
Schenectady, N. Y.	145	700	600	400	460	150	210	350	900
Scranton, Pa.	240	615	490	315	390	100	105	230	790
Seattle, Wash.	2500	1710	1950	2000	1920	2400	2385	2115	1695
Shenandoah, Ia.	1240	400	590	700	635	1110	1050	800	310
Springfield, Mass.	80	760	645	460	525	120	200	395	960
Tampa, Fla.	1160	1060	775	925	985	1000	930	870	855
Toronto, Ont.	440	425	400	190	200	350	340	225	640
Valparaiso, Ind.	815	45	200	270	210	670	625	370	255
Vancouver, B. C.	2500	1760	2000	2040	1950	2400	2385	2150	1750
Washington, D. C.	390	590	400	300	390	200	125	190	705
Winnipeg, Man.	1350	710	970	940	850	1295	1275	1050	845
Worcester, Mass.	40	800	700	500	570	155	235	435	985
Zion, Ill.	850	45	285	320	240	720	675	420	290

Sixteen

RADIO BROADCAST'S

Booklet of

American and Canadian Broadcasters

December 15, 1925

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
WSAI	Mason, Ohio	920	325.9	5000
WSAJ	Grove City, Pa.	1310	229	250
WSAN	Allentown, Pa.	1310	229	100
WSAR	Fall River, Mass.	1180	254	100
WSAU	Chesham, N. H.	Ceased activities October, 1925		
WSAV	Houston, Tex.	1210	248	100
WSAX	Chicago, Ill.	Ceased activities June, 1925		
WSAZ	Pomeroy, Ohio	1230	244	50
WSB	Atlanta, Ga.	700	428.3	1000
WSBC	Chicago, Ill.	1430	209.7	500
WSBF	St. Louis, Mo.	1100	273	250
WSBT	South Bend, Ind.	1090	275	250
WSDA	New York, N. Y. (Shortly to re-open)	1140	263	250
WSKC	Bay City, Mich.	1150	261	100
WSM	Nashville, Tenn.	1060	282.8	1000
WSMB	New Orleans, La.	940	319	500
WSMH	Owosso, Mich.	1250	240	10
WSMK	Dayton, Ohio	1090	275	500
WSOE	Milwaukee, Wis.	1220	246	500
WSRF	Broadlands, Ill.	1290	233	10
WSRO	Hamilton, Ohio	1190	252	100
WSUI	Iowa City, Ia.	620	483.6	500
WSY	Auburn, Ala.	1200	250	500
WTAB	Fall River, Mass.	1130	266	10
WTAC	Johnstown, Pa.	1120	268	100
WTAD	Carthage, Ill.	1270	236	50
WTAF	New Orleans, La.	Call signal changed to **WOWL**		
WTAG	Worcester, Mass.	1120	268	500
WTAL	Toledo, Ohio	1190	252	10
WTAM	Cleveland, Ohio	770	389.4	2500
WTAP	Cambridge, Ill.	1240	242	50
WTAQ	Osseo, Wis.	1180	254	100
WTAR	Norfolk, Va.	1150	261	100
WTAS	Elgin, Ill.	Call signal changed to **WLIB**		
WTAT	Boston, Mass. (portable)	1230	244	100
WTAW	College Station, Tex.	1110	270	250
WTAX	Streator, Ill.	1300	231	50
WTAY	Oak Park, Ill.	Call signal changed to **WGES**		
WTAZ	Lambertville, N. J.	1150	261	15
WTG	Manhattan, Kan.	1100	273	50
WTHS	Flint, Mich.	Ceased activities October, 1925		
WTIC	Hartford, Conn.	860	348.6	500
WWAD	Philadelphia, Pa.	1200	250	100
WWAE	Plainfield, Ill.	1240	242	500
WWAO	Houghton, Mich.	1140	263	250
WWGL	Richmond Hill, N. Y.	1410	212.6	500
WWI	Dearborn, Mich.	1130	266	500
WWJ	Detroit, Mich.	850	352.7	1000
WWL	New Orleans, La.	1090	275	100

To make these pages into a booklet, cut through the center, horizontally along the rule, and along the outside of the page. It will then be easy to fit the pages in order, as numbered. They may be bound with a pin or sewed with several stitches.

Fourteen

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
KFJB	Marshalltown, Ia.	1210	248	10
KFJC	Junction City, Kans.	1370	218.8	10
KFJF	Oklahoma, Okla.	1150	261	225
KFJI	Astoria, Ore.	1220	246	10
KFJM	Grand Forks, N. Dak	1080	278	100
KFJR	Portland, Ore.	1200	250	10
KFJX	Cedar Falls, Ia.	1160	258	50
KFJY	Fort Dodge, Ia.	1220	246	50
KFJZ	Fort Worth, Tex.	1180	254	50
KFKA	Greeley, Colo.	1100	273	50
KFKB	Milford, Kans.	Ceased Activities June, 1925		
KFKQ	Conway, Ark.	1200	250	100
KFKU	Lawrence, Kans.	1090	275	500
KFKX	Hastings, Neb.	1040	288.3	2000
KFKZ	Kirksville, Mo.	1330	226	5
KFLB	Menominee, Mich.	Ceased activities June, 1925		
KFLP	Cedar Rapids, Ia.	1170	256	20
KFLR	Albuquerque, N. Mex.	1180	254	200
KFLU	San Benito, Tex.	1270	236	10
KFLV	Rockford, Ill.	1310	229	100
KFLX	Galveston, Tex.	1250	240	10
KFLZ	Atlantic, Ia.	1100	273	100
KFMB	Little Rock, Ark.	Changes pending		
KFMQ	Fayetteville, Ark	1000	299.8	500
KFMR	Sioux City, Ia.	1150	261	100
KFMT	Minneapolis, Minn.	Call signal changed to **WHAT**		
KFMW	Houghton, Mich.	1140	263	50
KFMX	Northfield, Minn.	890	336.9	750
KFNF	Shenandoah, Ia.	1130	266	500
KFNG	Coldwater, Miss.	1180	254	10
KFNJ	Warrensburg, Mo.	Ceased activities June, 1925		
KFNL	Paso Robles, Cal.	Ceased activities June, 1925		
KFNV	Santa Rosa, Cal.	1310	229	50
KFNY	Helena, Mont.	Ceased activities June, 1925		
KFOA	Seattle, Wash.	660	454.3	500
KFOB	Burlingame, Cal.	1330	226	——
KFOC	Whittier, Cal.	Changes pending		
KFOJ	Moberly, Mo.	1240	242	10
KFON	Long Beach, Cal.	1290	233	100
KFOO	Salt Lake City, Utah	1270	236	250
KFOR	David City, Neb.	1330	226	100
KFOT	Wichita, Kans.	1300	231	50
KFOX	Omaha, Neb.	1210	248	100
KFOY	St. Paul, Minn.	1190	252	50
KFPG	Los Angeles, Calif.	1260	238	500
KFPL	Dublin, Texas	1190	252	15
KFPM	Greenville, Tex.	1240	242	10
KFPR	Los Angeles, Cal.	1300	231	500
KFPV	San Francisco, Cal.	Changes pending		
KFPW	Carterville, Mo.	1160	258	20
KFPY	Spokane, Wash.	1130	266	100
KFQA	St. Louis, Mo.	1150	261	100
KFQB	Fort Worth, Texas	1140	263	150

Three

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
KDKA	East Pittsburgh, Pa.	970	309.1	10,000
KDLR	Devils Lake, N. Dak.	1300	231	5
KDPM	Cleveland, Ohio	1200	250	500
KDYL	Salt Lake City, Utah	1220	246	50
KDZB	Bakersfield, Cal.	1430	209.7	100
KFAB	Lincoln, Neb.	800	340	500
KFAD	Phoenix, Ariz.	1100	273	100
KFAE	Pullman, Wash.	860	348.6	500
KFAF	San Jose, Cal.	1380	217.3	50
KFAJ	Boulder, Colo.	1150	261	100
KFAN	Moscow, Idaho	Ceased Activities October, 1925		
KFAU	Boise, Idaho	1060	282.8	750
KFAW	Santa Ana, Cal.	1400	214.2	10
KFBB	Havre, Mont.	1090	275	50
KFBC	San Diego, Cal.	1340	224	10
KFBG	Tacoma, Wash.	1200	250	50
KFBK	Sacramento, Cal.	1210	248	100
KFBL	Everett, Wash.	1340	224	50
KFBS	Trinidad, Colo.	1260	238	15
KFBU	Laramie, Wyo.	1110	270	500
KFCB	Phoenix, Ariz.	1260	238	100
KFCC	Helena, Mont.	1210	248	10
KFCF	Walla Walla, Wash.	1170	256	100
KFCY	Le Mars, Ia.	Call signal changed to KWUC		
KFCZ	Omaha, Neb.	1160	258	50
KFDD	Boise, Idaho	1080	278	50
KFDH	Tucson, Ariz.	1160	258	50
KFDJ	Corvallis, Ore.	1060	282.8	750
KFDM	Beaumont, Tex.	950	315.6	500
KFDX	Shreveport, La.	1200	250	100
KFDY	Brookings, S. Dak.	1100	273	100
KFDZ	Minneapolis, Minn.	1300	231	10
KFEC	Portland, Ore.	1210	248	50
KFEL	Denver, Colo.	1180	254	50
KFEQ	Oak, Neb.	1120	268	500
KFER	Fort Dodge, Ia.	Changes pending		
KFEY	Kellogg, Idaho	1290	233	10
KFFP	Moberly, Mo.	1240	242	50
KFFV	Lamoni, Ia.	1200	250	100
KFFY	Alexandria, La.	1090	275	50
KFGC	Baton Rouge, La.	1120	268	100
KFGD	Chickasha, Okla.	Call signal changed to KOCW		
KFGH	Stanford University, Cal.	1110	270	500
KFGQ	Boone, Ia.	1330	226	10
KFGX	Orange, Texas	1200	250	500
KFHA	Gunnison, Colo.	1190	252	50
KFHL	Oskaloosa, Ia.	1250	240	10
KFI	Los Angeles, Cal.	640	468.5	3000
KFIF	Portland, Ore.	1210	248	100
KFIO	Spokane, Wash.	1130	266	100
KFIQ	Yakima, Wash.	1170	256	100
KFIU	Juneau, Alaska	1330	226	10
KFIZ	Fondulac, Wisc.	1100	273	100

Canadian Broadcasting Stations

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
CFAC	Calgary, Alta.	690	434.5	500
CFCA	Toronto, Ont.	840	356.9	500
CFCF	Montreal, P. Q.	730	410.7	1650
CFCH	Iroquois Falls, Ont.	600	499.7	250
CFCK	Edmonton, Alta.	580	516.9	100
CFCN	Calgary, Alta.	690	434.5	750
CFCQ	Vancouver, B. C. (Not Active)	730	410.7	5
CFCU	Hamilton, Ont.	880	340.7	500
CFCT	Victoria, B. C.	910	329.5	500
CFCY	Charlottetown, P. E. I.	960	312.3	50
CFKC	Thorold, Ont.	1210	247.8	75
CFQC	Saskatoon, Sask.	910	329.5	500
CFRC	Kingston, Ont.	1120	267.7	500
CFXC	New Westminster, B. C.	1030	291.1	20
CFYC	Burnaby, B. C.	730	410.7	500
CHCS	Hamilton, Ont. (Not Active)	880	340.7	10
CHIC	Toronto, Ont.	840	356.9	500
CHNC	Toronto, Ont.	840	356.9	500
CHSC	Unity, Sask.	840	356.9	250
CHUC	Saskatoon, Sask.	910	329.5	50
CHXC	Ottawa, Ont.	690	434.5	250
CHYC	Montreal, P. Q.	730	410.7	850
CJCA	Edmonton, Alta.	580	516.9	500
CJCD	Toronto, Ont.	840	356.9	50
CJGC	London, Ont.	910	329.5	50
CJKC	Burnaby, B. C.	730	410.7	500
CJSC	Toronto, Ont.	840	356.9	500
CJWC	Saskatoon, Sask.	910	329.5	250
CKAC	Montreal, P. Q.	730	410.7	1200
CKCD	Vancouver, B. C.	730	410.7	1000
CKCK	Regina, Sask.	630	475.9	500
CKCL	Toronto, Ont.	840	356.9	500
CKCO	Ottawa, Ont.	690	434.5	100
CKCW	Durham Co., Ont. (Not Active)	910	329.5	5000
CKFC	Vanvouver, B. C.	730	410.7	50
CKOC	Hamilton, Ont.	880	340.7	50
CKY	Winnipeg, Man.	780	384.4	500
CNRA	Moncton, N. B.	960	312.3	500
CNRC	Calgary, Alta.	Uses stations CFAC or CFCN		
CNRE	Edmonton, Alta.	Uses station CJCA		
CNRM	Montreal, P. Q.	Uses station CHYC, CKAC or CFCF		
CNRO	Ottawa, Ont.	690	434.5	500
CNRR	Regina, Sask.	Uses station CKCK		
CNRS	Saskatoon, Sask.	Uses station CFQC		
CNRT	Toronto, Ont.	Uses station CFCA		
CNRV	Vancouver, B. C.	1030	291.1	500
CNRW	Winnipeg, Man.	Uses station CKY		

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
KFQC	Taft, Cal.	1300	231	100
KFQH	Burlingame, Cal.	Call signal changed to KFOB		
KFQP	Iowa City, Ia.	1340	224	10
KFQR	Oklahoma, Okla.	Changes pending		
KFQT	Denison, Tex.	1190	252	20
KFQU	Holy City, Cal.	1380	217.3	100
KFQW	North Bend, Wash.	1390	215.7	50
KFQY	Belden, Neb.	Ceased activities August, 1925		
KFQZ	Hollywood, Cal.	1330	226	50
KFRB	Beeville, Tex.	1210	248	250
KFRC	San Francisco, Cal.	1120	268	50
KFRH	Grafton, N. Dak.	Changes pending		
KFRL	Grand Forks, N. Dak.	Ceased activities October, 1925		
KFRM	Fort Sill, Okla.	1240	242	50
KFRQ	Portland, Ore.	Ceased activities June, 1925		
KFRU	Bristow, Okla.	Ceased activities October, 1925		
KFRU	Columbia, Miss	600	499.7	500
KFRW	Olympia, Wash.	1370	218.8	50
KFRX	Pullman, Wash.	1380	217.3	10
KFRY	State College, N. Mex.	1130	266	50
KFRZ	Hartington, Neb.	1350	222	15
KFSG	Los Angeles	1090	275	500
KFSY	Helena, Mont.	Ceased activities October, 1925		
KFU	Gridley, Cal.			
KFUJ	Breckenridge, Minn.	1240	242	50
KFUL	Galveston, Tex.	1160	258	10
KFUM	Colorado Springs, Colo	1240	242	100
KFUO	St. Louis, Mo.	550	545.1	500
KFUP	Denver, Colo.	1280	234	50
KFUR	Ogden, Utah	1340	224	50
KFUS	Oakland, Cal.	1170	256	50
KFUT	Salt Lake City, Utah	1150	261	100
KFUU	San Leandro, Cal.	1340	224	50
KFUV	Springfield, Mo.	Ceased activities October, 1925		
KFUY	Butte, Mont.	Ceased activities August, 1925		
KFUZ	Virginia, Minn.	Ceased activities October, 1925		
KFVC	Camden, Ark.	Ceased activities August, 1925		
KFVD	San Pedro, Cal.	1460	205.4	50
KFVE	St. Louis, Mo.	1250	240	500
KFVF	Hollywood, Cal.	1440	208.2	250
KFVG	Independence, Kans.	1270	236	10
KFVH	Manhattan, Kans.	1370	218.8	15
KFVI	Houston, Tex.	1210	248	10
KFVJ	San Jose, Cal.	1330	226	500
KFVK	Sacramento, Cal.	Ceased activities August, 1925		
KFVL	Vancouver, Wash.	Ceased activities August, 1925		
KFVN	Welcome, Minn.	1320	227	10
KFVO	Kirksville, Mo.	Call signal changed to KFKZ		
KFVR	Denver, Colo.	1220	246	50
KFVS	Cape Girardeau, Mo.	1340	224	50
KFVU	Eureka, Cal.	1430	209.7	5
KFVW	San Diego, Cal.	1200	246	500
KFVX	Bentonville, Ark.	1270	236	10

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
WOAX	Trenton, N. J.	1250	240	500
WOC	Davenport, Ia.	620	483.6	5000
WOCG	Sycamore, Ill.	1460	205.4	10
WOCL	Jamestown, N. Y.	1090	275	15
WODA	Paterson, N. J.	1340	224	250
WOI	Ames, Ia	1110	270	750
WOK	Homewood, Ill.	1380	217.3	500
WOKO	New York, N. Y.	1287	233	50
WOO	Philadelphia, Pa.	590	508.2	500
WOQ	Kansas City, Mo.	1080	278	1000
WOR	Newark, N. J.	740	405.2	500
WORD	Batavia, Ill.	1090	275	5000
WOS	Jefferson City, Mo.	680	440.9	500
WOWL	New Orleans, La.	1110	270	100
WOWO	Fort Wayne, Ind.	1320	227	500
WPAK	Agricultural College, N. Dak.	1090	275	50
WPAZ	Charlestown, W. Va.	Changes pending		
WPCC	Chicago, Ill.	1160	258	500
WPDQ	Buffalo, N. Y.	1460	205.4	500
WPG	Atlantic City, N. J.	1000	299.8	500
WPRC	Harrisburg, Pa.	1390	215.7	100
WPSC	State College, Pa.	1150	261	500
WQAA	Parkesburg, Pa.	1360	220	500
WQAC	Amarilla, Tex.	1280	234	100
WQAE	Springfield, Vt.	1220	246	50
WQAM	Miami, Fla.	1120	268	100
WQAN	Scranton, Pa.	1200	250	100
WQAO	New York, N. Y.	833	360	100
WQAS	Lowell, Mass.	Changes pending		
WQJ	Chicago, Ill.	670	447.5	500
WRAA	Houston, Tex.	Changes pending		
WRAF	Laporte, Ind.	1340	224	100
WRAK	Escanaba, Mich.	1170	256	100
WRAM	Galesburg, Ill.	1230	244	100
WRAV	Yellow Springs, Ohio	1140	263	100
WRAW	Reading, Pa.	1260	238	10
WRAX	Gloucester, N. J.	1120	268	250
WRBC	Valparaiso, Ind.	1080	278	500
WRC	Washington, D. C.	639	469	1000
WREO	Lansing, Mich.	1050	285.5	500
WRHF	Washington, D. C.	1170	256	50
WRHM	Minneapolis, Minn.	1190	252	50
WRK	Hamilton, Ohio	1110	270	200
WRM	Urbana, Ill.	1100	273	500
WRMU	New York, N. Y. (portable)	1270	236	100
WRNY	New York, N. Y.	1160	258	500
WRR	Dallas, Tex.	1150	261	350
WRST	Bay Shore, N. Y.	1390	215.7	250
WRVA	Richmond, Va.	1170	256	1000
WRW	Tarrytown, N. Y.	1110	273	500
WSAC	Clemson College, S. C.	Ceased activities October, 1925		
WSAD	Providence, R. I.	Ceased activities June, 1925		
WSAG	St. Petersburg, Fla.	Ceased activities August, 1925		

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
WJZ	New York, N. Y.	660	454.3	1000
WKAA	Cedar Rapids, Ia.	1080	278	500
WKAD	East Providence, R. I.	1250	240	20
WKAF	Milwaukee, Wis.	1150	261	250
WKAP	Cranston, R. I.	1280	234	50
WKAQ	San Juan, Porto Rico	880	340.7	500
WKAR	East Lansing, Mich.	1050	285.5	1000
WKAV	Laconia, N. H. (portable)	1430	209.7	50
WKBB	Joliet, Ill.	1400	214.2	100
WKBE	Webster, Mass.	1300	231	100
WKBG	Chicago, Ill.	1390	215.7	100
WKBK	New York, N. Y.	1430	209.7	500
WKRC	Cincinnati, Ohio	920	325.9	1000
WKY	Oklahoma, Okla.	1090	275	100
WLAL	Tulsa, Okla.	1200	250	150
WLAP	Louisville, Ky.	1090	275	20
WLAX	Greencastle, Ind.	1300	231	10
WLB	Minneapolis, Minn	1080	278	500
WLBL	Stevens Point, Wis.	1080	278	500
WLIB	Elgin (near), Ill.	990	302.8	1500
WLIT	Philadelphia, Pa.	760	394.5	500
WLS	Chicago, Ill.	870	344.6	1500
WLTS	Chicago, Ill.	1160	258	100
WLW	Harrison, Ohio	710	422.3	5000
WLWL	New York, N. Y.	1040	288.3	1000
WMAC	Cazenovia, N. Y.	1090	275	100
WMAF	Dartmouth, Mass.	680	440.9	1000
WMAK	Lockport, N. Y.	1130	266	500
WMAL	Washington, D. C.	1410	212.6	15
WMAN	Columbus, Ohio	1080	278	50
WMAQ	Chicago, Ill.	670	447.5	500
WMAY	St. Louis	1210	248	100
WMAZ	Macon, Ga.	1150	261	500
WMBB	Chicago, Ill.	1200	250	500
WMBC	Detroit, Mich.	1170	256	100
WMBF	Miami Beach, Fla.	780	384.4	500
WMC	Memphis, Tenn.	600	499.7	500
WMCA	Hoboken, N. J.	880	340.7	500
WNAB	Boston, Mass.	1200	250	100
WNAC	Boston, Mass.	1070	280.2	500
WNAD	Norman, Okla.	1180	254	250
WNAR	Butler, Mo.	1300	231	20
WNAT	Philadelphia, Pa.	1200	250	100
WNAV	Knoxville, Tenn.	1290	233	500
WNAX	Yankton, S. Dak.	1230	244	100
WNBH	New Bedford, Mass.	1210	248	250
WNJ	Newark, N. J.	1290	233	100
WNOX	Knoxville, Tenn.	1120	268	500
WNYC	New York, N. Y.	570	526	1000
WOAC	Lima, Ohio	1150	261	10
WOAI	San Antonio, Tex.	760	394.5	2000
WOAN	Lawrenceburg, Tenn.	1060	282.8	500
WOAW	Omaha, Neb.	570	526	1000

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
KFVY	Albuquerque, N. Mex.	1200	250	10
KFWA	Ogden, Utah	1150	261	500
KFWB	Hollywood, Cal.	1190	252	500
KFWC	Upland, Cal.	1420	211.1	50
KFWF	St. Louis, Mo.	1400	214.2	250
KFWH	Chico, Cal.	1180	254	100
KFWI	South San Francisco, Cal.	1330	226	500
KFWM	Oakland, Cal.	1430	206.8	500
KFWO	Avalon, Cal.	1420	211.1	250
KFWP	Brownsville, Tex.	1400	214.2	10
KFWU	Pineville, La.	1260	238	100
KFWV	Portland, Ore.	1410	212.6	50
KFXB	Big Bear Lake, Cal.	1480	202.6	500
KFXC	Santa Maria, Cal.	1430	209.7	100
KFXD	Logan, Utah	1460	205.4	10
KFXE	Waterloo, Ia.	1270	236	10
KFXF	Colorado Springs, Colo.	1200	250	500
KFXH	El Paso, Tex.	1240	242	50
KFXJ	Colorado (portable)	1390	215.7	10
KFXM	Beaumont, Tex	1320	227	10
KFXY	Flagstaff, Ariz.	1460	205.4	50
KFYD	Muscatine, Ia.	1170	256	250
KFYF	Oxnard, Cal	1460	205.4	10
KFYJ	Houston, Tex	1260	238	10
KFYR	Bismarck, N. Dak.	1210	248	10
KGB	Tacoma, Wash.	1200	250	50
KGO	Oakland, Cal.	830	361.2	3000
KGTT	San Francisco, Cal.	1280	234	50
KGU	Honolulu, Hawaii	1110	270	500
KGW	Portland, Ore.	610	491.5	500
KGY	Lacey, Wash.	1220	246	5
KHJ	Los Angeles, Cal.	740	405.2	500
KHQ	Spokane, Wash.	1100	273	500
KJBS	San Francisco, Cal.	1360	220	—
KJR	Seattle, Wash.	780	384.4	1000
KLDS	Independence, Mo.	680	440.9	1000
KLS	Oakland, Cal.	1200	252	250
KLX	Oakland, Cal.	590	508.2	500
KLZ	Denver, Colo.	1130	266	250
KMA	Shenandoah, Ia.	1190	252	500
KMJ	Fresno, Cal.	1280	234	50
KMO	Tacoma, Wash.	1200	250	100
KNRC	Los Angeles, Cal.	—	—	—
KNX	Los Angeles, Cal.	890	336.9	500
KOA	Denver, Colo.	930	322.4	2000
KOB	State College, N. Mex.	860	348.6	750
KOCH	Omaha, Neb.	1160	258	250
KOCW	Chickasha, Okla.	1190	252	200
KOIL	Council Bluffs, Ia.	1080	278	500
KOP	Detroit, Mich.	1080	277.6	500
KPO	San Francisco, Cal.	700	428.3	1000
KPPC	Pasadena, Cal.	1310	229	50
KPRC	Houston, Tex.	1010	296.9	500

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
WGBS	New York, N. Y.	949	316	500
WGBT	Greenville, S. C.	Ceased activities October, 1925		
WGBU	Fulford-by-Sea, Fla.	1080	278	500
WGBW	Spring Valley, Ill.	1170	256	10
WGBX	Orono, Me.	1190	252	100
WGBY	New Lebanon, Ohio	Ceased activities August, 1925		
WGCP	Newark, N. J.	1190	252	500
WGES	Oak Park, Ill.	1200	250	500
WGHB	Clearwater, Fla.	1130	266	500
WGHP	Detroit, Mich.	1110	270	1500
WGMU	Richmond Hill, N. Y. (portable)	1270	236	100
WGN	Chicago, Ill.	810	370.2	1000
WGR	Buffalo, N. Y.	940	319	750
WGST	Atlanta, Ga.	1110	270	500
WGY	Schenectady, N. Y.	790	379.5	5000
WHA	Madison, Wis.	560	535.4	750
WHAD	Milwaukee, Wis.	1090	275	500
WHAG	Cincinnati, Ohio	1300	231	100
WHAM	Rochester, N. Y.	1080	278	500
WHAP	New York, N. Y.	1250	240	100
WHAR	Atlantic City, N. J.	1090	275	500
WHAS	Louisville, Ky.	750	399.8	500
WHAT	Minneapolis, Minn.	—	—	500
WHAV	Wilmington, Del.	1130	266	100
WHAZ	Troy, N. Y.	790	379.5	1000
WHB	Kansas City, Mo.	820	365.6	500
WHBA	Oil City, Pa.	1200	250	10
WHBB	Stevens Point, Wis.	Ceased activities October, 1925		
WHBC	Canton, Ohio	1180	254	10
WHBD	Bellefontaine, Ohio	1350	222	20
WHBF	Rock Island, Ill.	1350	222	100
WHBG	Harrisburg, Pa.	1300	231	20
WHBH	Culver, Ind.	1350	222	10
WHBI	Chesaming, Mass.	Ceased activities June, 1925		
WHBJ	Fort Wayne, Ind.	1280	234	10
WHBK	Ellsworth, Me.	1300	231	10
WHBL	Logansport, Ind.	1390	215.7	50
WHBM	Chicago, Ill. (portable)	1290	233	20
WHBN	St. Petersburg, Fla.	1260	238	10
WHBQ	Pawtucket, R. I.	Changes pending		
WHBP	Johnstown, Pa.	1170	256	100
WHBQ	Memphis, Tenn.	1290	233	50
WHBR	Cincinnati, Ohio	1390	215.7	—
WHBS	Mechanicsburg, Ohio	Changes pending		
WHBT	Downers Grove, Ill.	Ceased activities June, 1925		
WHBU	Anderson, Ind.	1370	218.8	10
WHBV	Columbus, Ga.	Ceased activities August, 1925		
WHBW	Philadelphia, Pa.	1390	215.7	100
WHBX	Punxsutawny, Pa.	Changes pending		
WHBY	West De Pere, Wis.	1200	250	50
WHDI	Minneapolis, Minn.	1080	278	500
WHEC	Rochester, N. Y.	1160	258	100
WHK	Cleveland, Ohio	Ceased activities October, 1925		

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
WARC	Medford Hillside, Mass.	1150	261	100
WBAA	West Lafayette, Ind.	1100	273	500
WBAK	Harrisburg, Pa.	1090	275	500
WBAO	Decatur, Ill.	1110	270	100
WBAP	Fort Worth Tex.	630	475.9	1500
WBAV	Columbus, Ohio	1020	293.9	500
WBAX	Wilkes-Barre, Pa.	1170	256	100
WBBG	Mattapoisett, Mass.	1210	248	100
WBBL	Richmond, Va.	1310	229	100
WBBM	Chicago, Ill.	1330	226	1500
WBBP	Petoskey, Mich.	1260	238	200
WBBR	Staten Island, N. Y.	1100	273	500
WBBS	New Orleans, La.	1190	252	50
WBBU	Monmouth, Ill.	1340	224	10
WBBV	Johnstown, Pa.	Changes pending		
WBBW	Norfolk, Va.	1350	222	50
WBBY	Charleston, S. C.	1120	268	10
WBBZ	Indianapolis, Ind.	Ceased activities June, 1925		
WBBZ	Chicago, Ill. (Portable)	1390	215.7	50
WBCN	Chicago, Ill.	1130	266	500
WBDC	Grand Rapids, Mich.	1170	256	50
WBES	Takoma Park, Md.	1350	222	100
WBNY	New York, N. Y.	1430	209.7	500
WBOQ	Richmond Hill, N. Y.	1270	236	100
WBRC	Birmingham, Ala.	1210	248	10
WBRE	Wilkes-Barre, Pa.	1300	231	10
WBS	Newark, N. J.	Changed to **WGCP**		
WBT	Charlotte, N. C.	Ceased activities October, 1925		
WBZ	Springfield, Mass.	900	333.1	2000
WBZA	Boston, Mass.	1240	242	250
WCAC	Mansfield, Conn.	1090	275	500
WCAD	Canton, N. Y.	1140	263	250
WCAE	Pittsburgh, Pa.	650	461.3	500
WCAG	New Orleans, La.	Changes pending		
WCAH	Columbus, Ohio	1130	266	500
WCAJ	University Pl., Neb.	1180	254	500
WCAL	Northfield, Minn.	890	336.9	500
WCAO	Baltimore, Md.	1090	275	100
WCAP	Washington, D. C.	640	468.5	500
WCAR	San Antonio, Tex.	1140	263	500
WCAT	Rapid City, S. Dak.	1250	240	50
WCAU	Philadelphia, Pa.	1080	278	500
WCAX	Burlington, Vt.	1200	250	100
WCAY	Milwaukee, Wis.	Changes pending		
WCAZ	Carthage, Ill.	1220	246	50
WCBA	Allentown, Pa.	1180	254	500
WCBC	Ann Arbor, Mich.	Ceased activities October, 1925		
WCBD	Zion, Ill.	870	344.6	5000
WCBE	New Orleans, La.	1140	263	5
WCBG	Pascagoula, Miss.	1120	268	10
WCBH	Oxford (near) Miss.	1240	241	19
WCBI	Bemis, Tenn.	Ceased activities June, 1925		
WCBJ	Jennings, La.	Ceased activities June, 1925		

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
KPSN	Pasadena, Cal	950	315.6	1000
KQP	Portland, Ore.	1410	212.6	500
KQV	Pittsburgh, Pa.	1090	275	500
KQW	San Jose, Cal.	1300	231	500
KRE	Berkeley, Cal.	1170	256	50
KSAC	Manhattan, Kans.	880	340.7	500
KSD	St. Louis, Mo.	550	545.1	750
KSL	Salt Lake City, Utah	1000	299.8	1000
KSO	Clarinda, Ia.	1240	242	500
KTAB	Oakland, Cal.	1250	240	1000
KTBI	Los Angeles, Cal.	1021	293.9	750
KTBR	Portland, Ore.	1140	263	50
KTCL	Seattle, Wash.	980	305.9	1000
KTHS	Hot Springs, Ark.	800	274.8	500
KTW	Seattle, Wash.	660	454.3	1000
KUO	San Francisco, Cal.	1200	250	150
KUOM	Missoula, Mont.	1230	244	250
KUPR	Omaha, Neb.	1110	270	50
KUSD	Vermilion, S. Dak.	1080	278	100
KUT	Austin, Tex.	1300	231	500
KWG	Stockton, Cal.	1210	248	50
KWKC	Kansas City, Mo.	1270	236	100
KWUC	LeMars, Ia.	1190	252	50
KWWG	Brownsville, Tex.	1080	278	500
KYW	Chicago, Ill.	560	535.4	1500
KZKZ	Manila, Philippines	1110	270	100
KZM	Oakland, Cal.	1250	240	100
KZRQ	Manila, Philippines	1350	222	500
WAAB	New Orleans, La.	1120	268	100
WAAC	New Orleans, La.	1090	275	100
WAAD	Cincinnati, Ohio	1160	258	25
WAAF	Chicago, Ill.	1080	278	200
WAAM	Newark, N. J.	1140	263	500
WAAW	Omaha, Neb.	770	389.4	500
WABA	Lake Forest, Ill.	Ceased activities October, 1925		
WABB	Harrisburg, Pa.	Ceased activities October, 1925		
WABC	Asheville, N. C.	1180	254	10
WABI	Bangor, Me.	1250	240	100
WABL	Storrs, Conn.	Changed to **WCAC** Mansfield, Conn.		
WABO	Rochester, N. Y.	1080	278	100
WABQ	Haverford, Pa.	1150	261	100
WABR	Toledo, Ohio	1140	263	50
WABW	Wooster, Ohio	1450	206.8	50
WABX	Mount Clemens (near), Mich.	1220	246	500
WABY	Philadelphia, Pa.	1240	242	50
WABZ	New Orleans, La.	1090	275	50
WADC	Akron, Ohio	1160	258	100
WAFD	Port Huron, Mich.	1090	275	500
WAHG	Richmond Hill, N. Y.	950	315.6	500
WAIT	Taunton, Mass.	1310	229	10
WAMD	Minneapolis, Minn.	1230	244	500
WAPI	Auburn, Ala.	1210	248	500

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
WHN	New York, N. Y.	830	361.2	500
WHO	Des Moines, Ia.	570	526	500
WHT	Deerfield, Ill.	750	400	1500
WIAD	Philadelphia, Pa.	1200	250	100
WIAK	Omaha, Neb.	Changes pending		
WIAS	Burlington, Ia.	1180	254	100
WIBA	Madison, Wis.	1270	236	100
WIBC	St. Petersburg, Fla.	1350	222	100
WIBD	Joliet, Ill.	Ceased activities October, 1925		
WIBE	Martinsburg, W. Va.	Ceased activities August, 1925		
WIBF	Wheatland, Wis.	Changes pending		
WIBG	Elkins Park, Pa.	1350	222	50
WIBH	New Bedford, Mass.	1430	209.7	5
WIBI	Flushing, N. Y.	1370	218.8	50
WIBJ	Chicago, Ill. (portable)	1390	215.7	50
WIBK	Toledo, Ohio	Ceased activities October, 1925		
WIBL	Chicago, Ill. (portable)	Ceased activities August, 1925		
WIBM	Chicago, Ill. (portable)	1390	215.7	10
WIBO	Chicago, Ill	1330	226	1000
WIBP	Meridian, Miss.	Ceased activities October, 1925		
WIBQ	Farina, Ill.	1460	205.4	5
WIBR	Weirton, W. Va.	1220	246	50
WIBS	Elizabeth, N J.	1480	202.6	20
WIBU	Poynette, Wis.	1350	222	20
WIBV	Henderson, N. C.	1140	263	25
WIBW	Logansport, Ind.	1360	220	100
WIBX	Utica, N. Y.	1460	205.4	5
WIBZ	Montgomery, Ala.	1300	231	10
WIL	St. Louis, Mo.	1100	273	250
WIP	Philadelphia, Pa.	590	508.2	500
WJAD	Waco, Tex.	850	352.7	500
WJAG	Norfolk, Neb.	1110	270	250
WJAK	Greentown, Ind.	1180	254	100
WJAM	Cedar Rapids, Ia.	1120	268	100
WJAR	Providence, R. I.	980	305.9	500
WJAS	Pittsburg, Pa.	930	322.4	1500
WJAZ	Chicago, Ill.	1120	268	100
WJBA	Joliet, Ill.	1450	206.8	50
WJBB	St. Petersburg, Fla.	1450	206.8	10
WJBC	La Salle, Ill.	1280	234	100
WJBD	Ashland, Wis.	1290	233	100
WJBG	Charlotte, N. C.	1340	224	10
WJBI	Red Bank, N. J.	1370	218.8	250
WJBI	Joliet, Ill.	Call signal changed to **WCLS**		
WJBK	Ypsilanti, Mich.	1290	233	10
WJBL	Decatur, Ill.	1110	270	500
WJBN	Sycamore, Ill.	1170	256	10
WJBP	Buffalo, N. Y.	1370	218.8	50
WJBQ	Lewisburg, Pa.	1420	211.1	100
WJD	Granville, Ohio	1380	217.3	10
WJJD	Mooseheart, Ill.	990	302.8	500
WJR	Pontiac, Mich.	580	517	1500
WJY	New York, N. Y.	740	405.2	1000

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
WCBM	Baltimore, Md.	1310	229	50
WCBQ	Nashville, Tenn.	1270	236	100
WCBR	Providence, R. I. (portable)	1460	205	30
WCBU	Arnold, Pa.	Ceased activities October, 1925		
WCCO	St. Paul, Minn.	720	416.4	5000
WCEE	Elgin (near), Ill.	1090	275	1000
WCK	St. Louis, Mo.	Call signal changed to **WSBF**		
WCLO	Camp, Wis.	1300	231	50
WCLS	Joliet, Ill.	1400	214.2	100
WCM	Austin, Tex.	1120	268	250
WCSH	Portland, Me.	1170	256	500
WCTS	Worcester, Mass.	Call changed to **WTAG**		
WCUW	Worcester, Mass.	1260	238	250
WCWS	Providence, R. I.	1430	209.7	100
WCX	Detroit, Mich.	Now operating in conjunction with **WJR**		
WDAD	Nashville, Tenn.	1330	226	150
WDAE	Tampa, Fla.	1100	273	250
WDAF	Kansas City, Mo.	820	365.6	1000
WDAG	Amarillo, Tex.	1140	263	100
WDAH	El Paso	Ceased activities August, 1925		
WDAY	Fargo, N. Dak.	1150	261	50
WDBC	Lancaster, Pa.	1160	258	50
WDBE	Atlanta, Ga.	1110	270	100
WDBJ	Roanoke, Va.	1310	229	50
WDBK	Cleveland, Ohio	1320	227	100
WDBO	Winter Park, Fla.	1250	240	100
WDBP	Superior, Wis.	Ceased activities		
WDBQ	Salem, N. J.	1280	234	10
WDBR	Boston, Mass.	1150	261	100
WDBS	Dayton, Ohio	Call signal changed to **WSMK**		
WDBW	Columbia, Tenn.	Ceased activities June, 1925		
WDBX	New York, N. Y.	Call signal changed to **WOKO**		
WDBY	Chicago, Ill.	Call signal changed to **WPCC**		
WDBZ	Kingston, N. Y.	1290	233	10
WDCH	Hanover, N. H.	1170	256	100
WDM	Washington, D. C.	Changes pending		
WDOD	Chattanooga, Tenn.	1170	256	50
WDWF	Cranston, R. I.	680	440.9	500
WDZ	Tuscola, Ill.	1080	278	100
WEAA	Flint, Mich.	Call changed **WFDF**		
WEAF	New York, N. Y.	610	492	5000
WEAH	Wichita, Kans.	1120	268	100
WEAI	Ithaca, N. Y.	1180	254	500
WEAJ	Vermilion, S. Dak.	Call signal changed to **KUSD**		
WEAM	North Plainfield, N. J.	1150	261	250
WEAN	Providence, R. I.	1110	270	250
WEAO	Columbus, Ohio	1020	294	500
WEAR	Cleveland, Ohio	770	389.4	1000
WEAU	Sioux City, Ia.	1090	275	100
WEAY	Houston, Tex.	Ceased activities October, 1925		
WEBA	Highland Park, N. J.	1290	233	15
WEBC	Superior, Wis.	1240	242	100

CALL SIGNAL	LOCATION	FREQUENCY IN KCYS.	WAVE-LENGTH IN METERS	POWER IN WATTS
WEBD	Anderson, Ind.	1220	246	10
WEBE	Cambridge, Mass.	1280	234	10
WEBH	Chicago, Ill.	810	370.2	1000
WEBJ	New York, N. Y.	1100	273	500
WEBK	Grand Rapids, Mich.	1240	242	20
WEBL	United States (portable)	1330	226	100
WEBM	United States (portable)	1330	226	100
WEBQ	Harrisburg, Ill.	1330	226	10
WEBR	Buffalo, N. Y.	1230	244	100
WEBT	Dayton, Ohio.	1170	256	5
WEBW	Beloit, Wis.	1120	268	500
WEBZ	Savannah, Ga.	1140	263	50
WEEI	Boston, Mass.	630	475.9	500
WEHS	Evanston, Ill.	1480	202.6	20
WEMC	Berrien Springs, Mass.	1050	285.5	500
WENR	Chicago, Ill.	1130	266	1000
WEW	St. Louis, Mo.	1210	248	100
WFAA	Dallas, Tex.	630	475.9	500
WFAM	St. Cloud, Minn.	1100	273	10
WFAV	Lincoln, Neb.	1090	275	500
WFBB	Eureka, Ill.	Ceased activities June, 1925		
WFBC	Knoxville, Tenn.	1200	250	50
WFBD	Philadelphia, Pa.	1280	234	5
WFBE	Seymour, Ind.	1330	226	20
WFBG	Altoona, Pa.	1080	278	100
WFBH	New York, N. Y.	1100	273	500
WFBI	Camden, N. J.	1270	236	250
WFBJ	Collegeville, Minn.	1270	236	50
WFBK	Hanover, N. H.	Changes pending		
WFBL	Syracuse, N. Y.	1190	252	100
WFBM	Indianapolis, Ind.	1120	268	250
WFBN	Bridgewater, Mass.	Ceased activities August, 1925		
WFBQ	Raleigh, N. C.	1190	252	50
WFBR	Baltimore, Md.	1180	254	100
WFBY	Fort Benjamin, Ind.	Changes pending		
WFBZ	Galesburg, Ill.	1180	254	20
WFDF	Flint, Mich.	1280	234	100
WFI	Philadelphia, Pa.	760	394.5	500
WFKB	Chicago, Ill.	1380	217.3	200
WFRL	Brooklyn, N. Y.	1460	205.4	100
WGAL	Lancaster, Pa.	1210	248	10
WGAZ	South Bend, Ind.	Call signal changed to **WSBT**		
WGBA	Baltimore, Md.	1180	254	100
WGBB	Freeport, N. Y.	1230	244	100
WGBC	Memphis, Tenn.	1080	278	10
WGBF	Evansville, Ind.	1270	236	100
WGBH	Fall River, Mass. (portable)	Changes pending		
WGBI	Scranton, Pa.	1250	240	50
WGBK	Johnstown, Pa.	1210	248	5
WGBL	Elyria, Ohio	1320	227	10
WGBM	Providence, R. I.	1280	234	5
WGBQ	Menomonie, Wis.	1280	234	100
WGBR	Marshfield, Wis.	1310	229	10

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Methods for Controlling Oscillation in R. F. Circuits

The Systems at Present in Use for Neutralizing Radio-Frequency Amplifiers and a Discussion of the Recently Developed "Counterphase" Method for Controlling Oscillations

By JOHN BERNARD

BEFORE looking into the future and ascertaining what is in store for the dyed-in-the-wool experimenter and builder of radio circuits, it is well to pause for a moment in consideration of what has gone before.

Without any question, tuned radio frequency amplification, that discarded system of reception of years ago, has again come into its own and is now the general mainstay and backbone of receiver design.

But even up to the present time, the especial and particular difficulties which have accompanied this system of reception are far from being satisfactorily controlled.

Constantly, the birth of a new method for the successful handling and control of radio frequency amplication is heralded as the last word in efficiency and performance—and still we search on.

In brief reconsideration of the many methods of control of radio-frequency amplifiers, it is worthy of mention to restate the particular advantages and disadvantages of this system of amplification.

In the application of Ohm's law, we find that, if for a given voltage, the resistance of a certain circuit be reduced, then a greater current will flow. And conversely, if the resistance be increased then the current will be decreased.

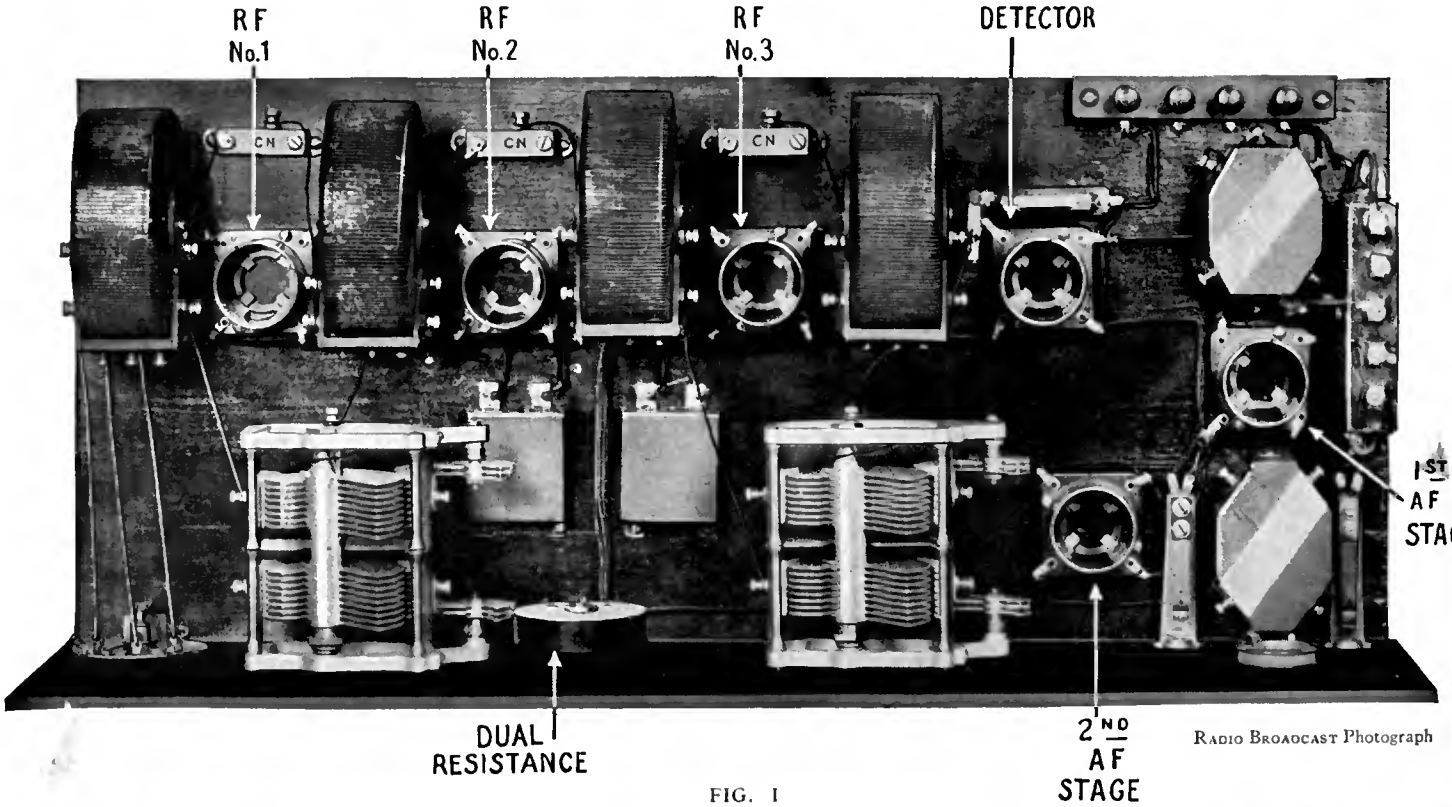
In a radio circuit where a coil is tuned by a variable condenser, a maximum of current will flow in the circuit when the condenser adjusts the circuit to resonance with the transmitted frequency. Where, in a vacuum tube circuit the grid and plate circuits are in resonance, a maximum of current will flow in each one and the only coupling agent between them is the tube capacity. When such a state of affairs exists, the entire circuit oscillates.

Where high-grade apparatus is employed to cut down the actual resistances of the circuit, sharp tuning of the circuit by the variable tuning element, as shown in Fig. 2, is obtained.

Now if it were possible to utilize such a circuit with its advantage of extra-fine tuning, there would be no obstacle to be overcome or problem to be solved. However, this is not the case. Whenever a circuit is in oscillation, it produces radio frequency energy which, when adjusted in frequency to the frequency of an incoming signal, produces distorted reception, sometimes unintelligible. It is as though two broadcasting stations were transmitting on the same frequency adjustment and were received simultaneously.

Yet if it were possible to prevent the

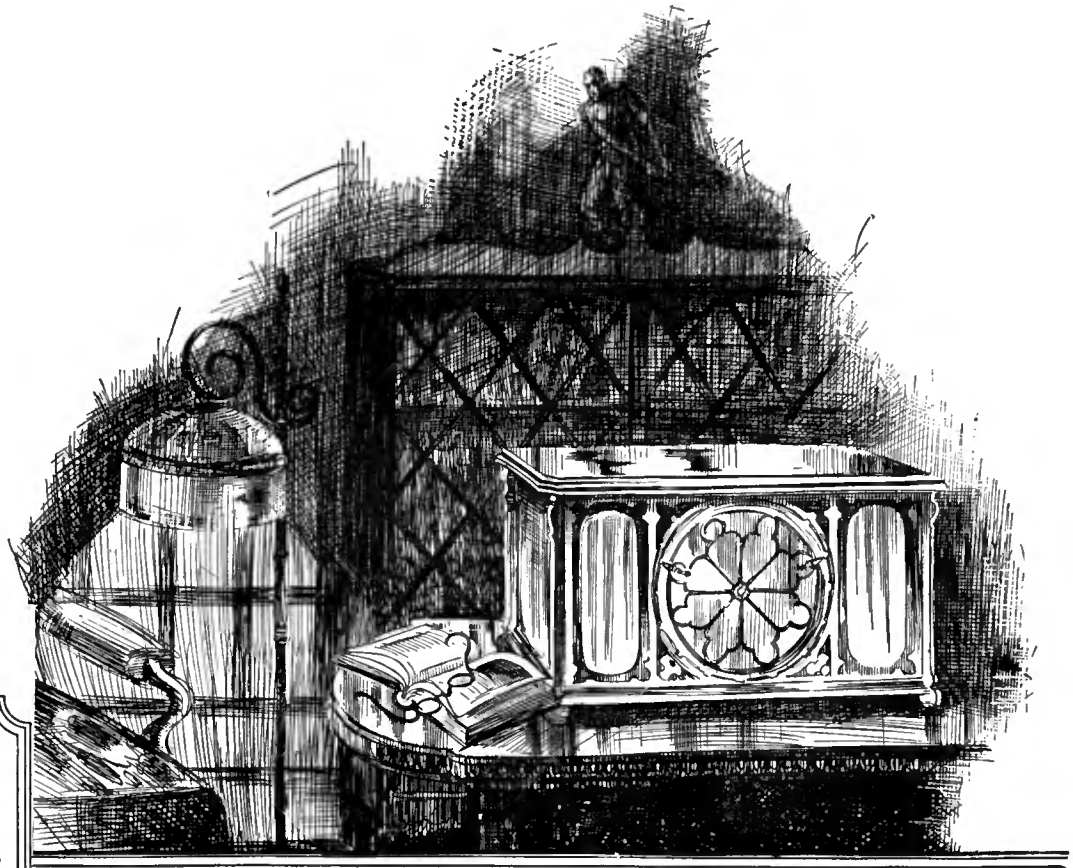
NEARLY every multi-tube receiver in use today employs some form of radio frequency amplification, and the matter of controlling oscillations in such circuits has always been a serious problem. In this article, the various popular methods are reviewed, and a description is offered of a method which differs from the conventional "losser" and from neutralizing schemes. The present arrangement combines resistance and capacity as a method of control, and should arouse a considerable amount of interest, for the idea may have wide application in r.f. circuits.—THE EDITOR



RADIO BROADCAST Photograph

FIG. 1

A base-board layout of the Bremer-Tully "Counterphase" receiver. The rectangular blocks shown above the tube sockets and between the toroidal coils, are the condensers, by means of which the tubes may be adjusted to the correct oscillating point. Note also the extra midget or trimming condensers, which are a part of the large tandem tuning condensers



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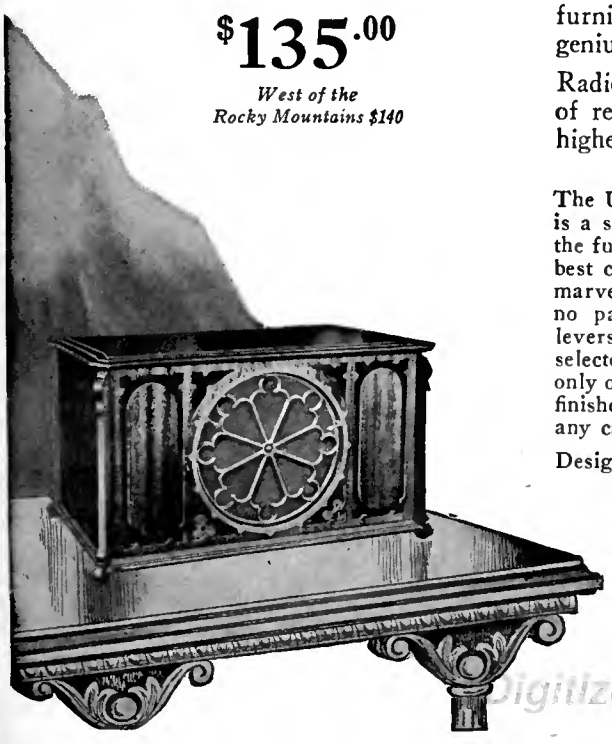

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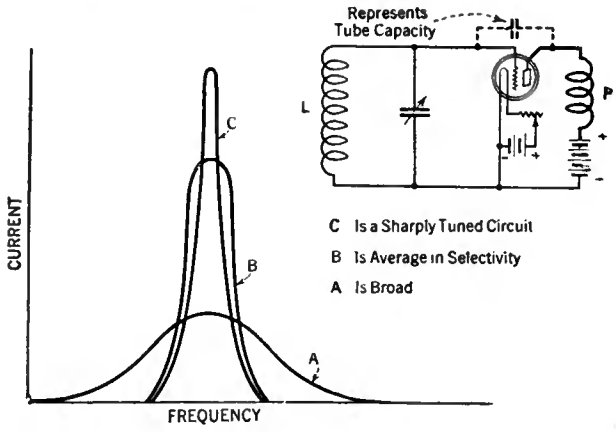

FIG. 2

The circuit above depends, for selectivity, upon the resistance of the tuned portion, represented by the coil L and the variable condenser shunting it. If the resistance is high, the tuning response will be broad as in the curve A. As the resistance is decreased the selectivity becomes sharper, as depicted on curves B, and C. Also, as the resistance of the circuit is decreased, more current will flow in the grid and plate circuits and oscillations will be produced due to the coupling between these two circuits by the inherent capacity of the tube

oscillation, but keep the circuit as sharply tuned to that particular frequency as before, then a distinct and worthwhile advantage would result.

The various systems for stopping this oscillation are known as neutralization methods.

The word itself carries a world of meaning, and implies an equalization or neutralization of the capacity of the tube which is the coupling agent producing the oscillation. In effect, neutralization is the setting up of an equal and opposing voltage which, due to its opposition, prevents unwanted oscillations from taking place in the grid-plate circuit of the tube in question. The well known neutrodyne system is shown in Fig. 3.

Another system worthy of comparison is that developed by Walter Van B. Roberts. It is shown in Fig. 4. Here, any potential set up in the plate coil P is set up also in the plate coil N, but in opposite relation to that flowing in P. Then through the capacity C, which balances out the tube capacity, this potential is applied to the grid of the tube, effectively preventing any possibility of oscillation because it is equal in potential, and opposite in phase, to that which might be fed back to the grid of the tube by the coil P through the tube capacity. Yet, even this method is not possible of adjustment independent of frequency.

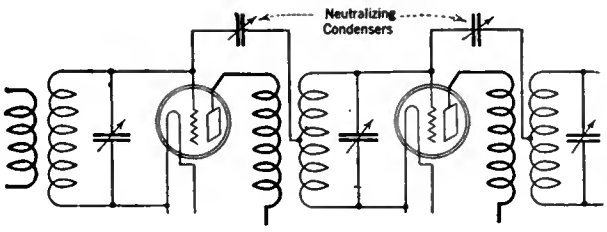

FIG. 3

Professor L. A. Hazeltine is responsible for the neutralization, or balancing-out system shown above. A goodly portion of all the manufactured receivers sold during the past few years incorporated this system using licenses granted under the neutrodyne patents

Absorption systems, still another way, never were regarded as truly a satisfactory neutralization method, and were more correctly termed "losser" systems.

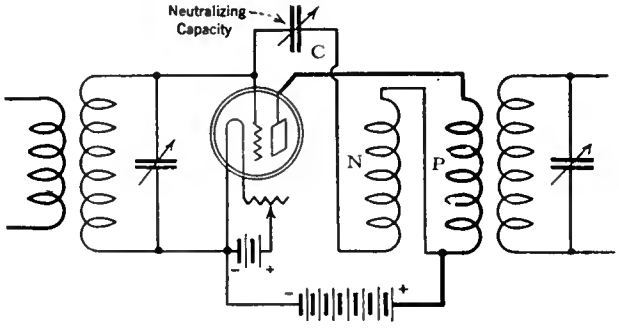

FIG. 4

The Roberts system of neutralization. The coil in series with the neutralizing capacity is connected counter to the plate coil, and produces an effect on the grid, through the neutralizing capacity, equal and opposite to that produced by the plate coil acting through the grid-plate capacity of the tube

OSCILLATION CONTROL METHODS

ONE of the most simple and common methods is to add sufficient resistance to the grid or plate circuit to prevent the possibility of oscillation. Considering the efforts that have been made to reduce resistance in coils and condensers, and the value attributed to such efforts, the fallacy of again deliberately introducing such losses into a circuit is evident. Were it not for the popular delusions, how much more simple it would be to use high-loss coils and condensers in the first place.

Eddy current losses result from placing condensers within the field

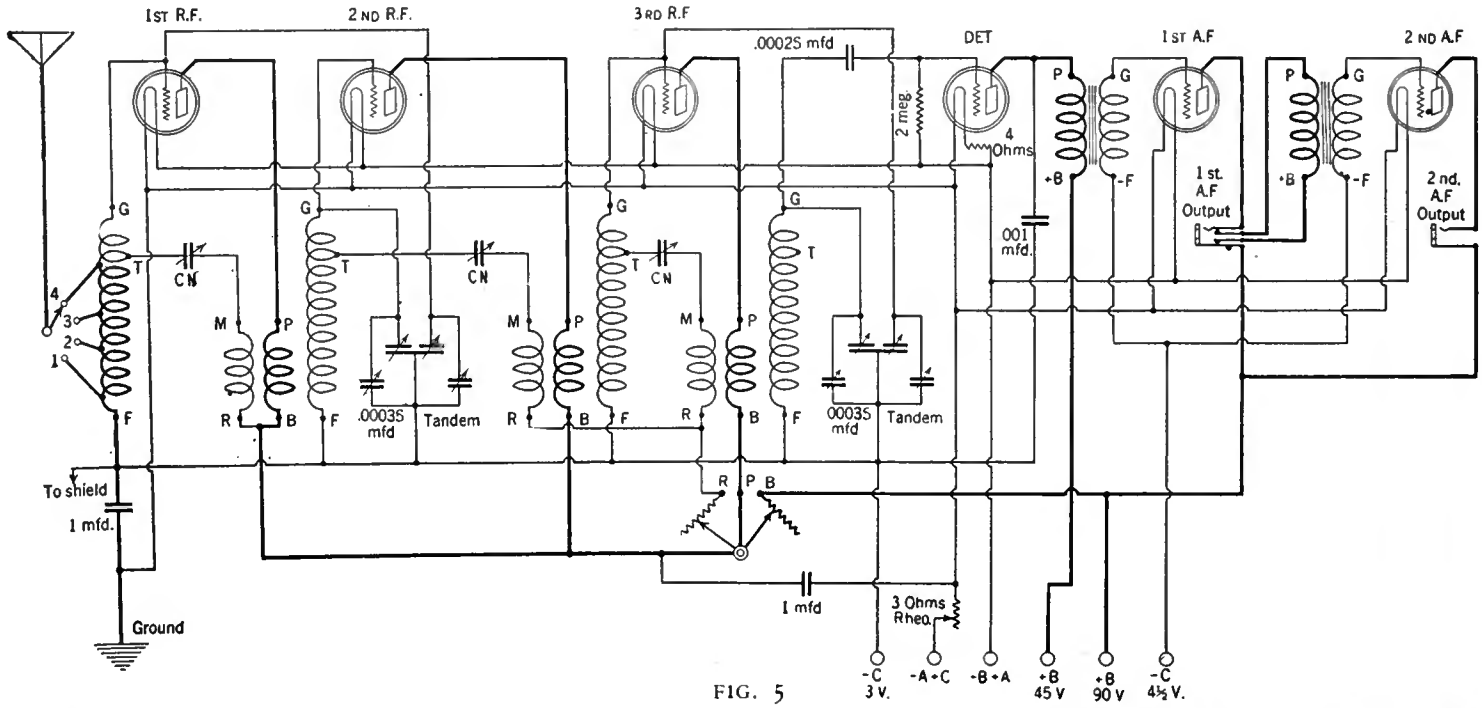

FIG. 5

In the "Counterphase" circuit shown here, the tendency of the radio frequency stages to oscillate is prevented by the separate circuits comprising the inductances M-R and the condensers C_n. It is necessary to adjust the condensers C_n, the variable part of this circuit, to suit the tube employed. On the high frequency end of the tuning scale, the tendency of a circuit to oscillate is greater than at the other end of the scale, the lower frequencies, so a panel adjustment is provided in the dual resistance control to compensate for these changes, thereby obtaining maximum efficiency on all frequencies within the tuning range

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of a coil, and this is another method that has been used and probably will be again.

It is evident also that if one circuit were slightly detuned, the tendency toward oscillation would be reduced. Another method has likewise been employed, oscillations being prevented by reducing the plate load or number of turns in the primary circuit of the transformer, which cuts down the coupling between primary and secondary.

This latter method increases selectivity, but unfortunately the energy transfer between tubes is thereby reduced, and if the coupling is cut down sufficiently to prevent oscillation on the higher frequencies (shorter wavelengths), this same insufficient coupling results in very unsatisfactory response on the longer waves.

CAUSE OF TROUBLE ON SHORTER WAVES

AT 550 meters, the upper end of the present broadcasting band, the frequency per second is only 545,100, but at 200 meters, or the lower limit, the frequency per second reaches the enormous number of 1,500,000 cycles. The resultant increase in tendency to oscillate on the higher frequencies (shorter wavelengths) has worried circuit designers from the earliest days of radio. It creates the problem that has been fought over, avoided, evaded, neglected, or ignored, according to the varying degrees of intelligence or intention involved.

Regardless, however, of what last year's arguments may have been, it is now quite generally agreed that when primary to secondary coupling is reduced to the extent that oscillation is prevented, the set will be satisfactory on the higher frequencies (shorter wavelengths) only. Within a narrow broadcast range 750 kc. wide (200 to 400 meters), such a set would be acceptable, but from 1500 kc. (200 meters) to 545 kc. (550 meters) gives a band 955 kc. wide,—greater than has been handled with satisfaction.

Some difficulty was avoided by the manufacture of sets and parts which would not reach the higher frequencies (shorter wavelengths), but this did not solve the problem for the user. When there were no stations assigned at the lower frequency end, the omission was not generally noticed, although undoubtedly part of the reason why stations were not assigned to this band was because of the trouble the Government knew would have ensued, and because of the complaints that would have arisen among those whose sets would not receive satisfactorily the full range in effect at the time they were made.

SYSTEMS OF NEUTRALIZATION

SINCE the reduction of coupling to the point of complete avoidance of oscillation gives acceptable results over part of the range, it follows that increasing the coupling somewhat by a few more primary turns will bring the point of complete suppression farther up the wavelength scale, and while oscillations will occur below that point, the middle range will respond favorably, and the upper range to a slight extent.

Similar results are obtainable under the other methods mentioned by varying the amount of resistance or losses, or by fixed

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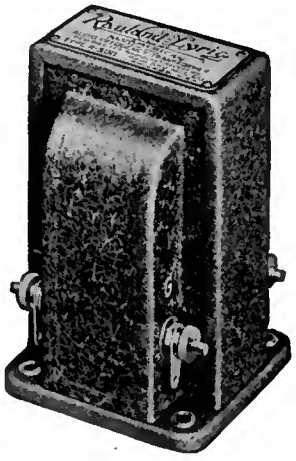

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neutralization on some wavelength below the mid-scale, but none of these methods give results over the entire scale. Should the wavelength be increased by dropping the lower limit, there is still less possibility of satisfactory operation.

EXTERNAL CIRCUIT REQUIRED

EVIDENTLY some other arrangement must be found to compensate for the inherent feedback of the present-day tube. A logical solution is an external circuit designed to feed back energy of opposite potential in such manner and amount as to overcome or neutralize the regenerative action of the tube. It must also be efficient over the entire tuning range of the receiver to which it is applied.

It is also evident that the adjustment of this external circuit should not remain constant for all broadcast frequencies. The sensitivity of a receiver is always greatest just below the point of oscillation of both r. f. and detector tubes. The action of a sensitive r. f. amplifier is therefore very similar to the regenerative circuit in which a regenerative control, or tickler, is always used to bring regeneration up to the point of oscillation. The difference is that, in a radio-frequency amplifier, this action is reduced below the point of oscillation.

Panel control of sensitivity is just as important and desirable, for example, as the panel control of a tickler in the well-known three-circuit regenerative receiver. Permanent neutralization, on the other hand, is to all practical purposes similar to what we would find with a permanent adjustment of the tickler in the circuit mentioned.

Only recently a new method of controling oscillation has been brought forward by the Bremer-Tully Company of Chicago, and has been secured by patent. This system has been termed the "Counterphase," and an explanation of its function is of interest.

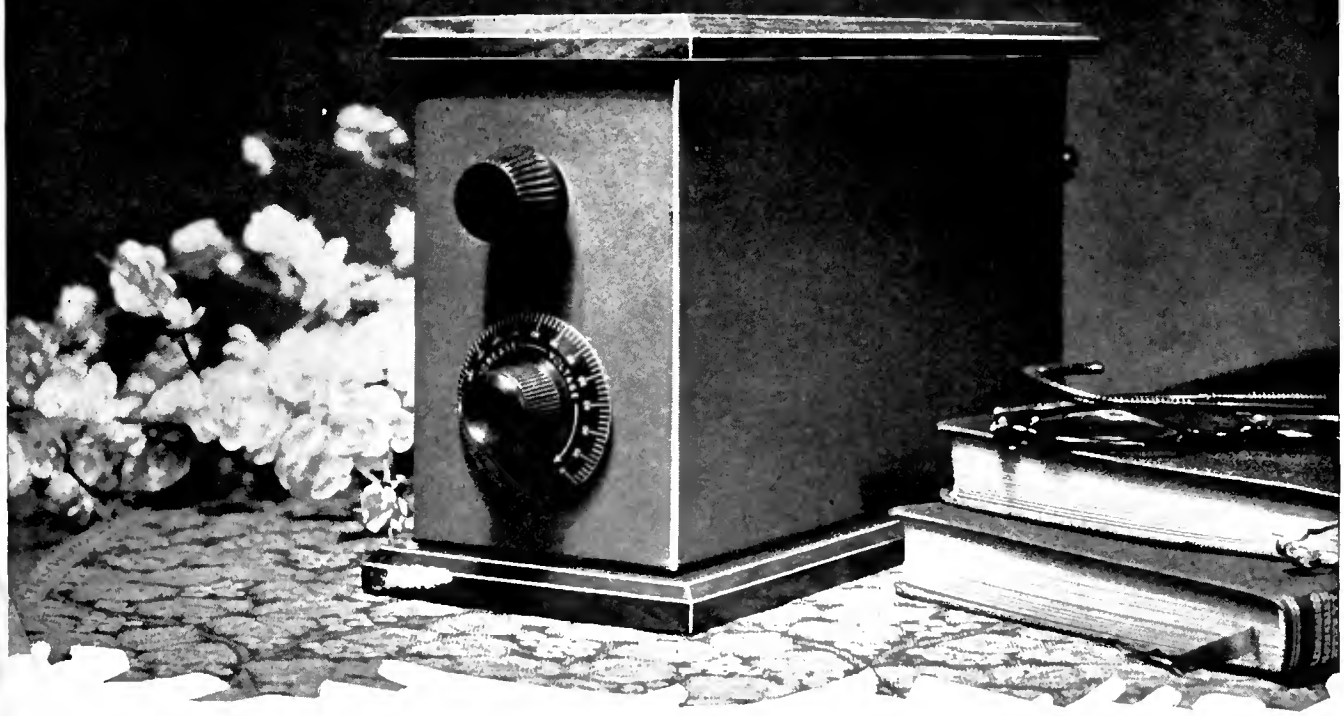
The Bremer-Tully "Counterphase" circuit includes a bridge between the output and the input circuits. Counter potential is derived from a coil coupled inductively to the plate circuit, and fed, through an adjustable capacity, to a coil inductively coupled to the grid circuit. Any connection made between plate and grid circuits must to some extent increase grid-to-plate capacity, which in turn tends to increase oscillation. The most careful design is necessary, therefore, to avoid such increase as to make neutralization impossible in any neutralizing circuit at the high frequencies (shorter wavelengths) of the broadcasting range. In the Bremer-Tully "Counterphase" method, this capacity effect is overcome to such an extent that neutralization on as high frequencies as 1500 kc. (200 meters) is easily accomplished.

As compared to any fixed method of neutralization, it will be noted that the link circuit between each r. f. stage includes a small adjustable condenser. The method of controlling two or more stages of r. f. amplification is extremely simple.

The circuit is shown in Fig. 5.

It is well known that the variation of a resistance in series with a condenser varies the effective capacity of the condenser.

DIS-TŌN



Employs no fluids of any kind. Uses only one rectifying tube. Separate adjustment for detector and amplifier tubes. Handsomely finished in rich velvet-green Duco with solid walnut, satin finish top and bottom. Ample continuous "B" current for one to ten-tube sets.

Give *your* Radio Set a "B" Current Supply—*for life!* ★

Dis-ton, using alternating current from your lamp socket, in place of "B" Batteries, is guaranteed to improve the overall efficiency of your set. It provides constant "B" current at proper potential for your receiver circuit, tubes and loud speaker.* Dis-ton is noiseless in operation—no crackles and popping such as you get with run down "B" Batteries—no hum of any kind to distort the finest aria or drown out the faint signals from distant stations.

Remarkable Clarity—Amazing Volume and Selectivity

Dis-ton is trouble free—the special Trans-Filter Unit is sealed in, protected against tampering and deterioration. It can't wear out. Consumes only eight watts from the nearest lamp socket and puts your "B" load on the big, powerful, carefully watched generators of your central station. You can rely upon Dis-ton to give you the best from your receiver.

Without attention of any kind after simple initial adjustment to your set—Dis-ton insures you the equivalent in performance of new "B" Batteries every time you listen in.

Dis-ton requires no change in the internal wiring of your set to secure either utmost efficiency or entire safety. Accidental improper connections can't result in tube "burn outs."

DIS-TON complete ready for operation 110 volt, 60 cycle $40.00
Special 3 Voltage DIS-TON, 60 cycle 110 volt, $45.00
Other voltages and cyclesonapplication

Know how much DIS-TŌN adds to radio

The advantages that Dis-ton will give you are outstanding and unusual. You have the opportunity to verify them all on your present receiver. A Dis-ton demonstration is yours for the asking. Send for Leaflet B and full details as the first step to greater radio enjoyment this season.

DIS-TON KITS Essential Parts for Home Builders 110 volt, 60 cycle $28.50
Other voltages and cyclesonapplication

RADIO PRODUCTS, Inc.

Dept. RB Richmond, Ind.

**Regular* Dis-ton *will modernize the performance of any of the good, older receivers in an amazing fashion. Three voltage* Dis-ton *is the only AC current supply adapted to the newest circuit where different detector, radio frequency and audio frequency "B" potential is required.*

★ Tested and approved by Radio Broadcast ★

Therefore, by placing one resistance in series with and common to all the neutralizing circuits, the capacity of each can be changed by varying this common resistance.

The effect is to unbalance these circuits, permitting an increased sensitivity, easily variable over all frequencies within the range covered.

Here again we find a fortunate factor operating in our favor. Aside from the advantage of enabling us to control several stages with one knob, this resistance does not introduce losses or interfere with selectivity, and in addition to that it does not affect dial readings by detuning the circuit.

DUAL RESISTANCE-CONTROL AN ASSET

INASMUCH as sensitivity is not required on stations where it is desirable to reduce volume, the same knob can be used to operate a separate resistance in the B battery circuit to control volume.

This is accomplished by a dual resistance containing two distinct resistance elements, each operable over an arc of 240 degrees.

When sensitivity is the objective, no reduction in volume is desired. When a decrease in volume is wanted, there is no demand for sensitivity. Therefore, in operation, it is necessary only to turn one knob to the right or left to secure either one or the other as desired.

In addition to the simultaneous unbalancing feature which makes it possible to secure sensitivity over the full range, the "Counterphase" method makes it possible to control three stages of tuned radio frequency efficiently with but two tuning controls.

In design the circuit is distinctly new and will no doubt appeal to those who are of that jaded group of circuit seekers and dyed-in-the-wool experimenters who are always on the look-out for "something new under the sun."

VALUES OF PARTS EMPLOYED IN CIRCUIT

THE coils employed in the "Counterphase" circuit are toroids, each wound on a frame $1\frac{5}{8}$-inches square. The secondary consists of 168 turns of No. 24 double silk covered wire and is tapped at the 124th turn from the filament end. It has an inductance value of 220 millihenries. The primary is spaced inside the secondary at the filament end, and consists of 52 turns of No. 36 d.c.c. or d.s.c. wire.

The "Counterphase" coil is wound with 96 turns of the No. 36 wire, its turns being spaced between the turns of the primary. The antenna secondary is tapped at the 2nd, 8th, 25th, and 40th turn from the filament end of the coil. The tuning condensers are .00035 mfd; the trimmers .000024 mfd. The "Counterphase" condensers C_n have a minimum of 1 mmf. and a maximum of 30 mmf.

The dual resistances are variable, the one located in the counterphase part of the circuit is 3000 ohms and that in the plate circuit 500,000 ohms.

The by-pass condensers are as follows:—A .001-mfd. across the first audio transformer primary; a 1-mfd. across the C battery, and a 1-mfd. across the B battery.

Separate All Stations Evenly

IT is not necessary to tear down and rebuild your present set in order to separate the stations evenly on the dials. By merely substituting *Rathbun Straight Line Frequency Converters* for your present dials—you will be able to secure real S. L. F. tuning.

Here is a variable vernier control that provides a ratio of 50 to 1 down where the stations are crowded—gradually and smoothly decreasing in uniform ratio over the full 360° of the dial. The stations are evenly separated around the entire circle. There are only two moving parts—a cam and a lever. The action is dependable and accurate—without a particle of backlash. Easier tuning and immeasurably better logging are obtainable from straight line capacity condensers with these new converters.

Remember that we build the *Rathbun Single Hole Mounting Condenser* with genuine Bakelite ends. This year's models are enclosed with transparent pyralin dustbands which preserve their high efficiency for life. They are small, light and rugged—*always reasonably priced.*

Ask your dealer for Rathbun Straight Line Frequency Converters
He has them in stock or will get them for you promptly

★

PRICE $3.50

RATHBUN MANUFACTURING CO., INC.
JAMESTOWN, N. Y.

MEMBER R.M.A.

★ Tested and approved by RADIO BROADCAST ★

If You Seek Economy, Buy the Best!

By HAROLD JOLLIFFE

The time has come, the Walrus said,
To talk of many things;
Of shoes and ships and sealing-wax,
Of cabbages and kings.

—CARROLL.

THE fellow who came out with that clever remark about economy, certainly was a wise old bird; his head was in the right place, and he knew what he was talking about. We do not know who the originator of this bright little maxim was; he probably dates 'way back down the dim corridors of time to the obscure and misty past, when the ancient Phoenicians dauntlessly set forth in their little vessels to invade the shores of distant Britain with their varied trade. Quite likely it had its inception at a far earlier date than that; maybe it was around about the time when that little fellow, David, got peeved and knocked his enemy, the great and husky Goliath, for a home run, with a well-directed stone from his sling.

But no matter when, where, or how. It is an axiom that applies now as ever; and it holds just as forcefully in radio as in anything else under the sun. You can't get away from it.

Take vacuum tubes, for instance. As everyone knows, for the standard price of two and a half dollars you can walk into any radio dealers' and purchase a good tube; a tube of recognized quality; a tube which is the result of the constant efforts of many of the greatest scientists of the age, and years and years of tireless study and ceaseless experiment. Millions and millions of dollars have been expended to bring it up to its present high state of perfection, and it has embodied in its construction all those desirable and necessary qualities which make for an efficient, serviceable tube. It is rated at a certain voltage and current consumption, and is guaranteed to perform exactly as indicated by the manufacturer when his directions, regarding its use and care, have been followed carefully, and provided it is not abused. Therefore, such a tube may be expected to do all that is claimed for it.

And yet, there are those who will waste one dollar—yes, one buck's the price! Can you beat it?—on a tube which, in the first place, is probably a "second" of a so-called independent manufacturer; a tube which, if rated as consuming .25 amps., will more than likely draw considerably in excess of that amount; a tube which may not even fit its socket, for that is exactly the case with some of the three-volt variety. You have to take a file and rub down what appears to be a small brass rivet projecting from one side of the base, before it can be inserted into a socket; others sit wobbly in their sockets because their bases have a diameter of one-sixteenth inch less than the internal diameter of the shell of the socket, which results in uncertain contact.

The writer knows of a case where an elderly couple had a four-tube receiver, and the tubes, having become worn out through continued use, needed replacement. Despite warning, they bought four tubes of the above-mentioned type, and without a word of exaggeration, these tubes gave absolutely no satisfaction. They ate very heavily into the dry A batteries—the tubes were of the three-volt class—and produced a most annoying whining sound which could not be eliminated and which was not due to any fault of the receiver, which was pulled apart and re-wired in an attempt to locate the trouble. In the end, they had either to buy four good tubes or let the receiver sit on the table and collect dust. Being devout fans they purchased the tubes, and presto!—the set worked like a charm.

It therefore cost them sixteen dollars to replace the tubes instead of twelve. But they were attracted by the low price. False economy! They might just as well have thrown the cheap tubes into the ash can.

What is the good of buying such tubes and taking a chance as to whether they will be any good? Admittedly, you will strike some good ones now and again, but at the most, they are good for but a fraction of the service you would get from the better class.

The writer, with the help of a certain dealer, tested several of these tubes with a device which registers the current in the plate circuit when the filament is heated to a certain temperature. If a recognized make of 201-A tube was inserted in the socket, and the customary five volts applied to the filament, the milliammeter indicated a current of anywhere between 1.1 to 1.4 milliamps. But if one of the dollar variety were tried, it was seldom indeed that a reading of more than one milliamp. was obtained; many went as low as .75 milliamps., but only once in a while would the meter indicate a good tube.

Then again many of them will not oscillate. The writer has three such tubes of the 201-A type which were loaned him for testing purposes. One will oscillate very strongly if a pressure of no less than 5.5 volts is applied to the filament. The remaining two will not oscillate at all, which, of course, renders them useless as detectors in a regenerative circuit. And do they play havoc with the A battery! I'll tell the world!

AND TRANSFORMERS!

CONSIDER audio frequency transformers. These, next to vacuum tubes, are probably the most delicate of all radio receiving apparatus. They must be designed and constructed with the greatest thought and care, for it is upon the design and construction of the audio amplifier that the quality of the received music depends. Oh, yes; the loud speaker does have a lot to do with it, but the audio amplifier first. Now, if there is anyone who believes it possible to produce a *good* transformer, one that will really do the work, for $1.50, let him take the floor and show us how! It simply can't be done, after the middlemen have taken their profits.

Yet, a rather doubtful looking affair can now be purchased at that price at certain cut rate stores—one dollar for the winding and fifty cents for the core, is the way they advertise them.

A socket for twenty-five cents, and not such a bad-looking affair at that. Cheap? Sure it is, until you apply the soldering iron and melt half of it. Nothing but "mud"!

Radio fans! If you wish to build a *good* receiver, one that will reward you with the greatest possible clarity and distance for a given number of tubes, one that will be easy to work with during construction, one that you can pull apart without damaging the apparatus when you wish to switch over to another circuit—then purchase, steal, or otherwise acquire good, dependable apparatus. There's a reason!

Take the case of John Brown, for instance. The radio bug bit Johnny good and hard; so having a nice little work bench and all the necessary tools down the cellar, he decided to "roll his own." Being a sensible sort of a fellow, he went out and bought the best he could afford, and since he didn't know much about it, he took someone along with him to show him what was what, and why. Johnny now has a fine outfit if there ever was one, a real low loss set, and he is justly proud of it. He gets splendid results; night after night the old stations come pounding in with a roar; and Johnny sits back in the old easy chair with a contented look on his face, and enjoys real radio satisfaction.

His neighbor, just a few doors down, is always tinkering around, fixing this and changing that and wondering why in heck his set won't work as well as Johnny's. The answer is simple. Although he could afford it, he wouldn't spend the necessary cash to buy the good parts that characterized Johnny's purchase. Disregarding the reliable dealer down at the corner, he went to the other store where "a real low loss" variable condenser sells for a dollar and a quarter, and bought a lot of cheap stuff that Johnny and his experienced friend passed up with a grin of derision. He now has more sense, and is thinking of junking the entirety of his original purchase and starting in all over again with good apparatus.

Johnny Brown doesn't have to do that, so he is just that much money to the good.

★ Tested and approved by RADIO BROADCAST ★

Powel Crosley, Junior
has always done
the Unexpected.

His Announcement
December 26th
will be no exception
to that Rule.

"NOW, I HAVE FOUND . . ."

A Department for the Exchange of Ideas and Suggestions of Value to the Radio Constructor and Operator

CONTRIBUTIONS to this department are welcome and those used will be paid for at the usual rates, that is from two to ten dollars each. A prize of twenty-five dollars is given for the best idea used during each three-month period. The prizewinner for the last period was announced in the November RADIO BROADCAST. *All manuscripts intended for this department should not exceed about three hundred words and should be typewritten. Little consideration can be given to manuscripts not typewritten. Envelopes should be addressed to this department,* RADIO BROADCAST, *Garden City, New York.*

THE ROBERTS CIRCUIT AND AUDIO AMPLIFIER WITHOUT A STORAGE BATTERY

THE circuit about to be explained consists of the well-known Roberts two-tube circuit plus one stage of audio amplification. One five-volt tube and two three-volt tubes are employed. The filament supply for the three-volt tubes consists of a battery of dry cells, while the five-volt audio amplifier tube is supplied through a transformer by the 60-cycle a. c. lighting system. In this way the expense and inconvenience of a storage battery are eliminated without sacrificing any of the good points of the set.

In order to eliminate the a. c. hum from the amplifier, a potentiometer and grid bias are necessary. By connecting the grid return of the amplifier to the negative terminal of the filament supply for the three-volt tubes, and connecting the potentiometer arm to the positive terminal of this battery, the grid of the amplifier acquires a $4\frac{1}{2}$-volt negative bias.

I have found by operation that a vernier is not necessary on the grid circuit tuning condenser of the first tube. However, on the second tube, a vernier condenser greatly facilitates tuning. Two jacks are so arranged that the loud speaker may be plugged-in on the output of the three-volt or on the amplifier output. A filament switch is used to control the filament circuits of the three-volters. In this manner the filament rheostats may be set at the proper value and the switch used for making and breaking the filament circuit.

A transformer with a secondary voltage of at least six, is used. This steps down the house lighting circuit voltage from 110 volts. A toy transformer is being used on my set at present. A bell ringing transformer which gives the required secondary voltage may be used. Do not burn the tube at greater brilliancy than is necessary to obtain good, clear tone quality.

The filament rheostats of the three-volt tubes are each of 25 ohms resistance. It is important that the negative terminal of the filament battery be grounded; otherwise a hum will be heard in the phones.

The adjustment of the amplifier consists merely in lighting *all the tubes*, plugging-in on the amplifier, and adjusting the potentiometer arm until the hum heard in the phones is at a minimum. The position of the arm should be midway between its extreme end positions. If the hum is not reduced to low audibility when the potentiometer arm is near its mid-position, check over the amplifier connections and examine the potentiometer itself for broken wire or loose contacts.

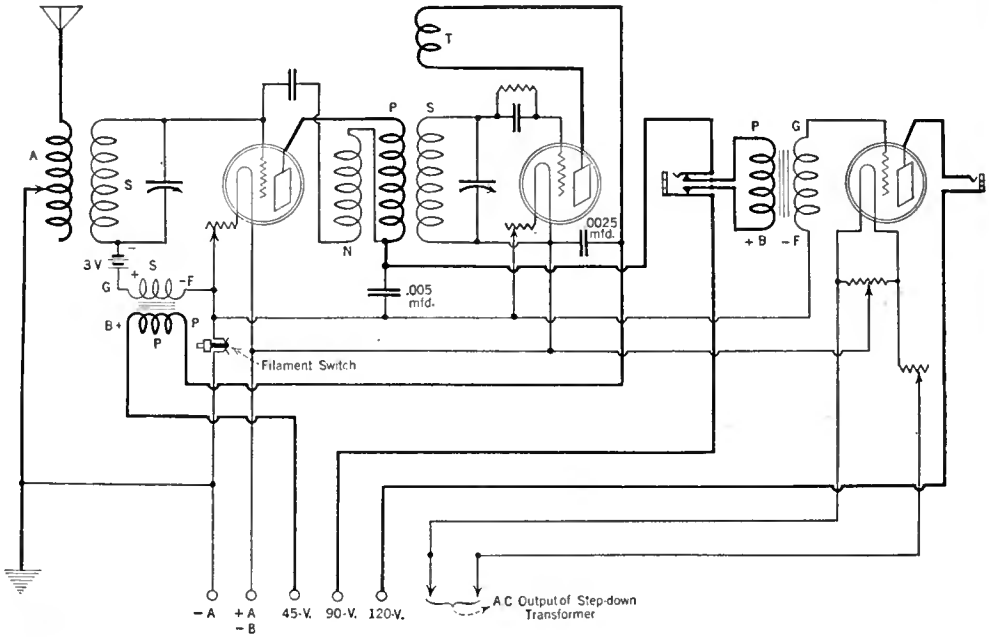


FIG. 1

The circuit as shown in Fig. 1 is correct for two three-volt tubes and one audio amplifier tube. This latter tube may be of any type capable of handling the output of the preceding tubes. The ohmic value of its rheostat is determined by the filament current and voltage, and by the output voltage of the filament transformer.

For a tube requiring a filament current of

NATIONAL Velvet Vernier DIAL

Type B, Variable

(Patents Pending)

Positive Control
Easily Mounted
Gearless

Variable Ratio
Velvety Smooth
Graceful Design

★

With This NEW National Type B, Velvet Vernier Dial, *YOU* Control the Reduction Ratio!

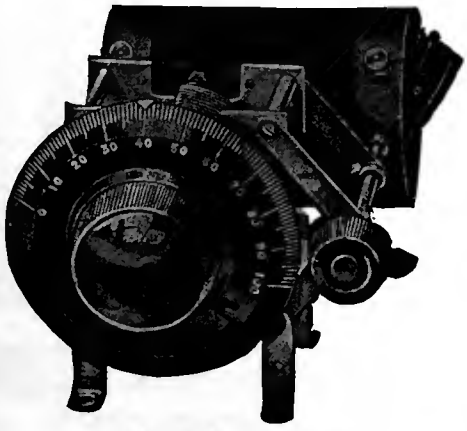
WHAT a difference in the tuning of your set when you replace your plain dial with a new NATIONAL Type B Variable (patents pending). You'll be astonished.

Any ratio you desire, from a minimum of 6 to 1 to a maximum of 20 to 1 is instantly obtained by shifting a small lever. Note how it separates the stations operating on the lower wave lengths.

Easily mounted on the $\frac{1}{4}''$ shaft of any standard type of variable condenser. The only tool you need is a screw driver.

The same velvety smoothness, the same freedom from backlash, the same mechanical drive as the famous Type A Velvet Vernier Dial, (patents pending). Price $2.50.

The NATIONAL Tuning Unit



NATIONAL Tuning Unit
Type B D-2

for the popular circuits and hook-ups gives amazing results to amateur set-builders.

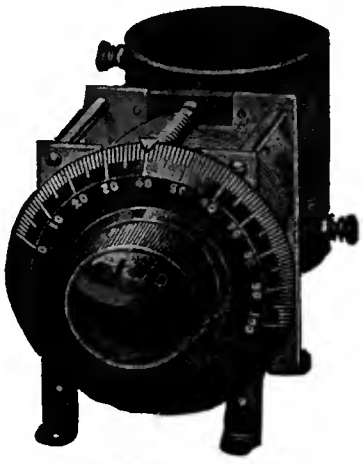
Comprises the NATIONAL CONDENSER and the wonderful BROWNING-DRAKE TRANSFORMER Complete in one package, Price $22. Makes a most welcome Christmas Gift.

Write for Bulletin 106 R. B.

NATIONAL CO., INC.

W. A. READY, *President*

110 Brookline St. CAMBRIDGE, MASS.



NATIONAL Tuning Unit
Type B D-1

★ Tested and approved by RADIO BROADCAST ★

¼ ampere, use a 6-ohm rheostat for a secondary voltage of 6 volts; use about a 25-ohm rheostat for any voltage between 6 and 10 volts.

For a tube requiring a filament current of one ampere, a 6-ohm rheostat may be used for any voltage up to 10 volts.

I have used plate voltages as low as 67 volts on both amplifier tubes with satisfaction. The optimum value of plate voltage for the detector tube can best be found by experiment, and for the three-volt tube will be about 40 volts.

JOHN B. CLOTHIER, JR.,
Lansdowne, Pennsylvania.

A HOME-MADE LOUD SPEAKER

THE main difficulty in loud speaker horn construction lies in cutting the parts to fit, and in obtaining well proportioned lines and acoustics, which will be a credit to the finished product.

A brief study of the patterns and details given below, will enable anyone to build easily a horn which will be very satisfactory with an audio-frequency amplifier.

It is constructed almost entirely of $\frac{3}{16}$ inch fibre or cardboard, and the dimensions for the various pieces are outlined in Fig. 2.

The back, A, is cut from a piece 9 inches wide and 24 inches long. A line drawn through the center and perpendicular to the 9-inch side, will aid in making the nine measurements, one every three inches, to secure the curves indicated. The two sides, B, and back, C, are likewise laid out and cut with a sharp knife.

The four parts are fitted together by lapping A and C over the two sides, B, beginning at the bell end and taking one corner at a time and bending to conform to the curves and fastening, wherever necessary, with a few stitches of No. 26 copper wire, which is threaded through perforations near the edge.

After all corners are fastened, four strips of strong paper, 4 inches wide, are cut to fit each corner. These are creased lengthwise, scored where bends cause wrinkles, and pasted on smoothly.

THE FINISHED SPEAKER

To assist in making the base, D, a circle 14 inches in diameter is drawn on a piece of cardboard. This is then marked, cut, scored on the dotted lines, bent over a sharp edge and the seven ½-inch woodstrips tacked in at the corners. Four of these may be used if desired. A $\frac{7}{8}$-inch hole is cut in the center of the base for a No. 522 CW Western Electric Loud Speaker Unit. The base and horn are then fastened together with moulding and small brass screws, and the whole given four coats of paranite. Paranite can be made by dissolving parts of an old phonograph record in denatured alcohol. It strengthens the horn and gives it a very desirable velvet black finish.

The unit is fastened in the base by first inserting the rubber bushing to a tight fit.

(Continued on page 374)

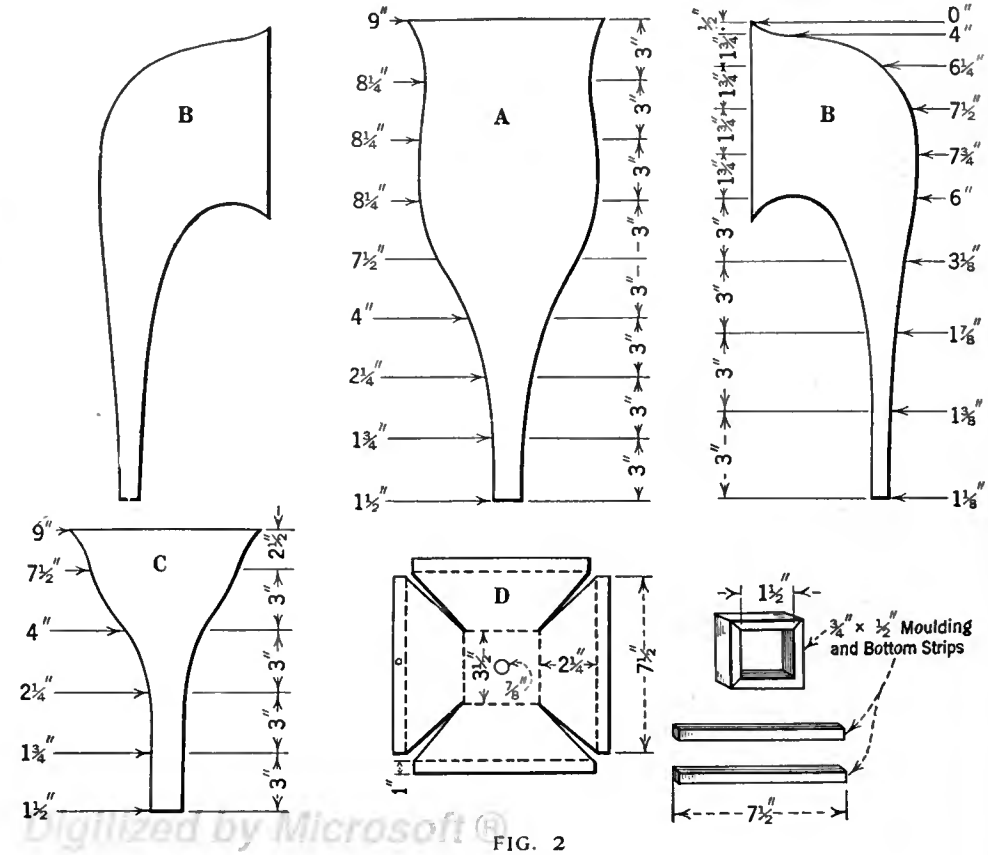


FIG. 2

★ Tested and approved by RADIO BROADCAST ★

The insertion of the nipple into this rubber under considerable force holds it permanently, while the cord is brought out through a small perforation in the side. The diaphragm of the unit is adjustable, and in conjunction with this horn and 90 volts on the plate of a two-stage amplifier, it brings in distant stations with as good definition and volume as many more expensive speakers.

J. T. GARVER,
Huntington, Tennessee.

CYLINDRICAL COILS FOR THE KNOCKOUT SET

THIS letter is in response to your request in RADIO BROADCAST regarding the use of cylindrical coils in the Roberts circuit. (Incidentally, I bought this particular issue at a newsstand in Singapore.)

I built a three-tube Roberts outfit last summer, using cylindrical coils, and consider it a very satisfactory set. I find that some distortion is present when receiving local or near-by stations, but on the DX stuff the reproduction is all that could be desired. The distortion on locals can be eliminated by slightly detuning the left hand condenser.

The circuit is shown in Fig. 3 while the arrangement of coils may also be seen in this diagram. Tubes of the UV-201A type, and General Radio audio transformers are used throughout.

This set has brought in KGO Oakland at 820 miles west of San Francisco, in broad daylight, and practically every important station in the country at night, until we were so far west of San Francisco that the daylight cut them off. It is interesting to note that all of the stations east of the Rockies suddenly fall off at about 3200 miles west of San Francisco, in longitude 173 East. The same effect is noticed on the 4200–3700 kilocycles-(75-80 meter) amateur signals which are very strong one night and unreadable the next as we go farther east. At the same time there is no decrease in the signal strength of the west coast stations.

I found that the use of No. 24 d.s.c. wire for the coils was satsifactory, and used this wire throughout. The dimensions of the coils and the data for their construction is perfectly simple, and is as follows: S-1 consists of forty-five turns wound in single-layer fashion, on a suitable tube of three-inch diameter; A, which is the primary coil, is next wound on the same tube and on top of S-1, in the center. It consists of 25 turns of the 24 d.s.c. wire, and is tapped at every fifth turn; N-P is the next consideration. It is formed of two 20-turn coils wound on top of each other, on a tube with a diameter of $2\frac{5}{8}$ inches; S-2 is bank wound, and is composed of 45 turns. Its cylindrical form is also $2\frac{5}{8}$ inches diameter; T, the tickler coil, is made by winding 20 turns on a 2-inch tube. The tickler coil is so arranged that it may be variably coupled to S-2, as shown by the dotted lines in Fig. 3. I have found this arrangement gives better results than if the tickler is mounted

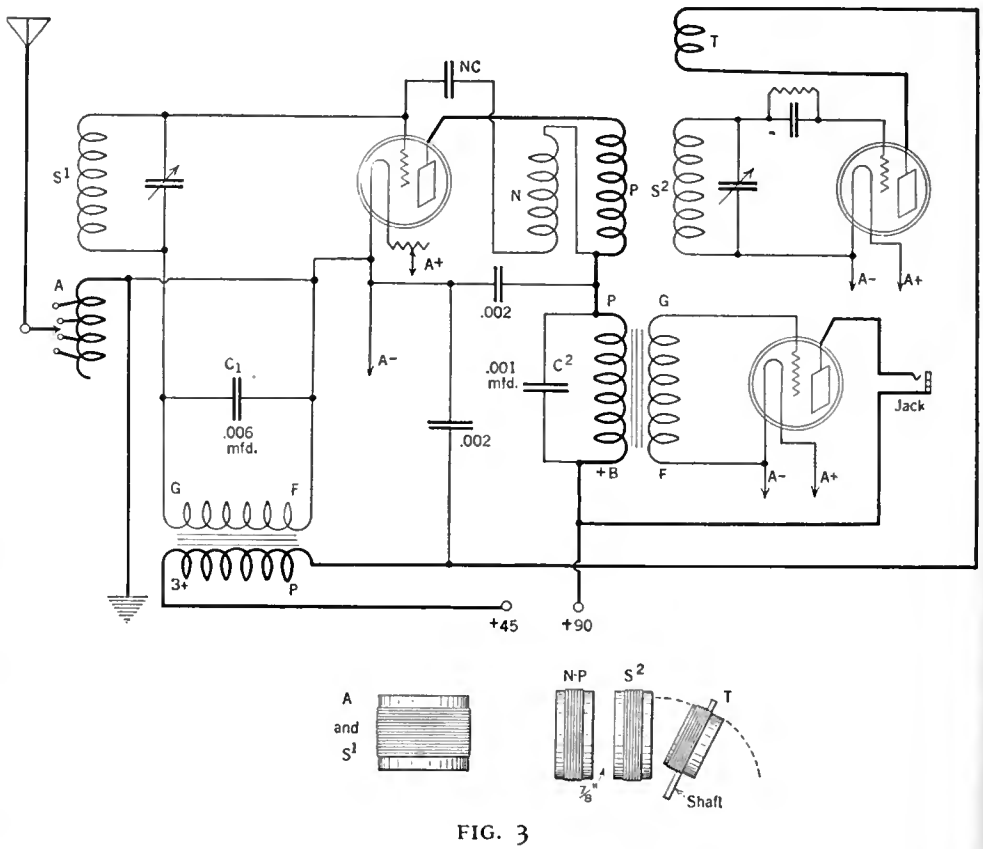


FIG. 3

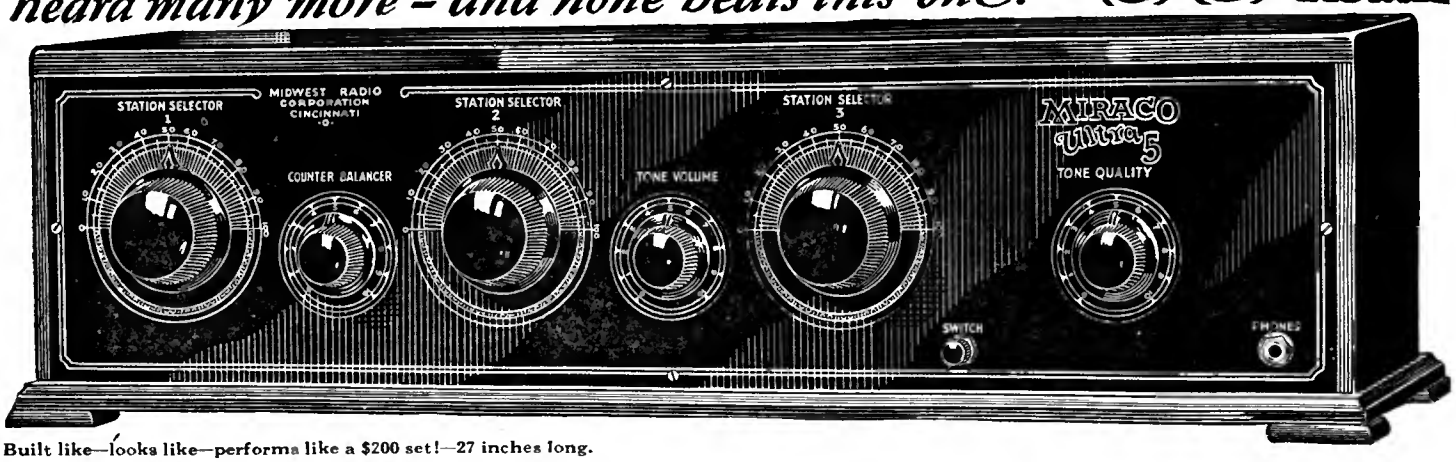
to rotate within S-2. N-P should be placed about $\frac{7}{8}$-inch from S-2 for best results. C1 and C2 were found necessary, as without them the receiver was found to be very unstable.

L. O. DORAN,
San Francisco, California.

¶ **As stated elsewhere in this department, a $25 prize is awarded each three months for the best contribution published. The winner for the December, January and February period will be announced in the next number of RADIO BROADCAST.**

"It works better than a lot of sets that sell for twice the price. I have owned four other sets and heard many more – and none beats this one."

Now only $59.50 Retail



Built like—looks like—performs like a $200 set!—27 inches long.

Demand Breaking All Records-More User Agents Wanted-Get Wholesale Prices Quick

MIRACO RADIO GETS 'EM COAST to COAST

Notice!

Enormous demand for the celebrated Miraco Ultra 5 (resulting from its many enthusiastic users so highly recommending it to their friends) enabled us to add hosts of costly new features, latest refinements and up-to-the-minute improvements such as you might expect to find only on the newest sets selling at much higher prices. So the Improved Ultra 5 for 1926 is even a better set—a more beautiful set—a more selective and more powerful set—incredible as this may sound! — for less money than ever before.

COAST TO COAST RECEPTION VERIFIED BY USERS

Reports from Ultra-5 users everywhere leave little for us to add. These are only a few of the many in our files and which we receive daily. Send coupon for plenty of additional proof. Let testimony of users instead of high-sounding claims convince you.

MANY SAY IT'S BEST THEY'VE HEARD

"Ultra 5" more than meets my expectations of a good radio set. Many think it is the best that they have heard. For volume, selectivity, clearness and long distance it is unsurpassed in my estimation . . . . . Auto Supply, Allentown, Penna.

PRAISES THE FINE TONE AND VOLUME

The Ultra-5 has a fine tone and good volume; last night had 24 different stations from 8 to 10—all on loud speaker, O. T. . . . . Malone, New York.

THE TONE IS "WONDERFULLY CLEAR AND POWERFUL"

Am more than pleased with my 5 tube Miraco. Tone wonderfully clear and powerful. D. C. . . . . Detroit, Michigan.

MORE PRAISE FOR MIRACO TONE QUALITY

The Ultra-5 received from you is the best I ever heard. It is just as clear as a crystal. Raymond W. . . . . Massback, Ill.

ONE OF THE CLEAREST EVER HEARD

All who have heard my Ultra-5 set pronounce it one of the clearest they have heard, and I must say that the MIRACO is in every way as represented by you. George . . . . . Colville, Washington.

MONTANA HEARS BOTH COASTS

Ultra-5 set is O. K. Have got them, New York to Los Angeles, Winnipeg to Dallas, Texas. W. H. . . . . Folson, Montana.

OHIO GETS 'EM COAST TO COAST

We are enjoying the Ultra-5 Radio. It is all you recommended. We get stations on the east coast, south and west coast. Walter . . . . . Van Buren, Ohio.

CALIFORNIA THE FIRST NIGHT

Headphones are not necessary with the Ultra-5 I had KFI, California, the first night with same volume as Pittsburgh. Fred G. . . . . Liverpool, Ohio.

COAST TO COAST FROM OKLAHOMA

With Miraco five tube set am getting stations on the Pacific and Atlantic coasts. Yerker E. . . . . Pauls Valley, Okla.

"COAST TO COAST" A REALITY

The two Miraco-5's have been working fine, in fact far beyond our expectations. Your statement of "coast to coast" reception proved absolutely a reality. T. D. . . . . Houston, Texas.

MICHIGAN GETS COAST TO COAST

I am overly pleased with the Miraco Ultra-5. Can get stations from coast to coast and from Texas to Canada. Geo. O'. . . . . Gordon, Michigan.

LOTS OF VOLUME – 20 STATIONS FIRST NIGHT

Will drop you a few lines to let you know that I received my Miraco Ultra-5 and that it works fine. Had 20 stations the first night—it has lots of volume. Fred . . . . , Versailles, Ill.

INDIANA HEARS BOTH COASTS

Miraco Ultra-5 is a first-class set in every respect. It can't possibly be beat for the price. The first night I received over twenty stations from both coasts. Adolph M. . . . . Indianapolis, Indiana.

MINNESOTA HEARS COAST TO COAST

Received Ultra-5 in fine condition. Have received programs from stations all over the United States and Canada. We find it is one of the best sets in this locality. We are well pleased with the wonderful results. Clarence . . . . . Nashwauk, Minn.

NEARS CALIFORNIA TO EUROPE

Enclosed is a partial list of the stations I received with the Miraco Ultra-5: KSD, WEBH, WBAV, WEAF, WLW, WCBD, WHN, WOR, WJAZ, WOC, WHAS, WWJ, CKAC, KFIX, WCK, WHAZ, KFAB, WHAA, WASH, WCAP, WTAS, WQJ, KFKX, WAAW, WTAM, WOAI, WSOE, WCCO, KDKA, WBAP, WMC, CNRO, WLS, WHJ, WSZ, WNH, KFNF, KFI, WEEI, WWL, WFAA, WAF, WGY, CKY, WRR, WCAE, WEAO, WRC, FFDM, WJJD, WGR, WASN, WCAL, WLB, WHN, WMAQ, WJZ, WLS, WOAW, WOO, WOS, CFAC, Sheffield (Eng.), Paris (France). Carl H. . . . Waukesha, Wis.

MONTANA HEARS CALIFORNIA TO IRELAND

I am more than pleased with the Ultra-5 Receiver. I have 90 stations on my record in 2 days' time, including KDKA, WCAL, KFLE, WFC, WCC, WIAM, WEAF, WEM, WGM, WCAL, WLW, CAM, CFCF, WJZ, WAE, KAKF, KGOW, WCCO, WOC, WCAZ, WHQ, WCCA, WOAW, CFAC, WOAI, WOS, WCKF, KFPU, KBB, KPO, KFAA, WMCR, CKY, WCCF, WMAW, WBAP, WGN, KJR, WHO, WOS, WMC, WJJ, WGAN, KKU, WGW, WLW, WOOI, WHB, WFAI, WJAZ, KGB, WCAE, KSAC, WTAP, KSKI, KFKA. On February 16th at 12:15 o'clock I received Ireland, the distance being several thousand miles. Richard . . . . . Comertown, Mont.

WEST VIRGINIA HEARS AUSTRALIA

Got 2-XB Wellington, Australia, plain last night at 12:46 A.M. over the Ultra-5 Miraco you sold me. I am delighted and would not trade for any instrument in town. Geo. . . . . Glen Ferris, West Va.

ALL WE CLAIM . . . AND MORE.

Miraco Ultra "5" Set installed yesterday evening—had wonderful results last night. Think Ultra "5" is all you claim and more. V. A. . . . . Hampshire. Tennessee.

The reports we print are from UNSOLICITED letters sent us by pleased users.

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The Powerful New MIRACO Ultra 5

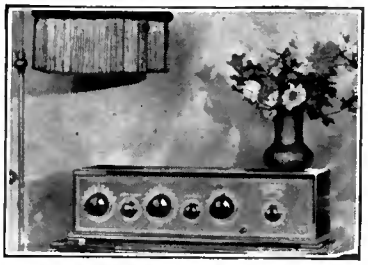
Guaranteed by One of the Oldest Radio Builders

Tested and Approved by Radio's Highest Authorities

[ULTRA SELECTIVE FIVE TUBE SET IN MAHOGANY CABINET]

You can either *save* or *make* a lot of money on sets and supplies by sending coupon today for our *Amazing Special Offer!* It will astonish you. Big profits easy—accepting orders for Miraco Sets. Only necessary to order one set to demonstrate in your home. No agreements to sign—no salesmanship required. The performance of Miraco Sets does the selling. Greatest demand in the six years we have been building sets—we need more user-agents to supply it.

This latest improved 1926 model Miraco Ultra 5—completely built, thoroughly tested and factory guaranteed by the Midwest Radio Corporation, one of America's oldest, reliable and most successful makers of quality sets—is an astonishing bargain in the opinion of radio experts. Selectivity, long distance reception, clarity of tone, power and volume have been amazingly increased—"B" battery consumption is minimized—oscillations are easily controlled on all wavelengths, through use of latest radio inventions. Among these are: "Duoformers" (ultra low-loss inductance coils); the "Counter-Balancer" (patented); flexible wiring which prevents broken or noisy connections; an adjustment for different length aerials; use of only two rheostats; a cut-out switch; concealed wiring under genuine Formica baseboard and other features of costliest sets.



The improved new Miraco Ultra-5 is a beauty! Handsomely gold-etched genuine Formica panel and large Bakelite knobs with "arrow point" indicators (for fine tuning) add to the stylish appearance. Mahogany cabinet is hand rubbed. A radio you will be proud to have your friends see and proud to have them hear perform.

Literature describes them fully. Send for it—and Special Offer that will surprise and interest you.

Other Miraco Long Distance Sets $13.75 up retail

AGENTS! DEALERS! Write for the new Miraco proposition. Nation-wide use and popularity of Miraco sets, coupled with their amazingly low prices make them wanted everywhere.

Get Special Offer! Wonderfully improved new models In one-tube and three-tube Miraco Long Distance Sets also ready at lower prices! New Miraco R-3 at only $27.35 (retail) operates loud speaker on distant stations. New one-tube Model R is also a record-breaker for distance at $13.75. All Miraco sets work on storage or dry batteries, are easily connected and operated. Unmatched values! Let testimony of users convince you. Write for literature and Special Offer—use coupon.

All the Proof you want is waiting for You!

Reports from hosts of users in every state prove Miraco sets—at rock-bottom factory prices—outperform sets costing up to three times as much. Send for latest literature, SPECIAL OFFER and plenty of additional testimony leaving no doubt that "Miraco Radio Gets 'em Coast to Coast."

MIRACO RADIO GETS 'EM COAST to COAST

MIDWEST RADIO CORPORATION
Pioneer Builders of Sets
Cincinnati, Ohio

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Send free literature, AMAZING SPECIAL OFFER and all particulars regarding your big money-saving proposition on Guaranteed Miraco Sets and all radio supplies.
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THE GRID

A Department Devoted to Solving the Problems of our Readers

QUERIES ANSWERED

1. WHAT ARE THE VALUES OF THE CONDENSERS, RESISTANCES, AND BALLASTS ETC., FOR THE RADIO BROADCAST "ARISTOCRAT"?
T. J. L. Lansing, Michigan.

2. WHAT ARE THE CAUSES OF SOME OF THE NOISES PRODUCED IN MY RADIO SET? CAN THESE ORIGINATE AT THE STUDIO?
A. W. T.—Pompton Lakes, New Jersey.

3. WHAT IS THE THEORY OF OPERATION OF IMPEDANCE AUDIO AMPLIFIERS?
W. S. Burlington, Vermont.

"ARISTOCRAT VALUES"

THE following values apply to the "Aristocrat" receiver which is shown diagramatically in Fig. 1: C1 and C2, .0005 mfd.; C3, .002 mfd.; C4, .0005 to .002 mfd.; C6, .00025 mfd.; C7, C8, and C9, not less than .01 mfd. C5 is a midget variable condenser and its capacity approximates .000032 mfd. The values for the various resistances shown in the diagram, are as follows: R1, R2, R3, R4, and R5 are filament ballasts, and their size will vary with the different types of tubes employed. Thus, for tubes consuming .25 amperes, ¼ amp. ballasts are necessary, etc.; R6, 2 to 4 megohms; R7, R9, and R11, 100,000 ohms each; R8, approximately 1 megohm; R,10½ megohm; R12,¼ megohm. The use of condenser C10 often improves the results but its use may not be essential. Its capacity will be in the neighborhood of .002 to .004 mfd. A large capacity condenser of about half a microfarad will often improve the tone if connected across the B battery binding posts. In the original RADIO BROADCAST "Aristocrat," single units consisting of two resistances and a coupling condenser all in one piece were, among other arrangements, tried out. It is for this reason that the two resistances and coupling condenser preceding each audio amplifier tube are surrounded by dotted lines.

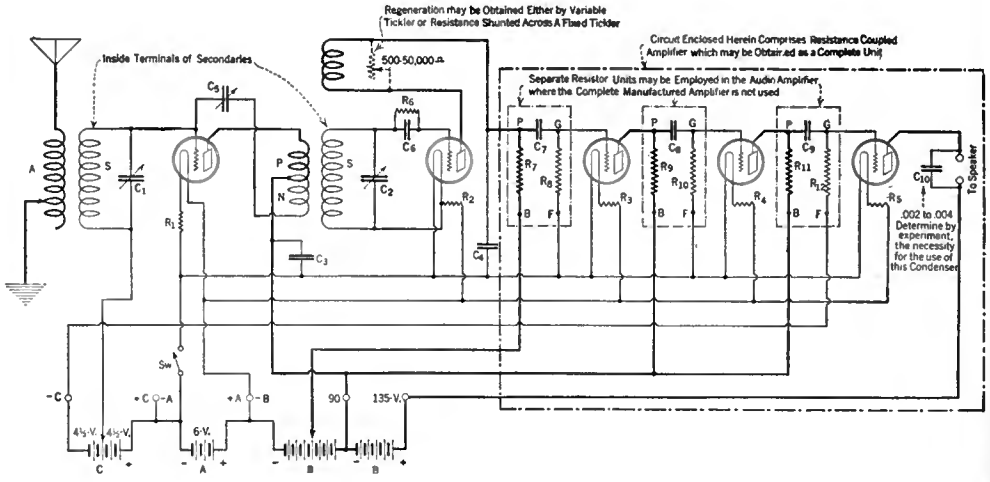

FIG. 1

NOISES AND THEIR CAUSES

IT IS possible that various noises heard through one's loud speaker can have originated at the transmitting station, but generally speaking the trouble can be traced to either the receiving equipment or the intermediate medium—the ether. Noisy microphones cause a steady hiss which often blurs the voice of the artist, while programs picked up outside of the studio and carried overland by wire for broadcasting, are often excessively noisy by induction from neighboring wires. A steady rushing sound, especially noticeable when the receiver is tuned to resonance, is often caused by the generator which supplies the plate potential to the transmitter tubes. This noise is more or less pronounced on all stations and continues until the broadcasting is finished and the stations sign off.

Noise contributed by the ether medium may be defined as those sounds which are caused by electrical disturbances between the broadcasting station and the receiver itself. In this group are found the disturbing influences of high tension power lines, violet and X-ray machines, leaky transformers, electrically operated elevators, sparking motors and generators, trolley and elevated systems, railway systems and telephone and telegraph wires, and a host of other electrical contrivances. Electrical impulses from those undesirable sources usually occur at short wavelengths and are picked up by sensitive receivers. Static also comes in this class and is more prevalent throughout the summer months. Many satisfactory programs are suddenly broken up by a series of unfamiliar clicks, and in many cases are interrupted entirely for short periods. Those may be caused by key clicks from continuous wave transmitters and by improperly operated regenerative and super-heterodyne receivers.

In another class are the noises which are caused by the receiver itself or by the equipment which is used in connection with it. Discharged B batteries become noisy and are usually the cause of a high pitched squeal when the receiver is operating on the second audio stage. These batteries should be discarded when their voltage drops below about thirty-four. Storage B batteries often cause the same trouble

Made to Last

RADIO tubes will continue to be used for many years, and with careful, intelligent handling and periodic flashing with the Burton and Rogers Tube Flasher they will last for many years.

So will the Burton and Rogers Tube Flasher. It is made to last. Its genuine Bakelite panels, resistances accurate under all conditions and wound on porcelain, baked green enamel sides; proclaim its quality and insure its durability.

Electrically its design is based on fundamental principles and long experience and experimentation. It is the scientific development of an idea—not an unintelligent imitation of something else. And because *what is made right, looks right*, it is an ornament to the accessories of the most particular radio owner.

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BURTON & ROGERS TUBE FLASHER

★ $7.50

One Model for D. C. or A. C. all cycles
For tubes with thoriated filaments.

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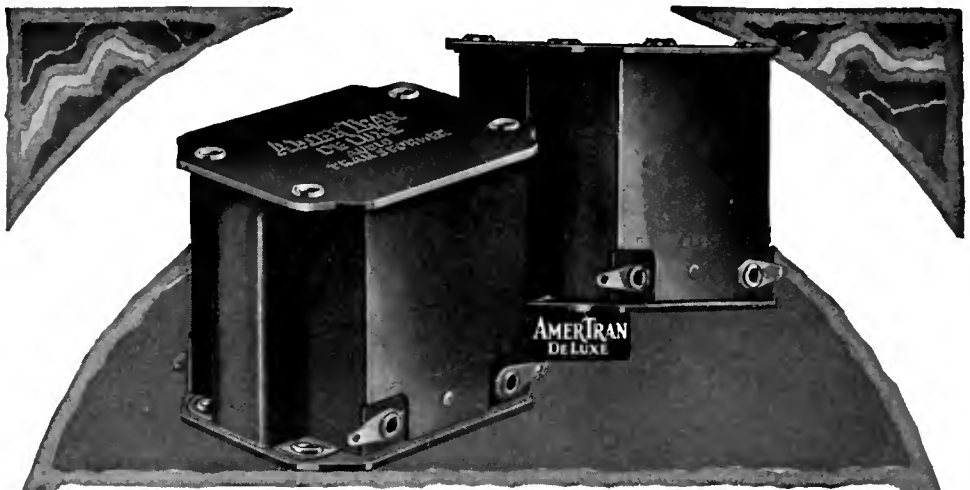
If Your Set Won't Percolate

write us about it. RADIO BROADCAST is establishing a special repair department to assist set builders in getting the best out of the receivers they build from plans published in the magazine. Write for complete information about this new department established for your benefit.



Volume—with True Quality!

The value of radio as an entertainer increases only with the realism and quality of reception. This requires good broadcasting—reception and amplification equal to, or better than, the broadcast range of audio frequencies—and a loudspeaker of uniform response over the same range. Heretofore one of the weak links in this chain has been the audio amplifier.

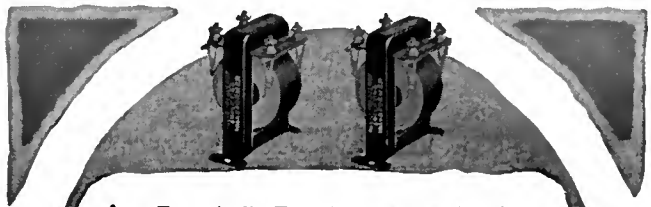
But it is now possible with AmerTran DeLuxe audio transformers to obtain faithful, strong reproduction over a range of frequencies down to the lowest pitched audible sound. *This is nearly three octaves lower than that previously obtained.* The deep boom of the drum, the thrum of the base viol, and the thunder of the pipe organ are reproduced with startling realism—and at no sacrifice of the highest notes within the audible range. Once tried, the AmerTran DeLuxe will be recognized as setting a new high standard of excellence in audio amplification.

AmerTran DeLuxe requires no special circuit other than the use of a large tube in the last stage to prevent overloading at the low frequencies brought out. It is made in two types.

Price, either type, $10.00

We have prepared a booklet describing these and other AmerTran products, together with recommendations for their use. We shall be glad to send you a copy upon request. ★

AMERICAN TRANSFORMER COMPANY
178 Emmet Street, Newark, N. J.
"Transformer builders for over twenty-four years"
SOLD ONLY AT AUTHORIZED AMERTRAN DEALERS



AmerTran Audio Transformers type AF6 (turn ratio 5) and AF7 (turn ratio 3½) have been substantially reduced in price. As before, they are today the leaders in their class. No changes have been made in the electrical characteristics since they were first sold. Either type now $5.00.

Be sure to see the other Amer-Tran ad on page 383

Why not subscribe to *Radio Broadcast?* By the year only $4.00; or two years, $6.00, saving $2.40. Send direct to Doubleday, Page & Company, Garden City, New York.

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even when the voltmeter reading is high. Squeals in this case are caused by one or more dead cells which are usually not detected unless a voltmeter reading is taken of each individual cell.

Noises are sometimes caused by the vacuum tubes themselves. While outwardly they appear quite satisfactory, it sometimes happens that their internal elements are not rigidly supported, and any disturbance in the vicinity of the receiver may cause these elements to vibrate. This defect in construction produces a bell-like sound which has been known to build up in volume and drown out the program.

A somewhat similar sound may possibly be produced by placing the loud speaker on top of the receiver or by pointing the horn in the direction of the receiver. This may be remedied by a slight change in the position of the horn.

Noises are also caused by dirty prongs of vacuum tubes or by sockets which do not make perfect contact. These noises may be overcome by sandpapering the prongs of the tubes or by bending up the spring contacts of the tube sockets.

IMPEDANCE AMPLIFIERS

THE desire for quality of tone, rather than excessive volume, is the dominant factor causing widespread investigation and research work in the quest of an audio amplifier that will entirely satisfy the critical tastes of the modern broadcast listener.

Up to recent times, transformer audio amplifiers have been accepted because very little was known about alternatives. The activity of independent investigators, however, led to very fine accomplishments as regards resistance-coupled amplifiers, yet there is still much to be found out about this very interesting phase of amplification work.

Now radio is repeating itself in a swing around

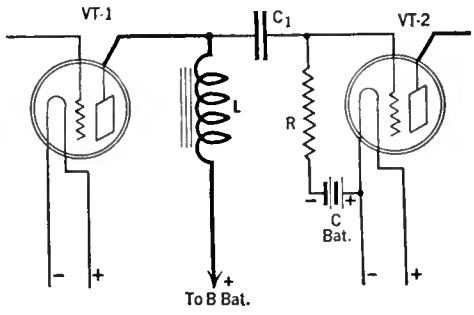

FIG. 2

the circle, and the old-time choke or impedance audio amplifier is coming into its own again.

Claims are being advanced to prove its particular advantages and superiority over other forms of amplification, and improvement has led to the development of a type of choke coil which has a satisfactory voltage step-up. Ordinarily, such amplifier units consisted of a single coil of wire having an iron core.

Such a coil is shown applied to an audio amplifying circuit in Fig. 2.

To-day, by means of a tap-off on the choke coil, it is possible to obtain a step-up ratio sufficient to overcome any drop that might take place in the condenser C. Commercially this type of choke coil is known as an "Autoformer."

Explaining the function of the circuit in Fig. 2, the variations in a.c. current in the plate circuit of the first tube set up a varying electromagnetic field in the choke coil; the e.m.f. produced is impressed upon the grid of the succeeding tube through the condenser C, which prevents the B battery potential from reaching the grid of the second tube.

Note the similarity in this type of amplifier to the standard resistance type. In the latter, a plate resistance unit replaces the choke coil. Some claim that the resistance amplifier requires higher B battery voltage to be applied to the plates of the amplifying tubes, because of the drop in voltage through the high plate resistance. However, all tests conducted at the RADIO BROADCAST Laboratory tend to indicate that as low as ninety volts on the plate of the last stage resistance-coupled amplifier will operate entirely

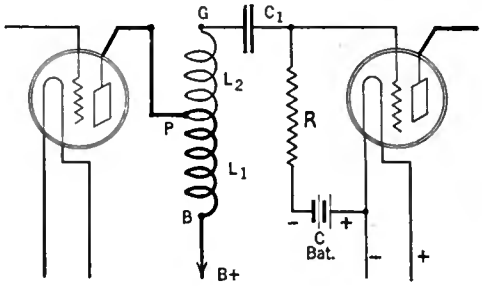

FIG. 3

satisfactorily. Of course, with the new high-Mu tubes, greater plate voltages are required.

The new type of choke coil, or impedance amplifier, as it is correctly called, employs the auto transformer system to obtain the desired step-up. In Fig. 3, P-B indicates the primary or plate winding of the coil, while G-B constitutes the secondary. Any variations of the electromagnetic field in P-B will cause corresponding but stronger variations in G-B. The resistance R, in both types of choke amplifiers, prevents excessive negative charges from piling up on the grid of the tube, by providing a leakage path back to the negative side of the filament. Ordinarily, the grid should be maintained at a negative potential in respect to the filament, and often a C battery is employed for this purpose; this, so that the tube may function on the proper part of its characteristic curve.

Several types of impedances suitable for use in an amplifier of this type, are finding their way to the radio market, and there are some companies, such as the Acme, General Radio, Dongan, Amertran, Thordarson, and National, that are either making such coils or have on stock a coil which may readily be employed in this capacity.

The experimenter may have an old transformer whose primary is burned out, in which case the secondary may be connected as in Fig. 2 to form quite an efficient choke coil for such an amplifier.

An important feature of the choke amplifier is the selection of a suitable isolating condenser, as C 1 is termed. If this condenser is too small, it will by-pass some of the higher frequencies. One on the order of .5 or 1 mfd. should be employed for satisfactory reproduction.

WHEN WRITING TO THE GRID—

A TYPEWRITTEN letter, written on one side of the paper only, is to be preferred, as it aids in the quick formation of a satisfactory reply.

Don't fail to send a stamped addressed envelope with your inquiry.

Don't send a second inquiry about the first.

Don't include questions on subscription orders or inquiries for other departments of Doubleday, Page & Company.

In asking questions give us all the information that will aid in advising you. If the question relates to apparatus described in RADIO BROADCAST, give the issue, page number, and figure number of the circuit diagram, etc.

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THE BEST IN CURRENT RADIO PERIODICALS

The Third Installment of a Useful Classified Survey of Material Appearing in the Radio Press

By E. G. SHALKHAUSER

How This Survey Can Help You

HOW often have you looked for information contained in some article which you recall having read months ago—the description of the Browning-Drake receiver, or the measurement of losses in inductance coils, for example? After looking through probably several issues of a dozen different publications, you either give up or become interested in something altogether different.

When data is wanted on some particular subject, a systematic file of subjects and titles becomes a real radio encyclopedia. Instead of having merely the title of an article given, which often is misleading, a summary of the contents gives all the information. These surveys cover the radio field as gleaned from material in to-day's periodicals. They will always serve as a future reference-guide to all who are interested in the science of radio, whether engineer, manufacturer, dealer, experimenter, or listener.

To be of practical value and easily accessible, these surveys should either be filed in a scrap book, or, better still, be pasted on individual cards and filed according to numbers, or alphabetically. In the matter of classification of articles, the Bureau of Standards circular No. 138 has been followed. This may be obtained from the Government Printing Office, Washington, District of Columbia, for ten cents. In addition, each abstract has certain key-words placed at the upper right, which may be used for the purpose of filing articles alphabetically.

With this series of surveys we hope to aid our readers and help them through many difficulties which they no doubt have often experienced. In future we will give information and references to articles previously surveyed upon receipt of a stamped and self-addressed envelope.

Following is the series of headings, made up according to the Dewey Decimal System used in the Bureau of Standards circular No. 138:

R000 RADIO COMMUNICATION IN GENERAL.
Under this heading will appear all subject matter pertaining to laws, regulations, history, publications, etc., which deal with radio in a general way.

R100 PRINCIPLES UNDERLYING RADIO COMMUNICATION.
Here will be given the phenomena of radio waves, their underlying theory of propagation, the principle of antenna and counterpoise, design and characteristics of vacuum tubes and their behavior in circuits, types of circuits, transmitting and receiving apparatus and their principles of operation.

R200 RADIO MEASUREMENTS AND STANDARDIZATION METHODS.
The various known methods which have been used in measuring frequency, wavelength, resonance, capacity, inductance, resistance current, voltage, dielectric constants, and properties of materials, will be mentioned here.

R300 RADIO APPARATUS AND EQUIPMENT.
A description of various types of antennas and their properties, the use of the electron tube in various types of receiving and transmitting sets, other methods of transmission of signals, various detecting devices used in reception, instruments and parts of circuits, come under this heading.

R400 RADIO COMMUNICATION SYSTEMS.
The spark, modulated wave and continuous wave systems in transmission, beat and other methods of reception, wired wireless, automatic printing, the buzzerphone and Fullerphone, will be given here.

R500 APPLICATIONS OF RADIO.
To aviation, navigation, commerce, military, private and broadcasting, and the specific information under their headings, are referred to here.

R600 RADIO STATIONS.
The operation, equipment, and management of radio installations, both transmitting and receiving, the testing, the rules and regulations concerning stations, the reports and bulletins issued, will follow under this heading.

R700 RADIO MANUFACTURING.
Data relative to costs and contracts of radio equipment from raw material to finished product, including factories, tools, equipment, management, sales and advertising, follows here.

R800 NON-RADIO SUBJECTS.
The matter of patents in general; the mathematics and physics, including chemistry, geology and geography; meters of various kinds; all information not strictly pertaining to radio but correlated to this subject, will be found under this heading.

R900 MISCELLANEOUS MATERIAL.

A Key to Recent Radio Articles

R333. THREE-ELECTRODE TUBES. VACUUM TUBES, *Life Testing*
Proceedings I.R.E. Oct., 1925, pp. 625–645.
"Life Testing of Tungsten Filament Triodes," W. C. White.
Triodes are life-tested primarily as an aid to the manufacturers in proving their performance and useful length of service rather than to obtain any average life figure. The apparatus employed and its method of operation, together with the procedure in handling the data, is next described. Actual results obtained are given to illustrate the methods used. These results are outlined in the form of tables and curves. One point emphasized throughout the paper is that triode life is just as much a variable factor as other factors, such as electron emission or impedance.

R430. INTERFERENCE ELIMINATION INTERFERENCE, *General.*
Popular Radio. Oct., 1925, pp. 318–323.
"How to Improve Broadcast Reception," J. V. Hogan. Part VII.
The question of interference in broadcast reception is taken up from the receiver standpoint. The receiving set can be made very selective by proper choice of apparatus and good arrangement of parts. Various primary and secondary circuits are discussed in detail, and their advantages and disadvantages noted.

R110. RADIO WAVES. MAGNETISM OF EARTH AND WAVES
Popular Radio. Oct., 1925, pp. 309–316.
"How Earth Magnetism Affects Radio Waves," H. Nichols and J. Schelleng.
The discrimination made against waves of different frequencies by the medium through which they travel, has changed our ideas of wave propagation within recent years. The atmosphere is supposed to have a marked effect on electromagnetic waves, much as a glass prism has on light waves. Because electrons move in the magnetic field of the earth, we would expect them to be affected by this field. Such an effect seems to be particularly noticeable at about 1199 kilocycles (250 meters), and the much-discussed question of fading may be explained in this way.

R134.4 REGENERATIVE ACTION OSCILLATIONS AND REGENERATION.
Popular Radio. Oct., 1925, pp. 388–390.
"The Prevention of Oscillation and Control of Regeneration in R. F. sets."
Radio frequency receivers usually have the tendency to oscillate at some frequency, especially if more than one stage is used. Several methods are described which can be used to prevent such undesirable noises. Diagrams are added to aid in applying these remedies

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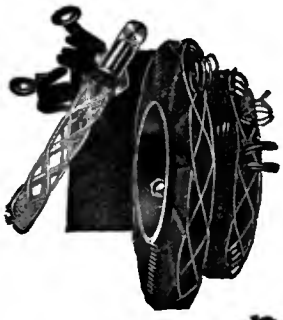

Complete set of coils for Roberts circuit, List Price $6.

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3 circuit HEXCELL tuner 200-575 meters	$3.00
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We have put real electrical and mechanical engineering into our inductances. Particular attention is given to efficient operation at the lower end of the Broadcast Wave Band.

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Flexible stranded wire for "point to point" and sub-panel wiring latest method of wiring sets. Five colors, black, yellow, green, red and brown, one for each circuit. Twenty-five foot coils.

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The best outdoor antenna you can put up. 7 strands of enameled copper wire; maximum surface for reception. Enameling prevents corrosion and consequent weak signals. 100, 150 or 200 ft. coils, boxed.

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Flexible Varnished "Spaghetti"

A perfect insulation tube for all danger points in set wiring. Costs a little more and is worth a lot more than the cheaper substitutes offered. Black, yellow, red, green, brown; for wires No. 10 to No. 18. 30 inch lengths.

Celatsite Battery Cable

For connecting A and B Batteries (or current supply) to radio set. Silk braid covering 5 flexible Celatsite wires—5 feet long—a different color for each terminal. Prevents messy wiring and "blown" tubes. Adds greatly to the appearence of your set.

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Made in $\frac{1}{10}$, $\frac{1}{4}$, $\frac{1}{2}$, 1, 2, 3 and 4 Microfarad sizes

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R560. MILITARY. WAR AND RADIO.
Popular Radio. Oct., 1925, pp. 301–308.
"Radio and the War Menace," Bruce Bliven.

Radio is considered as being one of the most powerful agencies either for war or peace among nations. The sooner it is harnessed for the purpose of maintaining peace the less likely are we to use it as a means of destruction. A common language is sought among nations so that broadcast programs will be understood by all. Radio should be used to help in disseminating new ideas and to foster a proper attitude among constituents. On the contrary, it may serve as a spreader of much wrong propaganda and be able to do much harm. Thus radio exists as a great force ready to be used either for good or evil.

R382. INDUCTORS. COILS, *Low Loss,*
Popular Radio. Oct., 1925, pp. 326–329.
"What Makes a Low Loss Coil?" Charles Burke.

A comprehensive discussion on the relation of inductance to high frequency resistance is presented. What size wire is best to use at definite frequencies, what shape of coil is best and how it should be constructed—these are questions considered. The specifications for coils of highest efficiency are presented, various forms of coils being shown in photographs.

R550. BROADCASTING.
Popular Radio. Oct., 1925, pp. 334–339. STUDIO SECRETS
"Secrets of the Studio," Paul Godley.

Much effort is being expended in improving the quality of programs coming from the broadcast studio. To secure good reproduction at the receiver, both transmitter and receiver must show little or no distortion. At the studio much intensive work is done to insure the best transmission possible from the artists. Better microphones, better circuits, and better apparatus for modulation, have improved broadcasting.

R381. CONDENSERS. CONDENSER
Popular Radio. Oct., 1925, pp. 340–345. LOSSES.
"How to Compare Losses in Condensers," S. Harris.

The question of condenser losses, and the method of testing condensers, is discussed. Various tests used in making comparisons of condenser losses have resulted in the drawing of wrong conclusions. The curve showing effect of resistance with change in frequency for a 500 mfd. condenser emphasizes the point to be considered. Condensers should be tested for losses not at a thousand cycles, but at frequencies for which they are to be used, in order to determine their efficiency and characteristics.

R134.75. SUPER-HETERODYNES. SUPER-HETERODYNES
Popular Radio. Oct., 1925, pp. 350–363. *Single Control.*
"How to Build the New Super-Heterodyne With a Single Control," J. McLaughlin.

The operation of an eight-tube super-heterodyne from a single dial is here described. Complete details include circuit diagram, parts to be used, layout of the set, and instructions for wiring and testing.

R514. RADIO COMPASS. COMPASS, *Radio*
Radio. Oct., 1925, pp. 10ff.
"Piercing Neptune's Shroud," V. G. Mathison.

A sketch of an actual occurrence aboard an American liner, is given, showing the extreme value of the radio compass. The author then goes into details concerning theory and the practical uses of the radio compass during fogs at sea. The compass designed by Kolster, and built by the Federal Telegraph Company, is shown. Many difficulties had to be overcome in order to obtain absolutely reliable results under any and all conditions, and some of these are mentioned. Diagrams of the set and photographs of the compass are shown.

R376.3. LOUD-SPEAKING REPRODUCERS. HORNS.
Radio. Oct., 1925, pp. 18ff.
"Limitations of Horn Type Loud Speakers," Dr. J. Minton.

A series of curves showing the relation of frequency of sound waves and sound pressures coming from horns of various shapes and sizes are presented. The curves are interpreted by the author. These so-called "response-frequency" curves show considerable variation, the best kind of a horn giving a high flat curve.

R341. DETECTORS, RECTIFIERS. DETECTORS.
Proceedings I.R.E. Oct. 1925, pp. 611–623.
"Detecting Characteristics of Electron Tubes," H. M. Freeman.

It is pointed out that, owing to the progress of the radio art, the opinions heretofore held as to the importance of the part played by detector efficiency in a receiving set are in need of revision.

Taking the well-known analysis of the operation of a detector tube with condenser and grid leak, curves are derived from the static characteristics of a typical general purpose tube, showing the performance of the tube as a detector under certain conditions of operation.

A method is described of measuring the output of a detector tube with a standard incoming signal, and experimental results obtained with the tube used for deriving the curves are compared with those obtained from theoretical considerations, showing that the method can be used to give a true picture of the effect on detector efficiency of variations in operating conditions.

Sample curves are given, showing the wide variations obtained in the efficiency of certain types of standard tubes by relatively slight changes from the customary operating conditions, and also the variations in efficiency of a number of similar tubes under normal operating conditions.

R611. LONG WAVE STATIONS. STATIONS, *Warsaw*
Proceedings I.R.E. Oct 1925, pp. 570–588.
"Transoceanic Radio Station, Warsaw, Poland," W. G. Lush.

A brief history and description of the Warsaw transoceanic radio station, as constructed and installed for the Government of Poland by the Radio Corporation of America, is given. A technical description of the details of the system used is not presented, as the system is similar in all respects to that in use in the United States by the Radio Corporation. Several photographs show the general plan of the station and the equipment.

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R431. STRAYS. INTERFERENCE.
Radio. Oct., 1925, pp. 17ff.
"How to Reduce Interference," L. W. Hatry.
Most receivers in use to-day employ the untuned primary method of reception. This is undesirable from several standpoints. A method whereby greater selectivity can be obtained, is described, by adding a loading coil to the antenna circuit. This will permit rough tuning of the antenna circuit and insure much better reception.

R127. ANTENNA CONSTANTS. ANTENNA CONSTANTS
Radio. Oct., 1925, pp. 20ff.
"How Antenna Characteristics Affect Reception," K. B. Morcross.
A description of the effect of resistance, capacity, inductance, direction, height, length and surroundings, of an antenna on transmission and reception of ether waves, is given. Various types of antennas are discussed, and equations are presented and interpreted for the benefit of the less experienced in the radio art.

R134.4. REGENERATIVE ACTION. OSCILLATIONS IN SETS.
Radio. Oct., 1925, pp. 22f.
"Elimination of Oscillations in R. F. Amplifiers," Dr. Buchbinder.
An analysis of the causes of oscillations and several of the methods used in preventing oscillations in radio-frequency amplifiers is given. Three general methods are employed usually: 1. Decreasing the amplification efficiency through losses; 2. Reducing stray magnetic and electro-static fields; 3. Using balancing-out arrangements. The last method is suggested as being the best because it leads to sensitive and selective receiving.

R145. REACTANCE REACTANCE DIAGRAMS.
Radio. Oct., 1925, pp. 24f.
"How Radio Circuits Work," G. F. Lampkin.
A theoretical discussion of resistance, capacity and inductance in radio circuits is presented. Graphs and concrete examples of the application of various equations to typical radio circuits brings this much misunderstood and difficult information within the grasp of the average experimenter.

R384.1. WAVEMETERS WAVEMETER.
Radio. Oct., 1925, pp. 29ff.
"A Detecting, Oscillating and Modulating Radiocast Wavemeter," E. E. Griffin.
The construction and operation of a simple wavemeter, which may be used as a receiver, a modulator, or an oscillator, is given. In design and general arrangement it resembles any ordinary one-tube receiving set, but its uses are many. Method of calibration and testing is given. Its many uses in measuring constants of radio apparatus make this one of the best laboratory instruments for any radio worker.

R420. MODULATED WAVE SYSTEMS. MODULATING SYSTEMS.
Radio. Oct., 1925, pp. 31–32.
"Plate and Grid Modulation Systems," L. Grignon and F. Jones.
A constant carrier frequency is modulated by either a decrease in antenna current (Heising system) or a decrease or increase in antenna current (grid modulation system). The theory underlying these two methods, their advantages and disadvantages on the broadcast range of wavelengths, as discussed, lead the authors to believe that the grid system of modulation is the better. Circuit diagrams and data are given for the benefit of those wishing to try out these two systems for comparison.

R351. SIMPLE OSCILLATORS. OSCILLATOR, *Quartz.*
Radio. Oct., 1925, pp. 33–34.
"A Quartz Crystal Oscillator," D. B. McGown.
A description of this new form of instrument, used as a standard of wavelength, and information on the construction of such an instrument, is given. The Hartley circuit is used. The parts that enter into the building of this oscillator are all standard and easily obtainable. It can be used as any other oscillator. Its accuracy is said to be much greater than ordinary forms of oscillators.

R342.6. RADIO-FREQUENCY AMPLIFIERS. RECEIVER, *Kellogg-RFL.*
QST. Oct. 1925, pp. 8–11.
"A True Cascade R. F. Amplifier," Dr. L. M. Hull.
According to Mr. H. Snow's experimental study, the so-called intermediate-frequency amplification in superheterodynes, using three tubes, will not give a voltage gain of more than from 800 to 1000. A marked "tapering-off" effect is usually apparent. Straight cascade one-way stages were tried at 750 kc. with a voltage gain, starting with seven, of seven times for each tube used. Five tubes gave an amplification of more than 16,000. A description of the set, its peculiarities of construction, and a circuit diagram are given. The instrument is very selective and has but two controls.

R113. TRANSMISSION PHENOMENA. SHORT WAVES, *Characteristics of*
QST, Oct. 1925, pp. 12–21.
"Wave Propagation at High Frequencies," Dr. A. H. Taylor and E. Hulbert.
This article contains a detailed discussion concerning the probable condition of the upper ionized atmosphere and its effect on the propagation of waves at high frequencies. Ionization, de-ionization, wave-energy losses, absorption, skipped distances and their cause, effects due to frequency changes, day and night transmission—these are subjects taken up in turn and discussed in a very clear manner. Experimental evidence substantiates most of the statements made, curves and diagrams serving to illustrate points in question.

R005. EXECUTIVE, ADMINISTRATIVE. PERSONNEL. AMATEURS LINKED WITH THE ARMY.
QST. Oct. 1925, pp. 22–24.
"The Army links up with the Amateur."A.R.R.L Plan.
A plan whereby amateur stations located in the United States will coöperate with the United States Signal Corps for a four-fold purpose: 1. To have channels available in case of emergency; 2. To have channels available for civilian components of the army; 3. To have operators available trained in army methods; 4. To have contact available between operators and Signal Corps for the exchange of new ideas in experimental work. The plan of affiliation is given verbatim.

R383. RESISTORS — RESISTORS.
QST. Oct. 1925, pp. 25–28.
"High Frequency Resistance Standards," J. M. Clayton.
In measuring frequencies above 2000 kc. the ordinary resistance units are inaccurate, either adding inductance, capacity, or both to the circuit being tested. A new form of resistance made of magnesium wire is described, which can be used for much higher frequencies with extreme accuracy. The method of construction is given. Diagrams illustrate method of mounting and adjusting.

R343. ELECTRON TUBE RECEIVING SETS. — RECEIVER, SHORT-WAVE,
QST. Oct. 1925, pp. 33–36.
"Short-Wave Receivers," R. R. Batcher. *Grebe CR-17.*
Valuable pointers concerning construction of short-wave receivers are brought out in this discussion, with particular reference to the Grebe CR-17. A short-wave tuner chart is used for inductance and capacity calibrations.

R356. TRANSFORMERS. — TRANSFORMERS.
QST. Oct. 1925, pp. 37–39.
"Transformers and Reactors in Radio Sets," R. H. Chadwick. Part II.
Audio-frequency transformers are discussed, more or less theoretically, with particular emphasis on the amplification factor at various frequencies. At low and high values of frequency, the amplification is less, due to effects noted in diagram, Fig. 10. Filter reactors are used for the purpose of introducing opposition to the flow of alternating current. Depending upon the circuit they are to serve, their construction will be determined. The discussion brings out the general principles involved in reactor design.

R110. RADIO WAVES. — SHORT WAVES, *Phenomena of*
Radio News. Oct. 1925, pp. 410ff.
"The Behavior of Radio Waves," Dr. E. F. W. Alexanderson.
Little is known concerning the radiation of energy from antennae. Our conception of the ether and the electron is more or less vague at present. Experience points towards the fact that short waves are reflected according to the Larmor Theory of propagation, herein described. A new phenomenon was noted recently, namely that of horizontally polarized waves when sent from a horizontally mounted multiple-tuned loop. The plane of polarization changes as the wave progresses. The method used for analysis, and the construction of the loop, are shown in photographs.

R594. GERMANY — GERMAN RADIO DEVELOPMENTS.
Radio News. Oct. 1925, pp. 412ff.
"Radio in Germany," Dr. E. Nesper.
Radio developments in Germany have been making great strides, as is indicated by the interest shown in recent radio exhibits. Since September 1st, the German radio laws and regulations have been greatly modified, so that experimenters have about the same range of freedom that we, here in America, enjoy. Interest in broadcast programs is keen. The broadcast system is owned by the Postal Company and licenses are issued for receivers. Photographs of several home-made receivers are shown.

R550. BROADCASTING. — SUPER STATIONS
Radio News. Oct. 1925, pp. 418ff.
"Super-power Broadcasting."
This article describes the new WGY 50-kilowatt broadcasting station. The accompanying photographs give a very clear idea of the size and scope of the equipment. The circuits used in the many transmitters at Schenectady are of the master oscillator type. Much of the work is experimental, for little is known regarding the use of super-power on the various frequencies. The stations are operating primarily for the purpose of learning more about the "attenuation constant" of transmitters.

R800(535.3) PHOTOELECTRIC PHENOMENA — PHOTOELECTRIC CELL, *Its use.*
Radio News. Oct. 1925, pp. 426ff.
"The Vacuum Tube and Photoelectric Cell," General G. Ferrié.
A method whereby the photoelectric cell is used in conjunction with three and four electrode tubes, to detect and amplify extremely small currents set up by light waves (particularly ultra-violet), is here given. This principle has many applications in astronomy. It is also used in determining the period of a pendulum, a mirror being attached to the swinging arm, and light reflected into the cell.

R130. ELECTRON TUBES. — VACUUM TUBES,
Radio News. Oct. 1925, pp. 434ff. *Detecting and Amplifying*
"Hard Tubes and Soft Tubes as Amplifiers and Detectors," Prof. C. Bazzoni. Part I.
An elementary but nevertheless very thorough and comprehensive discussion on the operation of vacuum tubes is presented. Emission, space charge, degree of vacuum and the action of gas atoms and electrons, determine detector and amplifier action in vacuum tubes. Graphic diagrams help to form a mental picture of the action within the tube.

R381. CONDENSERS. — CONDENSERS, *S.L.F.*
Radio News. Oct. 1925, pp. 447ff.
"Does a Straight Line Frequency Condenser Exist?" S. Harris.
The question of obtaining straight line frequency calibration curves with a so-called straight line frequency condenser, is a point much discussed. The author shows the relation between condenser capacity and coil at various frequencies. There is practically no deviation from the straight line even with coils of a large distributed capacity when connected to a straight line frequency condenser. So for all practical purposes the instrument does exactly what it is supposed to do.

R149. RECTIFICATION. — FILTERS.
Radio News. Oct. 1925, pp. 452ff.
"All About Filters," E. W. Berry.
In order to obtain a source of good direct current for plate supply, either a generator or alternating current rectifier is often employed. Both need considerable filtering. The article describes in detail the effect of choke coils and condensers in a circuit. Concrete examples serve to illustrate the points brought out. A series of graphs show the result of tests made with series, parallel, and series-parallel connections of chokes and condenses. A thorough presentation of the subject for experimenters.

BOOK REVIEW

A History of Radio Men and Their Contributions to Radio Progress

RADIO: BEAM AND BROADCAST. *By A H. Morse, Published by Ernest Benn, Ltd., London. In New York, by D. Van Nostrand Company. 186 pages. $4.*

THIS recent book on radio is well worth while the attention of any who expect to do developmental work in radio, or in any of its allied fields. While it is entirely different from what we had expected to find, it proved to be of sufficient interest that we stayed with it on the first reading until the last page had been covered.

Instead of being as we had supposed, a book written more or less in the manner of a text, it proved to be an interesting and continuous history of the art of radio as a whole, having no special connection with either beam or broadcast methods of communication. The author's intentions are perhaps best given in his own words. Says he in the introduction: "Within the last few years, the radio field has been invaded by many thousands of persons who know nothing of its evolution, and are therefore sometimes unable to distinguish between what is new and what is old. The consequence is that they waste much time and money in re-inventing old devices and in developing others to circumvent imagined patents, or inventions, long since in the public domain. The case of the spider-web coil may be cited as an example. This will be found to have been illustrated and described several years before the Great War, but was heralded as a novelty two or three years ago. It is one of the author's objects to help to create the perspective of these newcomers, and it is hoped that this book will be of some assistance to British and American patent agents' attorneys (new to the art), inventors, experimenters, journalists, radio enthusiasts, and 'why men' generally, on both sides of the Atlantic.

"The evolution of the radio art is traced herein mainly through the Patent Office records of inventions in use to-day, or their lineal forebears. As a consequence, many inventions of great merit and one time promise, receive little or no mention; and except in a few cases where inventions are cited merely as evidence of the contemporary knowledge of the art, a selection has been made, not by the author but by the test of utility. It may be observed that this test has proved too much for some of the most heralded inventions."

The first chapter of the book briefly relates the accomplishments of the early workers in the radio field, starting with Christian Huygens, who first propounded the undulatory theory of light in 1678, and ending with the year 1912. The author has been at a deal of trouble evidently in consulting original writings, and has given in an interesting manner a story of the high spots of radio's development during this period. To indicate the scope of the material given, there is a note that in 1843 Professor Joseph Henry succeeded in magnetizing needles two hundred and twenty feet distant from his energizing apparatus. In the opinion of one of America's foremost physicists, these experiments of Henry really constitute the first disclosure of radio communication, but they apparently were not appreciated as such by Linsely, and his work had no important commercial outcome. In 1879, Professor Hughes, an Englishman, succeeded in sending radio signals a distance of about sixty feet. Among those present were some of the most noted English scientists and engineers,

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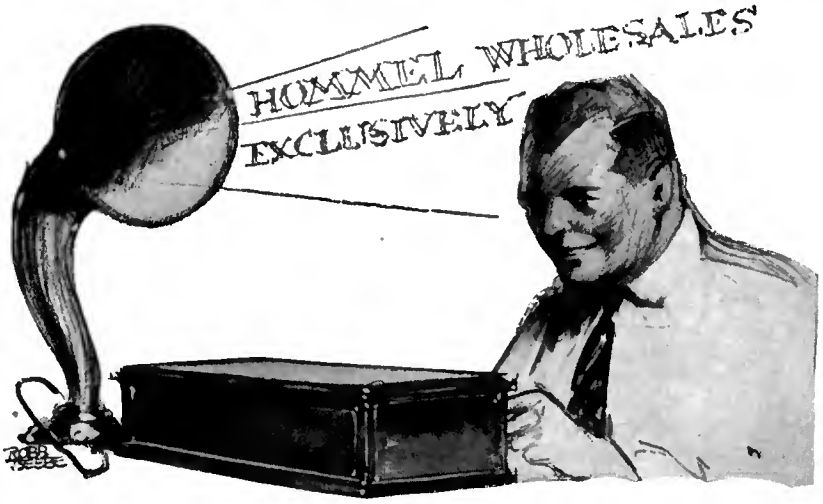

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but Hughes apparently did not really appreciate how important and real his work was, and so was discouraged by the comments of a fellow scientist. They took the romance out of Hughes's experiments by telling him that the ordinary laws of mutual induction might be used to explain all of his experiments. In 1899, Sir William Crookes, commenting on Hughes' work, said: "It is a pity a man who was so far ahead of all other workers in the field of wireless telegraphy should lose all the credit due to his great ingenuity and prevision."

Of course every radio enthusiast now knows that in 1888 Professor Hertz succeeded in showing that electro-magnetic waves and light waves are the same thing, and that he actually did carry on radio experiments in his laboratory with such skill and perseverance that one may read in his laboratory reports a description of practically all of the radio schemes which it has taken us thirty-five years to develop. For those who have not read Hertz's book, a real treat is in store, for one may see pictures and read about experiments disclosing the whole idea of radio beam communication, which many people believe originated in the comparatively recent experiments of Marconi.

The author takes us through the work of Branly (who recently received the Nobel prize for the work he carried out during this period), Thomson, Lodge, Popoff, Rutherford, Marconi, and Fessenden. In 1906 DeForest put the B battery in the plate circuit of the Fleming valve and, in 1907, introduced the third electrode, giving us the now famous audion. In the same year, in Italy, Bellini and Tosi were showing the possibilities of direction finding by radio, and in Germany von Lieben and Reisz were experimenting with the three electrode tube. This brings us up to 1912, when the regenerative circuit was patented in England by Franklin, in Germany by Meissner, and in America by Armstrong. Here the author expands greatly his previously brief presentation of the subject to show that DeForest should be credited, at least in America, with the regenerative and oscillatory features of the audion. He cites the recent decision of the United States Court of Appeals of the District of Columbia, which gives precedence regarding the invention of the oscillating audion to De Forest, whereas the public is accustomed to think that Armstrong was the first to develop this idea.

As we read over this part of the book, and again read over the comparison of the work of Fleming and De Forest, we were urged to look up the former connections of the author, and found on the title page that he was formerly associated with De Forest as superintendent of one of the De Forest wireless telegraph companies. In reading certain parts of the book this fact should be kept in mind.

Chapters II and III deal with radio between 1912 and the present time, and the prediction as to future development. It is not apparent why the prediction should be inserted in Chapter III, as this chapter is followed by others on such subjects as the Poulson arc, broadcasting, regeneration in reception, the triode as generator, one on beam and short wave radio, ending up with the ninth chapter entitled "Conclusion."

An interesting paragraph in the final chapter calls our attention to the fact that many inventors fail to get the credit which is due them. In this place the author writes as follows: "Prior to 1896, Preece had in operation a system of inductive wireless telegraphy, and it was just when he was smarting under the failure of this system to provide communication with East Goodwin lightship, that Marconi came to him with a letter of introduction from Mr. A. A. Campbell-Swinton. Both Lodge and Rutherford had already shown that wireless telegraphy was practicable, and by the same essential

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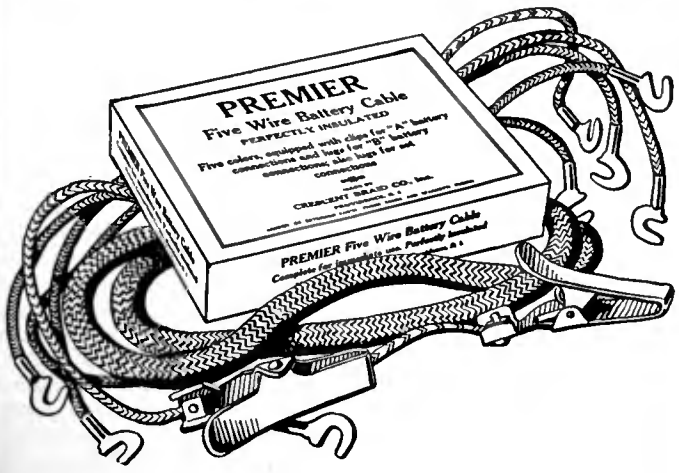

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method that was used by Marconi, but apparently they did not see, or were not interested in, its commercial potentialities, or were too much engrossed in other activities to endeavor to exploit them. This circumstance has no doubt contributed to the fact that to-day the layman regards 'Marconi' and 'Wireless' as interchangeable terms, while the credit which is due to Hughes, Lodge, Popoff, Braun, Fessenden, Stone, and others, is in danger of being forgotten, except by technicians."

The author's views on monopoly are especially interesting in light of the investigation now being carried on by the Federal Trade Commission regarding the activities of the Radio Corporation of America. Quoting Sir William Crookes, regarding the activities of the Marconi Company, the author says: "The whole effect of the operations of the Marconi Company has been to check and really stop the growth of wireless telegraphy as a convenience to navigators as well as a commercial undertaking." This comment, it is to be borne in mind, is made regarding the British Marconi Company, and quite possibly Sir William Crookes might not have expressed the same thing regarding an American monopoly.

In the appendix, which occupies the second half of the book, there are given copies of the important patents which have been granted in the radio field since its inception.

The material given in the book, although not presented in very carefully thought out manner, is extremely interesting, and is well worth the attention of anyone who wishes to appreciate the development of radio and its growth.

J. H. MORECROFT

HIGH-SPEED FADING

MUCH experimental work is being carried out by British "hams" with a view to finding some feasible explanation, and a suitable cure, for high-speed fading. This phenomenon manifests itself, at nearby receiving stations, by distortion and very ragged modulation. As an example of the far-reaching effect of high-speed fading, it is interesting to cite a case experienced by that well known British "ham" Mr. Gerald Marcuse, who operates station 2NM, and whose telephony transmissions are often heard in this country on 6663 kc. (45 meters). He states that, while his short-wave telephony tests, carried out on Sunday evenings with Iraq and India, are reported as being received with crystal purity in those countries, nearby listeners (within a hundred miles or so) write and tell him that his modulation is terrible; nothing can be received intelligibly.

Often this condition is far less troublesome during the hours of daylight, and in this instance we might mention an interesting fact about the short-wave transmissions of KDKA. Listeners in the city of Washington state that it is impossible to receive this station's short-wave emission with anything like good quality during the night hours. However, during the daylight hours, the Pittsburgh programs are perfect.

High-speed fading is only one of the many short-wave telephony problems with which the amateur has to cope, and it is hoped that the recommendation by the recent Washington Radio Conference, that amateurs should be permitted the use of a short-wave band for telephony experiments, will materialize. Already, we understand, the United States Navy Department have concentrated their attention in an effort to overcome this and other short-wave difficulties. If, then, the American amateur is permitted the use of the short waves for his radio vocal efforts, it is more than likely that the data already collected by the Navy Department, will be greatly supplemented, and at least, the many short-wave problems greatly mitigated.

WHAT OUR READERS WRITE US

What Some Famous Radio Men Think of the New "Radio Broadcast"

HERE are a few extracts from letters of radio men known to all of our readers, telling us what they think of the new RADIO BROADCAST.

DE FOREST PHONOFILMS, INC.
NEW YORK CITY

Edi'or, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

I have just had time to look over the last issue of RADIO BROADCAST. I am highly pleased with its appearance and contents. The new is certainly a distinct advance over the old style.

Mr. Thompson certainly succeeded in making another live, interesting story on the "Audion"—full of the personal touch which surely appeals to the average reader. Congratulations and continued success to RADIO BROADCAST.

Very truly yours,
LEE DEFOREST.
President

DEPARTMENT OF COMMERCE
WASHINGTON

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

The November number of RADIO BROADCAST makes a very fine appearance in its new form. . . . I wish you the best of fortune in the further development of your very excellent periodical.

Very truly yours,
J. H. DELLINGER.
Physicist.

RADIO CORPORATION OF AMERICA
NEW YORK CITY

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

On my return to the city, after a week's absence, I had brought to my attention the new RADIO BROADCAST. . . . It is a well prepared magazine and should meet with the public's approval.

Very truly yours,
J. G. HARBORD.
President.

NATIONAL ASSOCIATION OF BROADCASTERS
NEW YORK CITY

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

I am very happy to see the recent changes in RADIO BROADCAST. It augurs well for a continued advancement in publications dealing with radio. We have always considered RADIO BROADCAST a foremost radio magazine of the country, and hope that it will always continue to be so.

Very truly yours,
FRANK W. ELLIOTT.
President.

★ Tested and approved by RADIO BROADCAST ★

★ Tested and approved by RADIO BROADCAST ★

GRID INQUIRY BLANK

Editor, The Grid
RADIO BROADCAST
Garden City, New York

DEAR SIR:

☐ I am a subscriber to RADIO BROADCAST and therefore will receive answers to my queries free of charge.

☐ I am not a subscriber and enclose $1 to cover cost of answers.

NAME .....

ADDRESS .....

.....

G.D.

THE CROSLEY RADIO CORPORATION
CINCINNATI, OHIO

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

I wish to compliment you on the beautiful copy of RADIO BROADCAST which has just come to my desk. . . . It is certainly attractive, and I feel sure that in its new form it is destined to greater accomplishments than ever before.

Very truly yours,
POWEL CROSLEY, JR.
President.

A Remedy for Congestion

SOMETHING will have to be done to reduce the congestion of broadcasting stations, which is probably felt more in New York than in any other city. Even in Europe trouble is being met with in this respect, and it is suggested that some of the British relay stations will have to be closed down to make room in the ether. Here is a reader's suggestion to alleviate the congestion in New York.

Editor, RADIO BROADCAST
Doubleday, Page & Company,
Garden City, New York.

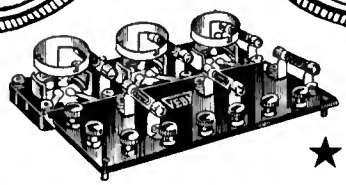
SIR:

Regarding the congested condition of available wavelengths for broadcasting, particularly in this vicinity, I would like to state my views in the nature of constructive criticism. I believe that a mistake is being made in granting so many New York stations exclusive Class B wavelengths. There are now nine Class B stations operating in and around this city on seven different frequencies, only four stations dividing time, namely, WOR and WJY on 740 kc. (405 meters) and WGBS and WAHG on 949 kc. (316 meters), and now, another station, WLWL, has been granted a license to operate on an exclusive frequency, 1041 kc. (288 meters). When there is already a shortage of wavelengths, I cannot understand why every new New York station is given its own wave instead of dividing time with some other station, particularly when such fine stations as WCAP and WRC in Washington are compelled to share time. Each of these two stations, I believe, deserves its own wavelength as they both give the highest grade of programs. Here in New York only two stations, WEAF and WJZ, are in my opinion rendering the type of service which justifies an exclusive wave.

I have no grievance against any particular station, but I fail to see any good reason for stations WHN, WMCA, and WNYC not dividing time. The latter, especially, could easily rearrange its programs and allow some other station to share its wavelength. At present it is only on the air for three or four hours a day, seldom starting before 7 P. M. and usually signing off by 10:30 or 11 P. M. If these three stations and the new one, WLWL, were put on a part time basis (WEAF, WJZ, WOR, WJY, WGBS and WAHG continuing as at present), New York would still have six Class B channels which, with the Class A stations in operation, should be enough to satisfy any listener. This would leave two waves available for other eastern cities, one of which should be assigned to Washington and the other reserved for future use.

In Chicago, every station divides time with another and I believe this arrangement has been satisfactory to all concerned, while the programs broadcast from that city are in most cases of the highest caliber. If such a plan were put into effect here, while no doubt it would not meet with the approval of the owners of the stations concerned at once, it would enable them to concentrate more on the time they would be on the air and thus furnish better programs.

Yours very truly,
GEORGE W. CLINCHY,
New York City.



The VEBY *Resistance Coupled* Amplifier

A REVELATION to Music Lovers—amplifies all frequencies alike, thereby producing the radio concerts with utmost fidelity. Size 5x7 inches—fit within any receiving set. Price **$12.00**

A. F. 20 High Mu Tubes for R. C. Amplifiers..... **$3.00**
A. F. 6 Power for the last stage... **4.50**
A. F. 30 Super High-Mu Tube.... **6.50**

VEBY PRODUCTS are uniform at all times—you can depend on them.

Manufacturers, Distributors and Dealers write or wire for particulars.

VEBY RADIO COMPANY
"Quality Resistors"
47-51 Morris Avenue
NEWARK N. J.

IF you like this magazine with its coated paper and enlarged size—then why not subscribe and get it regularly—by the year, $4.00, Six months, $2.00.

Doubleday, Page & Co.
Garden City New York

"a new 5-Tube Set with all the power and none of the grief of the Supers"—so wrote Henry M. Neely, Editor of **Radio in the Home**, Philadelphia.

Get This Book

Write to-day for this big fascinating 32-page booklet which tells how *you* can build the truly amazing new QUADRAFORMER receiver. Based on a new radio principle, five tubes give remarkable results.

Enclose 10c and you'll have it by return mail

Gearhart-Schlueter Radio Corp'n.
713 Voorman Avenue, Fresno, California

-it's in the Tube

A receiving set is no better than its tubes.

With other parts and connections *right* a set may be as good as its tubes—no set can be better.

That's why you want CECO Tubes. They stand up and deliver. With them your set works at its maximum. Clarity of tone, rich volume, long life—CECO has them all to a superlative degree.

Our charted tests (results confirmed by laboratories of national reputation) PROVE CECO TUBE SUPERIORITY—whether used as detectors, audio or radio frequency amplifiers.

CECO Tubes make a Good Receiver BETTER. Try them and you'll BUY them always—for results.

Now Ready! CECO Tubes with new type Long PRONG BASES. Also, Power Amplifier Tubes, E (Dry Cell Type), F (Storage Battery), for last stage of Audio Frequency.

Dealers write giving jobbers name.

C. E. Mfg. Co., Inc.
702 Eddy Street, Providence, R. I.

CECO TUBES ★

This is a good time to subscribe for

RADIO BROADCAST

Through your dealer or direct by the year, only $4.00

DOUBLEDAY, PAGE & CO. **GARDEN CITY, NEW YORK**

RACO RADIO ANTENNA
TRADE MARK REG.

RADIO WIRES

We manufacture all types.

Round braided antenna wires
Flat braided antenna wires
Round stranded antenna wires

Above types in copper—tinned copper—enameled copper—tinned bronze.

Loop wires in silk or cotton covered.
Litz wires.
Enameled wires.
Antenna supporting springs.
Cotton and silk covered wires for set wiring.

Write us for descriptive catalogue. ★

ROSS WIRE COMPANY **69 Bath St., Providence, R. I.**

★ Tested and approved by RADIO BROADCAST ★

Is All Broadcasting Advertising?

WHETHER advertising should or should not be permitted is a question which the radio public will ultimately have to decide for itself. It is a much-mooted question and one in which most of the readers of RADIO BROADCAST have a deep interest. As long as broadcasting stations are owned and operated by private individuals they will be advertising, regardless of whether they are or are not doing so in the abstract. When an announcer states that "This is station WPY, broadcasting from Bambell Brothers Store, West Oskaloosa," he is placing the name of that concern before the public in a manner which defies competition. Yes, after that, it is advertising, regardless of whether or not he broadcasts grand opera or education or economics. The letter printed below sets forth some very interesting ideas on the subject.

Editor, RADIO BROADCAST
Doubleday, Page & Company,
Garden City, New York.

SIR:

Referring to the invitation to express views on the matter of advertising matter being broadcast, I venture to ask if all broadcasting is not advertising? What difference does it make to the listener whether he is told that Miss Jones will sing from station WOC, the Palmer School of Chiropractic, etc., or that the A & P Gypsies will play from station WEAF? In either case it will be a good number, well worth hearing. The number from WOC advertises the Palmer School, the one from WEAF advertises the little red store. Or take for illustration the stations operated by educational institutions; is the purpose for which they are conducted to furnish laboratory facilities for their students or to make the college better known, that is, to advertise the college?

Speaking only from recollection, I am of the opinion that the newspapers were among the first to install broadcasting stations. In any event several good stations are still operated by newspapers. What purpose is there for the operation of stations by newspapers except advertising?

It seems to me that advertising is the logical support of a broadcasting station the same as it is the support of periodicals, and that there can be no more objection to advertising in connection with broadcasting than there is in connection with publishing. Any owner of a receiving set, except possibly a crystal set, is within range of more than one station and as free to make his choice of the station to which he listens as he is to read the newspaper he prefers. Any newspaper that cannot make its news pages of sufficient interest to have enough readers to make its advertising space valuable loses money and in time goes out of business. If a broadcasting station does not make its programs interesting it will have few regular listeners, it will have no advertising value and in time it will go out of business. If we could have a frank expression from the owners of the broadcasting stations that have been discontinued we would find that these stations were discontinued because they did not pay, in other words that they did not have sufficient advertising value to warrant the cost of operation.

The use of broadcasting for advertising purposes seems to be the logical way to maintain good broadcasting; the broadcasting has to be good to make the advertising worth while. Even the talks which are purely advertising, such as those given some time ago regarding tea and surety bonds, are in no way objectionable because such talks must be of sufficient interest to hold the attention of listeners, or they would dial another number.

Very Truly Yours
B. O., New York.

(Not a Wave Trap!)

It *IS* true!

188 times the energy . . . and there is absolutely nothing else at all like

PENETROLA

Without Penetrola the signal intensity of WOAI was 11, on the Audibility Meter—an impartial precision measuring device. With Penetrola the signal intensity of WOAI jumped above 2000—188 times the signal strength!

Without Penetrola the scientifically measured signal intensity of WCAL was 35, scrambled with WCBD at 29. With Penetrola WCAL went to 2000+ and WCBD to zero—*selectivity with a vengeance!*

This is just exactly the sort of thing any Penetrola demonstration will show you on any set with any number or arrangement of stages. The wanted station is immensely intensified; interference is overwhelmed by Penetrola. There is so much volume available for the most distant signals that a shorter aerial may be used, curing excess static. Your set is stopped from radiating, and is stabilized. It is needless to operate near the oscillation point. And dial readings stay substantially the same.

Radio principles known to be of immense promise, but hitherto elusive, are now successfully applied by Walbert Penetrola. The widely heralded Isofarad Circuit, latest development of Walbert engineers, is the foundation of Penetrola performance. Here is one radio appliance literally unduplicated in any way by anybody, because there is no other Isofarad circuit. Nor is there any substitute for Penetrola action, which amplifies *ahead* of the detector entirely, strengthening signals which would otherwise never be detected! Remember, signals too weak to detect cannot be amplified by any means placed *beyond* the detector.

In a few moments any receiver, however costly, can be transformed with Penetrola. Or anyone can quickly assemble the Penetrola kit and obtain amazing Penetrola results most economically. The Penetrola price buys performance which cannot be obtained with any amount of investment in a receiver alone.

1st Walbert Made It FIRST

For the sensation of the European tests note Penetrola Reception!

Penetrola in beauteous Black Crystallite, for Instant Attachment **$35**

Penetrola Kit with Complete, Simple Instructions **$15**

★

If your dealer is not stocked, remit purchase price direct to factory and you will be promptly supplied. State whether you wish Penetrola for outdoor aerial or for loop receiver.

WALBERT

Manufacturing Company, 923 Wrightwood Avenue, Chicago