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Edited by HUGO GERNSBACK

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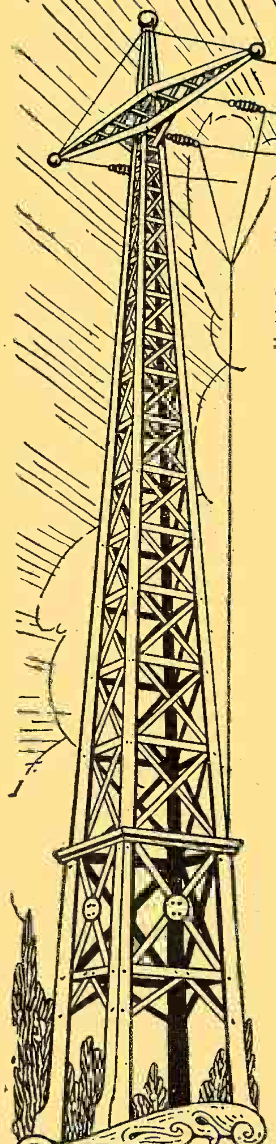

RADIO NEWS

Volume 10 April, 1929 Number 10

HUGO GERNSBACK, Editor-in-Chief

C. P. MASON, Associate Editor
H. M. BAYER, Technical Editor
BERYL B. BRYANT, Laboratory Director
C. WALTER PALMER, Director Information Service

Contents of This Issue

In Our May Number

A COMBINED RADIO AND PHONOGRAPH CONSOLE: The second Handiwork Blueprint article will describe the construction of a very attractive piece of furniture for the music room. Its construction, whether for personal use or profit, will interest every set builder who is striving for attractive appearance in his product.

THE "PERIDYNE" A.C. SCREEN-GRID FIVE: While the recent announcement of this receiver was premature, the numerous Peridyne fans will be glad to learn that it has been developed into a set with improvements worth waiting for. Very high amplification with "Peridyne" quality, and greater ease of construction and operation are afforded by this new design.

THE "NEW YORK TIMES" SHORT-WAVE RECEIVER: How to construct an electrical duplicate of the receiver with which Commander Byrd's messages from the Antarctic are received day in and day out reliably, will be told by F. E. Meinholtz, manager of the *Times* station at the New York end of this 10,000-mile communication lane.

Blueprint Notice—*see page* 929

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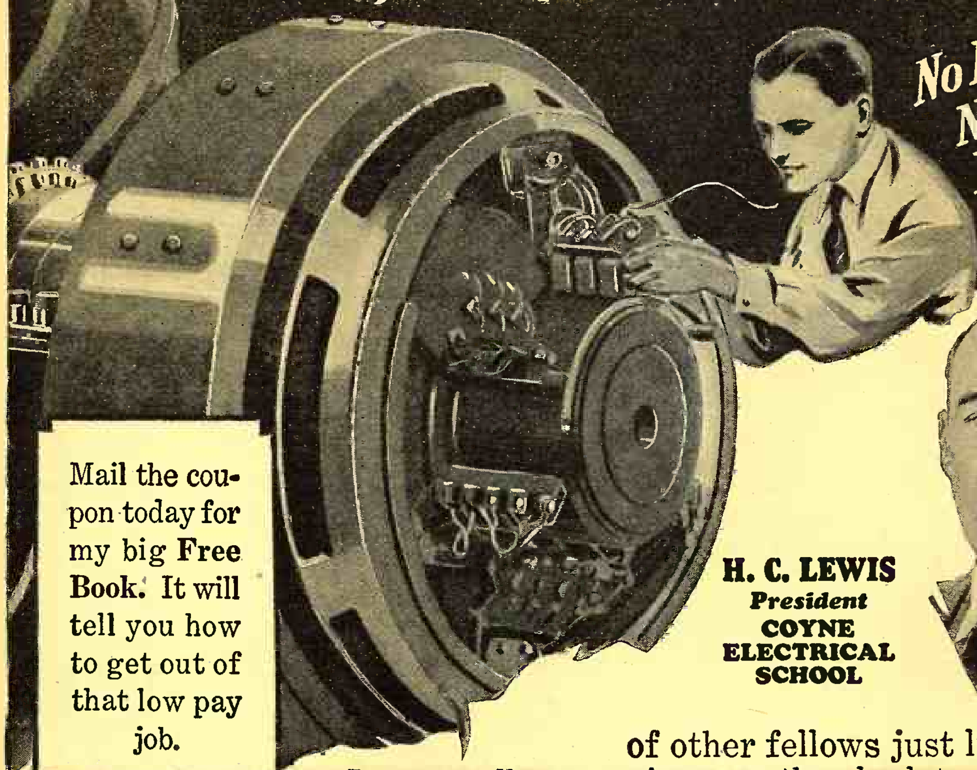

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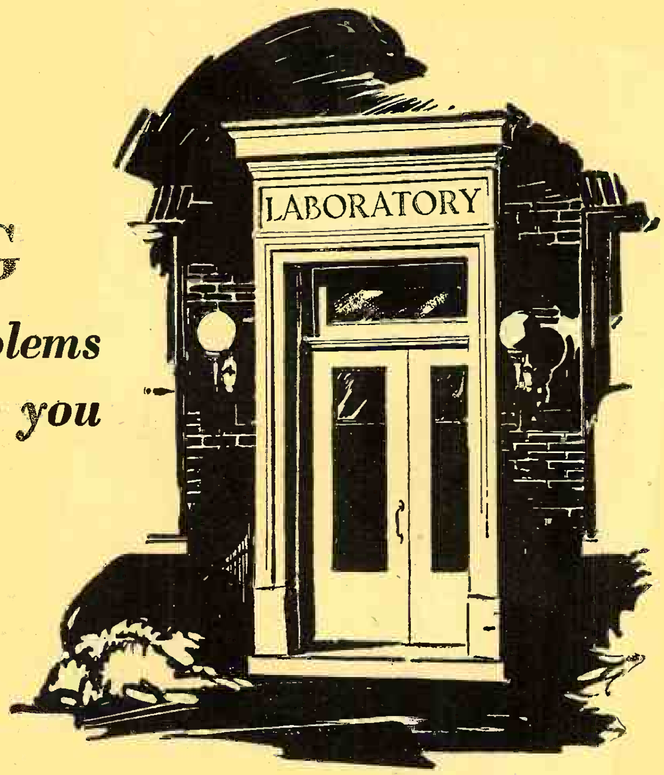

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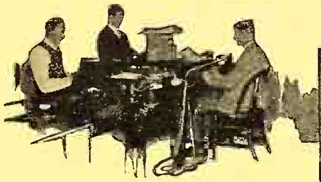

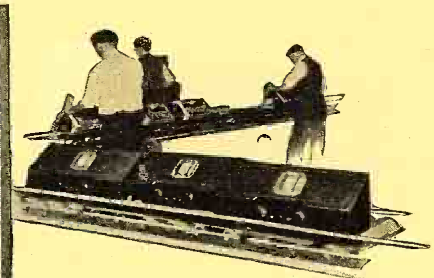

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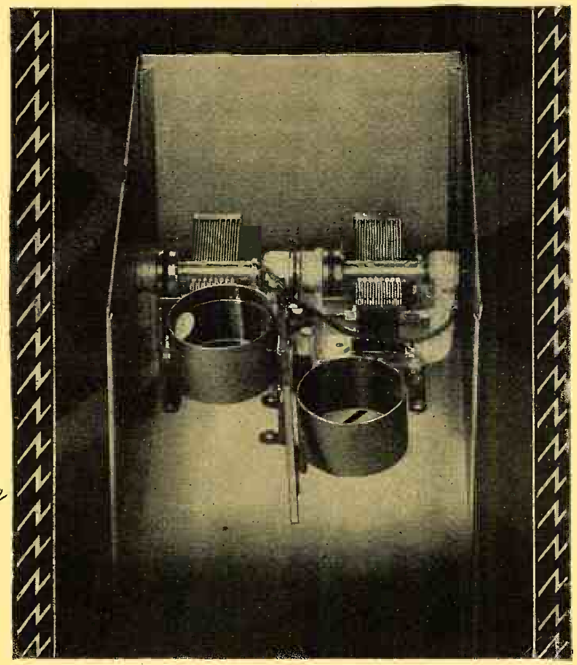

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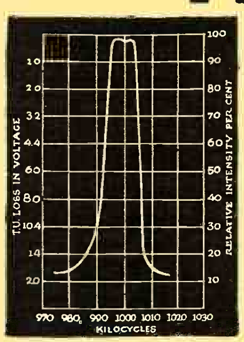

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Radio News
Hugo Gernsback Editor & Publisher
Editorial and General Offices, 230 Fifth Avenue, New York
Vol. 10 APRIL, 1929 No. 10

Radio in the Sphere of Music

By HUGO GERNSBACK

DURING the past eight years a peaceful, yet most amazing, revolution has taken place, not only in this country, but practically throughout all the civilized world, wherever radio is now a household word. The revolution that I have in mind is the enhancement that has come to pass in musical appreciation, which is now permeating practically all strata of our population.

It is true that the phonograph, previous to the era of broadcasting, had left an indelible stamp upon the musical education of the masses; but even this cannot be compared in magnitude with the musical movement brought about by the universality of radio.

The reason is simple. Unless a family were extremely well-to-do, it could not own the number of phonograph records required for a musical education; because the investment in even a moderate library, in phonograph records, of the standard composers' works would run into a formidable sum. On the other hand, today, the average family with a moderately-priced radio set brings the entire musical world into its modest home, and even into the smallest tenement.

Nor was it possible for the phonograph to present complete the lengthy works of certain composers; because phonograph records are too small, considering the length of time it takes to play the entire score. All this, radio has overcome.

Incidentally, works of famous composers, hardly ever heard in the old days, except by confirmed music lovers, are now familiar to the man in the street; who is just as apt to whistle *Kammenoi Ostrow* or snatches from the *Nutcracker Suite,* instead of the "popular" music that once made up practically the entire musical fare of our average population.

Indeed, it may be said that radio has been the direct cause of the public's new appreciation of the best kind of music, in preference to jazz and the highly-specialized "popular" music. Recent investigations, made by some of the foremost radio stations in this country, have shown conclusively that, though the younger element is still calling for jazz (mainly as dance music), the demand for classical music is becoming greater every day.

Some time ago, the New York Edison Company (in connection with its "Edison Hour" broadcast over WRNY) made a survey by sending out a questionnaire in numbers which ran into several hundred thousands. When the returns were compiled, it was found that the majority of the listeners had voted for classical music, and that "popular" and jazz music were quite in the minority.

Such a finding, ten years ago, would probably have been called fantastic, or could have been secured only through a canvass among musicians and a special class of music lovers; whereas today, the demand for good music comes from practically every stratum of the population.

It may therefore be said without fear of contradiction that, during the last few years, the public at large has heard more music of the better kind than it has ever had available before. Indeed, the various stations, in order to avoid duplicating their own offerings too frequently, and because of the competition of other stations, find it continually necessary to broadcast compositions which were hitherto practically unheard of, even in symphony concerts and chamber music.

Only in the past few years have we begun to hear over the radio the compositions which formerly were played only by professionals; in other words, music in which the theme is not easy to follow, and which could not have been understood at all by "the man in the street" only five years ago.

Music, in this respect, is much like a new language. If I recite a poem in a language familiar to you, you have no trouble in quickly digesting it. If, however, I try you with a recitation in a tongue with which you are not well acquainted, you will find it difficult to understand, and many repetitions will be required before you finally become familiar with it. It is exactly so with music; particularly when it is in the advanced style of composers.

For instance, some of the heaviest operas of Wagner must be played a number of times before the average man can understand and interpret the meaning of the composer. It is quite patent that, before the advent of radio, it was hardly possible for the man in the street to listen repeatedly to the same opera (even if there were an Opera House available to him) and to familiarize himself with its harmonies. Radio, however, has changed all this because, if the same score is given at intervals, the average man finds little trouble in understanding even the most difficult composers.

And it is here that radio has done its musical work, and is still doing it, and will continue doing it in the future. It is only by constant repetition that we become well acquainted with composers, and I know of no instrumentality through which this can be done better than by radio; it is, as I will show, far superior to even the best orchestra seat.

Most people are "eye-minded," and even such a trifle as observing an orchestra detracts momentarily from the musical impressions that are reaching the ear. In the privacy of your home, as a rule, the eye has nothing to distract it and the impression upon the ear is all the stronger; and, therefore, the effect of music is made more lasting.

From the technical side, radio audition offers another great advantage over the large symphony hall. Unless you are fortunate in obtaining a perfect seat in the theatre or hall, you are not unfrequently disturbed by bad echoes, loud neighbors and other noises about you, which prevent you from enjoying the music to the fullest degree.

Ever since the advent of the loud speaker, which became universal only about three years ago, the technique of broadcasting has kept pace with the perfection of the reproducer. It is now possible, for that reason, to hear and enjoy a concert to a far greater degree in your own home than you could while actually sitting twenty feet away from the orchestra. For one thing, modern microphone technique is such, that it picks up all the instruments perfectly, but practically no outside noises such as arise in the audience itself.

On the other hand, a good loud speaker will reproduce all tones from the lowest of the drum to the highest of the piccolo, without difficulty; and it may, therefore, be said that (given a good microphonic pick-up, which is common nowadays, and a good loud speaker) it should be possible for everyone to obtain in his own home music such as no one heard in former days, since the beginning of music itself.

Incidentally, it should be noted that there are springing up, already, composers of music dedicated expressly to radio purposes. The point is, not that any good composition cannot be rendered faithfully over the radio, but that an entirely new technique can be and, right now, is being evolved.

Mr. Hugo Gernsback speaks every Tuesday at 9.30 P. M. from Stations WRNY (297 meters) and W2XAL (30.91 meters) on various radio and scientific subjects.

Movies Bring Radio Messages to Lay Audiences

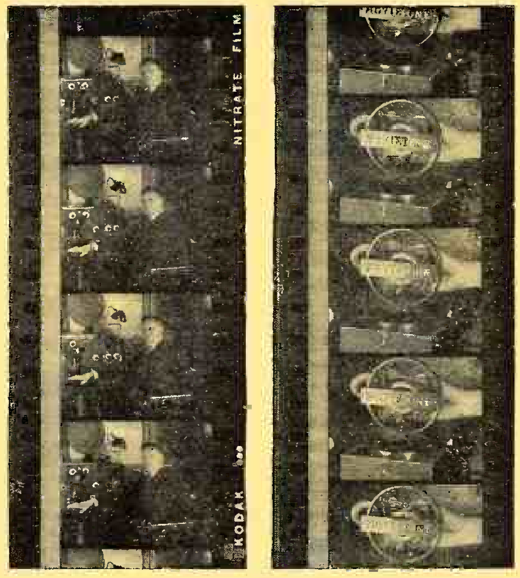
Dots and Dashes of Commander Byrd's Signals Are Heard by Theatre-Goers Ten Thousand Miles From the Antarctic Wastes

By Herndon Green

"RADIO MOVIES" of a new kind, differing from the near-television demonstration implied by the term, were presented throughout the country a few weeks ago, when the dispatches of Commander Byrd from his base in the Antarctic, ten thousand miles away, were heard clearly and loudly through hundreds of theatres.

While these dispatches, reproduced in the identical dot-and-dash form of their transmission, were not in themselves intelligible to more than a few of their hearers, the accompanying translation and explanation were sufficient to arouse the interest of hundreds of broadcast listeners; who had never before fully appreciated the wonders of short-wave communication, now being carried on daily and nightly over distances far exceeding the reception range of the most powerful broadcast stations.

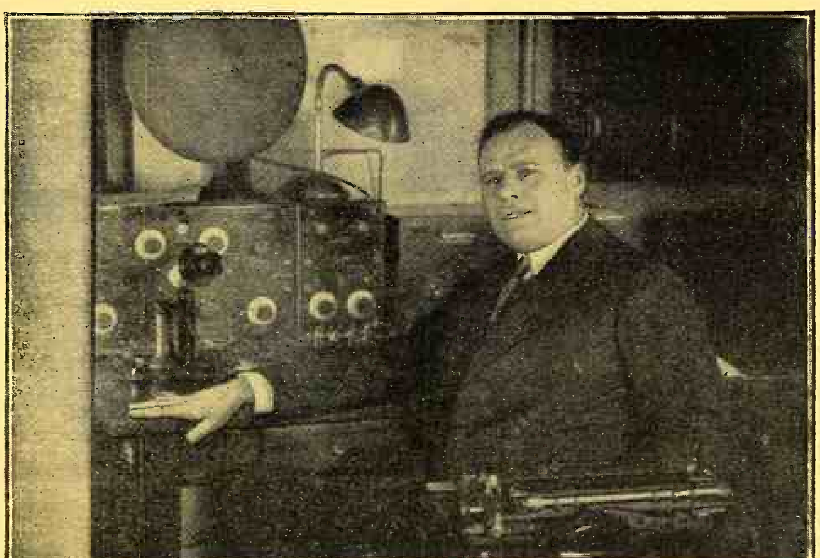
The messages thus heard by them were not being received directly, however (though any good short-wave receiver which could pick up such signals might readily enough be attached to an amplifier and give volume enough to fill any auditorium). They had instead, for greater ease in reproduction, been recorded upon a roll of motion-picture film; and the positives of this were distributed with a well-known newsreel feature and reproduced by the "Movietone" process.



The strips of film, reproduced about actual size, differ from the ordinary kind in that they carry in a band at the left of each (as shown) streaks of light and darkness corresponding to sound waves impressed on them, and which are reconverted into sound by the mechanism shown on the opposite page.

WHAT WAS DONE

The master film was made in the radio station, WHD, of the *New York Times,* which has been in constant communication with the Byrd expedition since its sailing; and shows the operation of the radio apparatus, both receiving and transmitting. The first action reveals Fred E. Meinholtz, manager of the station, at the key of the transmitter, who first reads a message from the producers to Commander Byrd, and then sends it over the air. Instantly the audience hears the continuous note of the transmitter, broken up by the telegraph key into the signals; which amateurs and other operators present in a theatre could follow easily. There is a pause, and Mr. Meinholtz is seen with headphones adjusted receiving the prompt reply that leaped upward from the bottom of the world. The message, announcing that all is well, and that geographic exploration has just revealed a new bay to be named after a heroic companion of former flights, Floyd Bennett, is written down; and then a hand holds up the headphones of the receiver before the sensitive microphone, and the veritable message of the Byrd operator, as he signs off for the night under the Antarctic midnight sun, is heard by the audience in the theatre. Many, no doubt, could not repress a feeling of awe; and even "hard-boiled" hams (or "owls") would enjoy the excellent handling of the presentation.



An enlargement of one "frame" of the "sound film" illustrated above. The bands which record the waves of sound may be seen quite clearly at the left. (Courtesy Fox Film Corporation.)

RADIO METHODS IN THE FILMS

The processes of recording and reproduction of the sounds may be of interest here. Like the television methods which have become more or less familiar to our readers, they depend upon the use of a flash-lamp and of a photoelectric cell; although these devices need respond only to audible frequencies. The system, however, has so much in common with radio apparatus that it is not surprising that the same engineers have been active in both radio and the "talkies."

The sounds which accompany each action in a "sound" motion picture are made upon the same strip of film as that which carries the action, in the Movietone system; although, because of the different characteristic of the record, the sound corresponding to the exposure at a given instant must be made on the margin of another "frame" or picture, a short distance above the first.

The microphone which picks up the sound is connected into a powerful audio amplifier; its output, however, is not used for carrier-wave modulation, as in a broadcast transmitter, but controls a special flash-lamp of high actinic power. This lamp has a filament coated with oxides of calcium and barium, which give an electronic emission, and has a plate of polished nickel. The tube is of a special quartz composition, to pass the actinic light freely, and contains helium gas to add to its luminosity. It responds very quickly to fluctuations in the current feeding it; unlike the ordinary receiving tube, in which it is sought to equalize the emission of electrons.

Through a tiny slit in the hood covering this tube (Fig. 2) an oblong streak, hardly more than a point of light, is thrown upon one side of the film, which has been screened from previous exposure to the image gathered by the camera lens. As the glow-lamp or "AEO" (alkaline-earth-oxide) lamp fluctuates in accordance with the received sound-frequencies, it creates alternate streaks of light and darkness; the reproduction of which will be seen more clearly in the enlarged pictures of single "frames." (If it were possible for us to see the air in which sound waves are moving, the effect of compressions and expansions produced in the atmosphere would be very similar to the alternations which appear in the "sound-track" of the films.)

A very ingenious mechanism was necessary to accommodate the same film to both sight and sound reproduction. The camera acts instantaneously over a total area; it is necessary to stop the film, expose a "frame," and then move it until it clears the field of the lens, at a rate of sixteen times a second. But the sound, with its the method, are now familiar to every movie fan.

A demonstration of the practicability of reproducing film records by radio was given on January 24 from the RADIO NEWS stations WRNY and W2XAL, New York, when the records of "Weary River," a new sound picture, were broadcast on both long and short waves; and probably have been heard on the latter in distant continents. To accomplish this, it is necessary only to lead the output of the amplifier to the modulator of a broadcast transmitter, instead of to a system of reproducers.

AIRPLANE RADIO DX RECORDS

Hard after the movie demonstration of reliability of communication with the Byrd base at the Bay of Whales (in the Ross Sea, amid the eternal ice of the Antarctic) an even more remarkable feat, from the

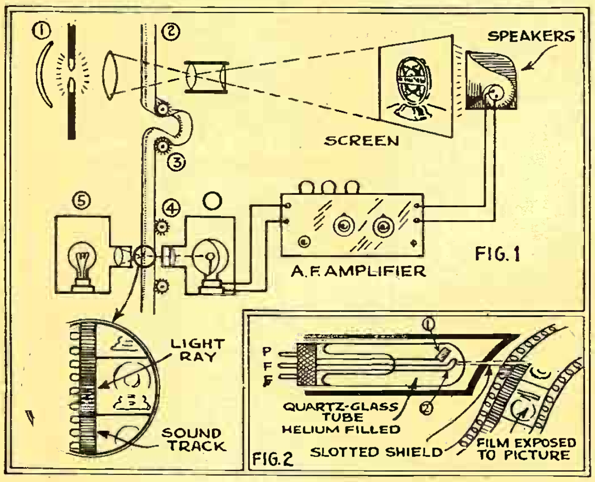


Fig. 1 shows the method of reconverting the film record into sound; the film is fed jerkily by the usual sprockets (2, 3) past the arc light 1; it is then caused to move smoothly by 4, taking up the slack, and passes a slit through which the lamp 5 shines. Each streak causes a corresponding "kick" in the photoelectric cell. Multiply the number on one "frame" by 16, and it will be seen there is an audio frequency to be amplified and reproduced. In Fig. 2 we have the original recorder; the filament 2 of the glow-lamp flickers and its light is reflected by the plate 1 through the slot, making the alternating streaks we see—and hear.

continuous waves, could not be recorded on a jerkily-moving surface of this kind without very complicated compensating mechanism. Therefore, a certain amount of slack in the film is allowed between the set of sprockets, moving jerkily, which govern the picture exposure, and the set of sprockets, moving steadily, which guide the same film past the sound-recording glow-lamp.

IN THE THEATER

After the usual processes of printing, development, duplication, etc., the film is taken to the theater to be reproduced. Here a similar duplex winding mechanism (Fig. 1) governs its operation; the picture is moved (upside down) one frame at a time, past the projector in the combination apparatus. On the other hand, a short distance further down, the film is passed before a photoelectric cell (see page 910 for a description of the photoelectric action of the alkaline-hydride cell). Behind it a small, specially constructed incandescent lamp throws a wide, shallow spot of light *through* the film into the cell. Wherever a black bar crosses the path of the beam, the latter is cut off, and the current output of the cell drops; while each streak of light in the "sound-track" gives an impulse of current. These, passed through an audio amplifier of sufficient size, operate large dynamic and exponential units placed conveniently near the screen; and reproduce every sound originally recorded at the same frequency, but with high volume. The effects, if not

radio standpoint, was accomplished when the Byrd plane, the *Stars and Stripes*, while in flight, communicated with the *Times* station; thus establishing a distance record for both successful reception and transmission by aircraft, on the evening of January 25 at New York, which was the following morning at the Byrd base. The transmission was carried on in the 34-meter channel which has proved so effective at this distance. The plane, operating with the call WFC, sent out mes-

As this picture appears on the screen, the audience hears the radio dot-and-dash message. While the sound is photographed on another frame from that with which it is synchronized, it will be noticed that the quality of the sound shown here differs from that in the picture opposite.

THE *NEW YORK TIMES* SHORT-WAVE RECEIVER

(1,500-30,000-kc.—10-200-meters)

THE instrument in use at the office of the New York Times *to receive the messages of the Byrd expedition is the latest model, constructed by the staff of the radio station to meet greater demands than have been heretofore put upon any receiver for continuous long-distance reception.*

This receiver, which is illustrated in two of the views accompanying this article, will be described fully in the May issue of RADIO NEWS, *with construction details showing the components arranged in a standard-size cabinet which is obtainable by any of our readers, and with simplified shielding. It will be especially worthy of construction by every advanced short-wave listener. Blueprints will be available, if required.*

The receiver has two tuned stages, the first one of screen-grid radio frequency, and the other an oscillating detector; these are controlled by a single vernier dial! *Four knobs on the front panel are all the minor controls required by this set, whose remarkable efficiency may be gauged from the work it has been doing, day in and day out, in handling traffic with the Byrd expedition and other parties in remote, almost inaccessible corners of the world. The short-wave fan will find this set the next piece of construction to be considered.*

sages also on 65 meters; but this wave proved unsatisfactory. Two-way communication was also established with the Mussel Rock station at San Francisco.

The power used by the *Stars and Stripes* in this test was but 50 watts; supplied by direct coupling to the shaft of a motor, rather than by a wind-driven generator, as usual. A fixed antenna, stretched across the tips of the wings, is used by the plane for short-wave work! The receiver used in this test by Malcolm P. Hanson, radio expert of the expedition, is a four-tube super-regenerator of his own design.

STATION WHD

The interior and equipment of the *Times* station, located in the very heart of midtown New York, is shown in more detail by another of the reproduced photographs accompanying this article.

The operating table before which Mr. Meinholtz is seated is the station's center of activity, in that it mounts the telegraph keys which control the transmitter. The latter is located on the seventeenth floor of the same building and remotely controlled from the operating room shown. The main short-wave receiver handling Byrd's traffic is on the same table, as is the Kennedy intermediate and long-wave receiver. (While long-wave to the broadcast listener may mean anything between 300 and 500 meters, the term in this case, represents 20,000 meters.)

What appears to be a number of receivers along the wall to the left of the operating table is really a number of units comprising a single long-wave receiver; (long-wave, here, as above, represents 20,000 meters.) The size of these units may cause some wonder to those unaccustomed to sets tuning to high waves but, when it is absolutely necessary to receive *every day* stations such as Rome, Italy, Rugby, England, and Nauen, Germany, with sufficient intensity to operate a loud speaker, receivers must be, not built, but *engineered.*

When mention is made of receiving these stations on the loud speaker this, of course, does not mean that the messages are copied in this manner. Loud-speaker intensity is desired, so that the receiving operators can be assured of at least headset reception when receiving conditions are poor. In other words, it is a matter of having a reserve of amplification.

Another long-wave receiver, at the right of the operating table, is not shown in the photograph; with the apparatus illustrated, it completes the receiving equipment in the "shack."

TRANSMITTER 200 FEET ABOVE

The short-wave transmitter heard by Byrd's operators in the Antarctic is a 500-watt, "500-cycle," tuned-grid tuned-plate arrangement; it is located on the seventeenth floor of the *Times* building where it is remotely controlled from the operating room on the third floor. This is the only transmitter used by the *Times* and is operated only on short waves, with the call WHD.

A number of interesting facts are found about the make-up of the station; the two long-wave receivers, each running for five feet along the walls on one side of the operating table, are the first to attract the attention of the station visitor. Each comprises nine tubes, functioning as two stages of untuned-radio-frequency amplification, two stages of tuned-radio-frequency amplification, one oscillator stage, one detector and three stages of *tuned*-audio-frequency amplification. The waveband each covers is between 5,000 and 20,000 meters.

The two large units at the left of the operating table compose the Kennedy receiver and its two-stage audio amplifier; this is merely a stand-by emergency set and used for that purpose only.

The short-wave receiver at the right comprises four tubes functioning as one stage of screen-grid tuned-radio-frequency, a regenerative detector and two stages of transformer-coupled audio-frequency amplification. As customary in the design of commercial code receivers, a phone jack is mounted on the front panel for the convenience of the operator. One drum dial of the illuminated type controls the two variable condensers tuning the grid and plate coils of the screen-grid tube. The set covers a waveband from 10 to 200 meters.

A BIG LOOP

The experimenter who possesses a loop antenna of conventional size may be interested to learn that a large one of this type is employed at this station in conjunction with a 250-foot single-strand, vertical aerial, for long-wave reception. However, the sum of the sides of the loop happens to be 1,000 feet! A 250-foot single-wire aerial is dropped from the tower of the building to provide an aerial for the short-wave receiver. The ground system for the receivers is similar to that employed by other fans in the city—the water-pipe system.

(*Continued on page* 946)

In the central picture, above, a view of the radio station of the New York Times. *The short-wave receiver used to pick up the messages from the Byrd expedition, and which will be described in the next issue of* Radio News, *is on the table at the right. Behind Mr. Meinholtz are his transmitting key and a long-wave receiver for emergency use. At the left, with horn, the long-wave set (up to* 20,000 *meters) in daily use for press-dispatch reception.*

In the picture at the left, below, the long-wave transmitter of the City of New York *is at the left, next is the radio compass, and in the center the* 1,500-*watt short-wave transmitter now connecting the Byrd party with the outside world. In the view at the right, the Byrd short-wave receiver is seen in front, and the ship-wave set in the center. A broadcast receiver is on the shelf above. Photos © J. V. Candido.*

Experiments with "Light-Sensitive Cells"

Circuits Adapted to Use for Various Photometric Purposes

By H. M. Bayer

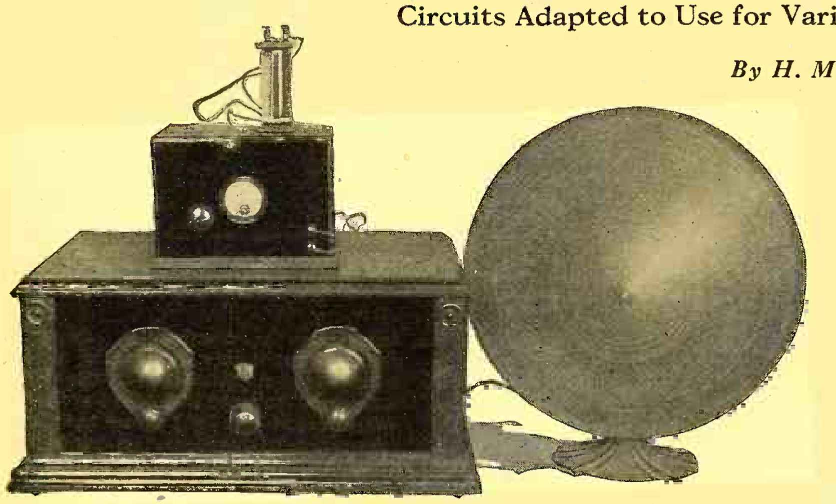


Fig. A

When the light in the room is turned off, the photo-voltaic cell (shown above its relay box) will throw the switch of the receiver. When the light returns, the switch is again thrown.

"LIGHT-SENSITIVE" apparatus has undoubtedly figured in the mind of the average home experimenter, when he has read of it, as a kind of device originated by deep-thinking research scientists, bearded physicists pondering over laboratory tables strewn with mysterious glassware, and engineers plowing through reams of profound calculations in quest of the unknown. True, these devices occasionally emerge, as all know, to make a display of sublimated parlor magic at expositions of scientific progress; but it is probable that few indeed appreciate the fact that the automatic operation of recording and other machinery by the action of light has become almost a commercial commonplace with more enterprising manufacturers.

The experimenter is looking on the photoelectric cell and its companions as he did, perhaps, on the vacuum tube fifteen, ten, or five years ago, whenever he began his radio education. Going back still further, we find a day when many practical "wireless" men discussed the vacuum tube with bated breath, and looked upon it as a device too fragile to endure outside the laboratory where it had been born.

Today every schoolboy of an inquiring turn of mind is familiar with the theory and operation of the vacuum tube, its construction and its functions in a radio receiver. It is true that its design and some of the engineering connected with its adaptation to special purposes require much skill and calculation; but the art of using it for ordinary reception requires no mystery or complex figures, and can be comprehended with a little study and thought by any layman.

This holds true for the light-sensitive call also; there is nothing mysterious about its action, nor is its application to practical usage limited to the trained engineer or confined to the laboratory. It is the purpose of this article (and of others which will follow it) to acquaint the experimenter with some practical types of cells now available to him, their methods of operation and some of their practical applications; so that he may perform many interesting experiments in his home with surprisingly little equipment. The field for these home experiments is unlimited; for example, a radio receiver can be turned on automatically when the room in which it is placed is illuminated. With the same arrangement, the receiver is automatically turned off when the light in the room is turned off; the circuit diagram for this experiment is illustrated in Fig. 1. However, this is only one of a multitude of stunts that will suggest themselves to the ingenious experimenter after he has obtained his equipment.

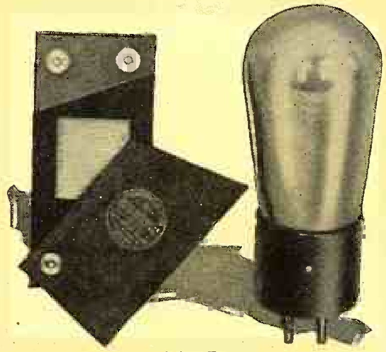


Fig. B

The old-style selenium cell, at the left, compared in size with a standard vacuum tube.

CURRENT-OPERATED CELLS

There are three distinct classes of light-sensitive cells, in each of which the phenomenon, or the manner in which it reacts to light impulses, is different. The first is classified as the "actino-electric" or *photo-resistive* type; this cell consists of a metal (or compound) to which there is connected a source of potential. On the exposure of the cell to light it will exhibit a change of resistance, thus affecting a flow of current across its terminals. Cells of this type, which most commonly use the element *selenium*, have been in use for many years. A commercial form of this cell consists of a small porcelain, or marble, slab on which a thin coat of crystalline selenium is deposited, and two or more copper or gold wires wound bi-spirally over the slab. This assembly is enclosed in a bakelite case, which is equipped with a shutter of the same material. Such a cell (as illustrated in Fig. B) lends itself to the needs of the experimenter because of its simplicity; but it has the disadvantage of operating with a distinct amount of lag or *inertia*. That is, it requires a short, though measurable, time to recover its resistance after its exposure to illumination. Thus, it can be seen, in experiments requiring response at very high frequencies to the action of the shutter this type of cell will not do. It is not, therefore, adapted to television, though it may serve for many other purposes, commercial and experimental.

The second type, which is perhaps now most familiar to the experimenter because of its use in television and the consequent publicity it has received, makes use of the *photoelectric* effect. In this cell a film of an alkaline metal, such as potassium or sodium, is deposited on the inner surface of the glass of a vacuum tube, and a centrally fixed "collector" is placed in the center of the bulb so that it faces the "coating"; a large cell of this type is illustrated in Fig. C. When the cell is exposed to a source of light, the alkaline metal emits electrons in much the same way as the heated filament of a vacuum tube;

Fig. C

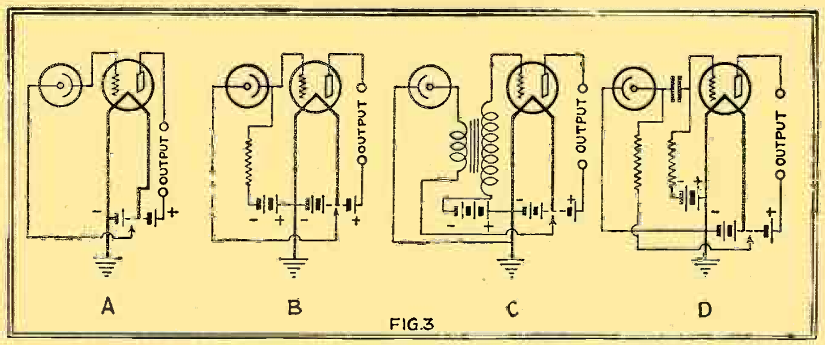
A photoelectric cell of the alkaline type; it has a seven-inch bulb. Note the "collector."

only, in this case, the emission of electrons is caused by light instead of heat. Thus, it can be seen, in this cell the circuit is closed through the electrical path provided by the flow of electrons from the alkaline coating to the central "collector." Fig. 2 shows the elements of its construction.

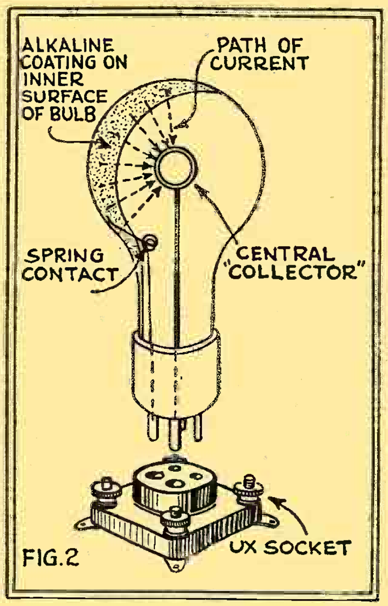
The simplest circuit for a cell of this type is shown in the first diagram (A) in Fig. 3. The cell is connected to the grid of an amplifier tube (a 112A-type will do) which must be correctly biased for best operation; this biasing voltage should be near that specified for the tube, and should be variable so that the best operating point may be found.

A more elaborate and better arrangement is shown (at B in the same figure) wherein a separate battery is required for the cell. The value of the resistance is determined by actual test. In a further refinement (shown at C) a suitable transformer is employed as a coupling between the cell and the amplifier tube. A resistance-coupling arrangement may prove more satisfactory, when a wide range of light-variations is to be handled accurately; in which case the arrangement shown at D may be preferable. In the last, the coupling unit may be the same as that employed in the audio amplifying system of a receiver; increased amplification will usually be experienced with this arrangement.

On the vacuum-type cell, high potential is essential for best operation; voltages up to 600 (D.C.) are recommended. The gas-filled cells, on the other hand, should be operated as close to their *"ionization-voltage"* as possible. The best way to obtain this condition is to expose the cell to the maximum light to be used, and gradually increase the applied voltage until "ionization" occurs, evidenced by a pinkish glow in the cell. This voltage is noted; and a voltage about ten lower is then selected as the best to be applied.



Four circuits adapted for use to amplify the output of a photoelectric cell for practical application; C and D are the two most commonly used. This is the type of cell illustrated in Figs. C and F; it is extremely sensitive and has little lag, but its output is very small.



The photoelectric cell generates a minute current in the form of a stream of electrons picked up by the anode, or "collector." It has made television possible.

A VOLTAGE-GENERATOR

The third classification is that of a newly-devised cell which may be, perhaps, of most interest to the experimenter because of the fact that it may be operated without *vacuum-tube amplification.* In this device a source of potential is obtained as the result of exposing to light one of two plates immersed in an electrolyte, thus creating the *photo-voltaic* effect. The voltage created across its terminals is the result of chemical action on the plates, the degree of which varies with their exposure to light. This voltage is then employed to actuate a sensitive relay, which in turn actuates another relay; the terminals of the latter are connected to whatever apparatus is to be operated.

In detail, the photo-voltaic cell consists of a cylinder of special glass, which is very transparent to light-rays of visible and other frequencies; to this are cemented bakelite top and bottom plates. The top plate holds the electrode assembly, which consists of a coated copper plate and one of lead brought out to two binding posts; the electrolyte is a weak acid solution. The apparatus is shown in Fig. D, with its relays.

The cell, when placed in a circuit with a low-resistance milliammeter, gives a minute "dark current." However, when it is exposed to ordinary diffused daylight, a current of 0.3- to 0.4-milliampere is obtainable; this is ample to actuate a meter-relay. This fact brings us to the outstanding feature of this cell; it is capable of supplying sufficient power, without vacuum-tube amplification, to actuate an inexpensive relay which in turn will perform the desired operations.

METHODS OF OPERATION

When the cell is connected in a circuit as shown in the first diagram (A) in Fig. 4, the meter response will be at maximum for any given light intensity. However, if left in this circuit, the cell will soon dissipate its useful energy, even while in the dark, just as would a dry-battery cell; the useful life of the cell in such a circuit would be about 50 hours.

On the other hand, if the hook-up shown at B in the same figure is used, the cell may be left closed (in the dark) almost indefinitely, without affecting its sensitivity, or causing the cell to lose its effective power. The charging current from the 1.5-volt cell (an ordinary flashlight unit) *with nothing in parallel with the cell* should be 0.4 milliampere. The resistor R1 is variable between zero and 10,000 ohms.

Perhaps the best method of controlling the cell is shown at C in this sketch; but in employing this circuit care should be taken not to leave the potentiometer arm too far

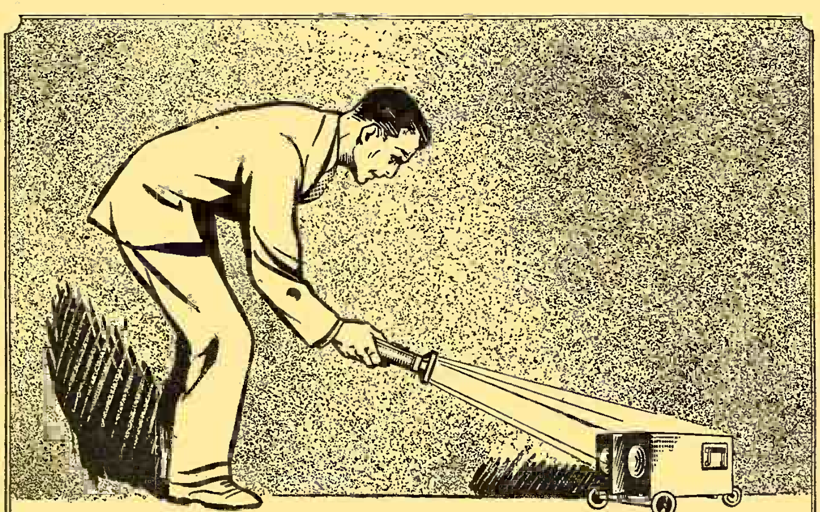


Fig. 6

"The Electric Dog," invented by John Hays Hammond, Jr., some years ago, is an ingenious toy; but the principle may be applied to practical purposes. The movements of the little self-propelled box are guided toward or away from the light, as desired by the operator.

to one side. If it is left too far to the left (toward the positive side), the cell is short-circuited; if too far to the right, the charging current from the 1.5-volt dry cell will be too high. The potentiometer should be adjusted so that 0.4-milliampere flows through the light-sensitive cell; as this has been found the optimum value of battery current needed to keep the cell in condition when in a closed circuit.

THE METER-RELAY

If we provided a meter with a stop which would make contact with the needle, or pointer, at a certain position on the dial, and close a circuit, it is obvious that the meter would then operate as a sensitive relay as well as a current indicator. Such a contact arrangement is illustrated at the left of Fig. 5.

To do this, a thin vane of pure silver or platinum is fastened to the pointer, and a contact point of the same metal is used as a stop. The instrument may be of the one-milliampere full-scale type, having a resistance of 20 or 30 ohms. The stop should be then placed so as to make contact at about the 0.6-milliampere point on the scale, as indicated in the sketch at the right of Fig. 5.

This relay, which we will describe as a meter-relay, is capable of actuating a power relay (the heavier relay performing the actual operation) when the proper circuit hook-up is employed; this circuit is shown in Fig. 1. (Though the details of the meter-relay are shown, the experimenter is advised not to attempt its assembly, unless he is an expert mechanic trained in precision work; instruments of this nature can be purchased, reasonably enough, to insure successful experiments and applications without going to the trouble of attempting to build a meter-relay. It is painstaking work and quite beyond the mechanics of the average experimenter.)

The circuit shown at the left of Fig. 1 should be used by the experimenter in his operations. It will be noted that when the meter-relay A closes (because of the current supplied by the light-sensitive cell as soon as it is exposed to light) resistor R1 is shorted; this causes a sufficient increase in current flow through the secondary relay circuit B to actuate and cause it to operate any device which may be connected to its contacts D and E. It should be remembered that the cell will operate in reverse fashion, as well, in the presence of a source of light; for example, it will be noted that relay terminals C and D are closed when no current is flowing through the cell or relays, or, in other words, when the cell is dark. This feature makes it possible to break one circuit and make another when a light is directed upon the cell; that is, while the cell is dark, terminals C and D will be closed; in the presence of light, however, these terminals open and C and E will close.

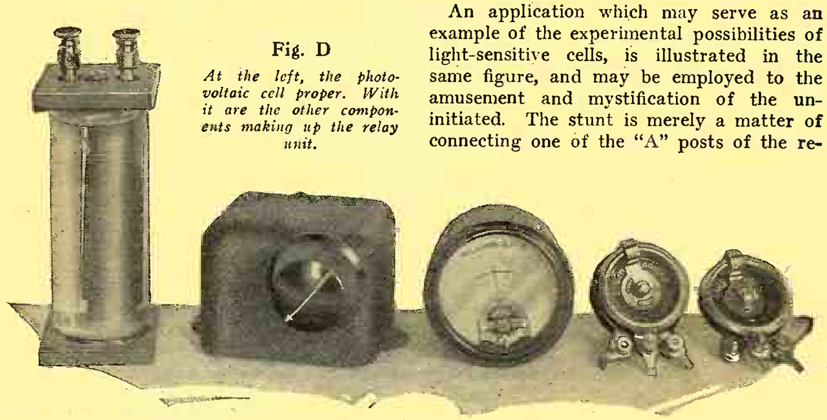
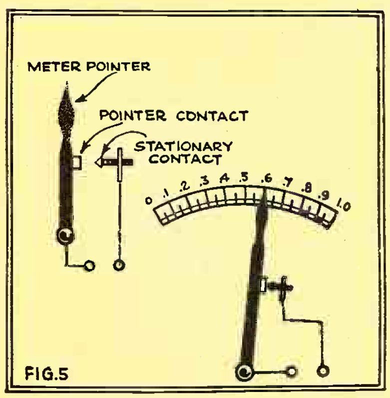


Fig. D

At the left, the photo-voltaic cell proper. With it are the other components making up the relay unit.

Since the meter-relay and the cell have been described, it will be necessary to identify only the resistors and the secondary relay; the latter should be capable of actuating on 3 to 6 milliamperes of current, and should have a resistance of about 700 ohms. Resistors R1 and R2 must be of a non-inductive type, and be capable of carrying 10 milliamperes; each should have a resistance of 1,000 ohms. A 2,000-ohm potentiometer will do nicely.



An ordinary milliammeter makes a sensitive relay, if we have a contact to close a circuit with the pointer at some reading.

THE AUTOMATIC RADIO SET

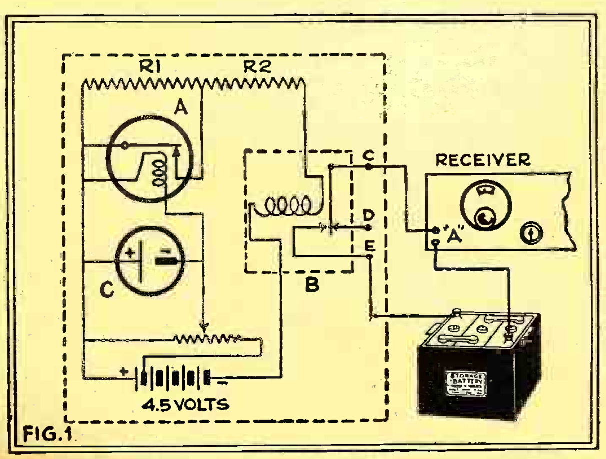
An application which may serve as an example of the experimental possibilities of light-sensitive cells, is illustrated in the same figure, and may be employed to the amusement and mystification of the uninitiated. The stunt is merely a matter of connecting one of the "A" posts of the receiver and one of the terminals of the storage battery (as shown at the right of Fig. 1) to relay terminals C and E. In this manner, the receiver will be turned on automatically whenever the light in the room is turned on; when the light is turned off, the receiver also will be turned off.

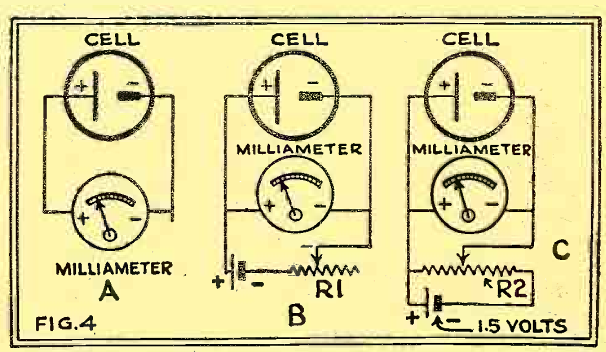
By placing the cell on top of the set as shown in Fig. A, and properly adjusting the potentiometer controlling the bias, it is possible to control the action of the receiver whenever anyone steps between the cell and its source of light. Should anyone do so, the set will automatically cease playing; but, on his stepping away from the cell, the receiver will again operate.

Of course, there are many simple experiments that can be performed with the apparatus outlined above; buzzers and bells may be operated by employing the same circuit illustrated for the receiver. Modifications of this experiment are employed in burglar-alarm systems, fire-alarm systems and numerous other operations where light is a controlling factor.

As a suggestion: construct a miniature lighthouse, in the tower of which is placed a six-volt lamp connected in series with a storage-battery and relay terminals C and D. Noting the circuit diagram we find that employing these terminals will cause the bulb to light when the cell is "dark." In

(*Continued on page 961*)





The development of the circuit of the photo-voltaic relay is shown above; A and B are experimental, C the practical circuit of the cell. This is incorporated in the more complete arrangement of Fig. 1 at the left; the unit illustrated in Fig. A with the cell outside the cabinet uses this circuit.

All apparatus described in this department has been tested in the RADIO NEWS *Laboratories and found of high quality in design and construction.*

A Complete Testing Outfit For Radio Work

ALMOST indispensable as an addition to the serviceman's equipment, is a complete test unit, which must comprise a number of meters and all the necessary adapters for testing both A.C. and D.C. circuits and tubes. The apparatus illustrated herewith is designed especially for the trouble-shooter, and affords instruments to make any conceivable test or adjustment that might be encountered by a serviceman. It is equipped with three meters: the first a D.C. voltmeter with three scales (0-10, 0-100, 0-600); the second an A.C. voltmeter, also with three scales (0-3, 0-15, 0-150); and the third, a milliammeter, with two ranges, 0-2.5 and 0-125 milliamperes. A system of plugs and jacks provides means for finding all desired values in the operation of a receiver, and of making the connections at all points desired.

Contained within the case is a step-down transformer, tapped in the secondary to provide the various voltages required by the numerous types of A.C. tubes. The unit is provided also with a tube rejuvenator operating from the same step-down transformer; with this arrangement the servicer may reactivate tubes of the thoriated-filament type. An oscillator, for testing different types of tubes under actual operating conditions, as well as for balancing single-control receivers, and for reneutralizing purposes, is incorporated, and adds greatly to the convenience of operation.

Various cabled plugs, tube sockets and adapters are provided to facilitate the testing of all tubes and all circuits; a tap at the base of one of the sockets gives an additional connection for testing screen-grid tubes. Rectifier tubes may be tested by comparing the output with the normal for the type in question.

The complete unit is housed in a leather-covered carrying case, measuring 14x12½x5 inches; snap fasteners and a key lock are provided, as well as a complete servicing manual containing complete instructions for its successful operation.

Manufacturer: *Supreme Instruments Corporation, Greenwood, Mississippi.*

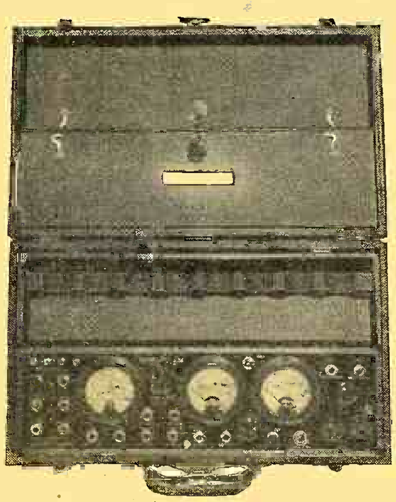


Fig. A
This is practically a portable radio laboratory for all measurements. A novelty is the inclusion of an oscillator for set testing.

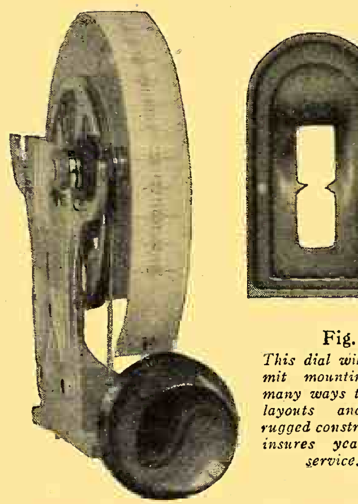


Fig. B
This dial will permit mounting in many ways to suit layouts and its rugged construction insures years of service.

Drum Dial Permits Flexibility of Arrangement

A NEW, illuminated drum-dial presenting a number of interesting features is illustrated (Fig. B) with its accompanying window. The dial consists of a die-cast metal drum carrying a translucent 100-degree scale, and a die-cast bracket which, in turn, carries the drum, a miniature lamp socket, and the driving shaft. The die-cast bracket is arranged so that it may be fastened upon a chassis and, when so mounted, will be rigid enough to carry a single, double or triple tuning condenser, which will require no other support. The bracket is pierced with five holes so arranged as to accommodate almost any standard condenser.

A feature of the assembly is that the bracket itself need not be fastened down; thus, in case a set's condensers are firmly fastened to a chassis, it is necessary merely to clamp the dial drum to the condenser shaft, and allow the bracket and drive shaft to "float." The bracket is prevented from turning by a ¼-inch hole in the front panel or escutcheon plate, through which the ¼-inch driving shaft projects.

The dial has an 8:1 reduction ratio, and is controlled entirely by a knob on the front panel, located directly below the center of the scale window. The scale itself, about six inches long (drum diameter, 3⅞ inches), provides a full 1/16-inch for each scale division; making it easy to read to a half-division, or closer. While it is of the so-called "string-drive" type, this dial uses, not the usual fish-line, but a bronze cable, wound from shaft to drum and *vice versa*. The drum is free to turn a little more than 180 degrees; then it is arrested by rubber-cushioned bumpers, preventing strain on the condensers or the dial cable.

Two models are available; they differ in the position of the bracket, at the right or left of the scales. Both turn in the same direction, and are essentially similar, except for their scales.

Manufacturer: *Silver-Marshall, Inc., Chicago, Ill.*

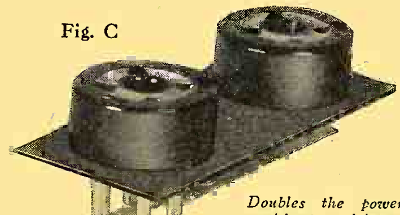
Double Adapter Mounts Two Tubes in One Socket

AN ingenious unit designed for those who desire to parallel two output tubes as a simple means of increasing reserve power in an A.F. amplifier is being marketed by an eastern manufacturer; it is designed for the purpose of expediting the use of an additional power tube in this manner, by the conversion of a single-tube output stage into a parallel arrangement without the necessity of rewiring the audio system, or changing the voltages applied.

As shown in Fig. C, the device consists of two sockets of the UX type, mounted upon a bakelite strip, and with the filaments, grids, and plates of both wired in parallel. While the change from a single output tube to parallel amplifiers requires some extra wiring, the latter is entirely contained within this device.

It is installed by simply removing the last audio tube from its socket, and in its place inserting the prongs of the unit; two tubes answering the requirements of the receiver's voltages are then inserted in the twin sockets of the converter. No other changes are required, except the replacement of a filament-ballast suited to the additional current requirement, perhaps.

Fig. C



Doubles the power without rewiring.

Electrically, the use of this unit provides satisfactory power transfer between the power stage and the speaker, since the output impedance of this stage, by using parallel tubes, is reduced to half its value when a single tube is employed; a condition making for better quality, especially on low tones, than when the impedances are fully matched.

Manufacturer: *Arthur H. Lynch, Inc., New York City.*

Six-Tube Kit Designed For Rapid Assembly

A KIT of all parts for a six-tube, all-electric receiver of simple construction and low cost has been brought out by a prominent parts manufacturer, and will appeal to both the home constructor, who builds sets for his own amusement, and to the custom radio builder, who makes them for resale at a profit; for it involves a minimum of labor in assembly and is of a "sure-fire" electrical design that assures good results out of the loud speaker. Full-size blueprints showing the assembly and wiring are furnished with the kit; these are clear enough to enable even a tyro to put the instrument together successfully.

The various parts are mounted on a metal front panel and a metal sub-panel, both of which are accurately drilled for all mounting screws. A sample kit submitted to the Radio News Laboratories was assembled in two hours without difficulty, all the instruments fitting nicely in place.

The front surface of the front panel is grained to resemble fine wood and presents a tasteful and decorative appearance, shown in Fig. D. The vernier dial controls a triple tuning condenser (C2), which extends at right angles from the back of the front panel; it is mounted securely to the sub-panel by means of machine screws.

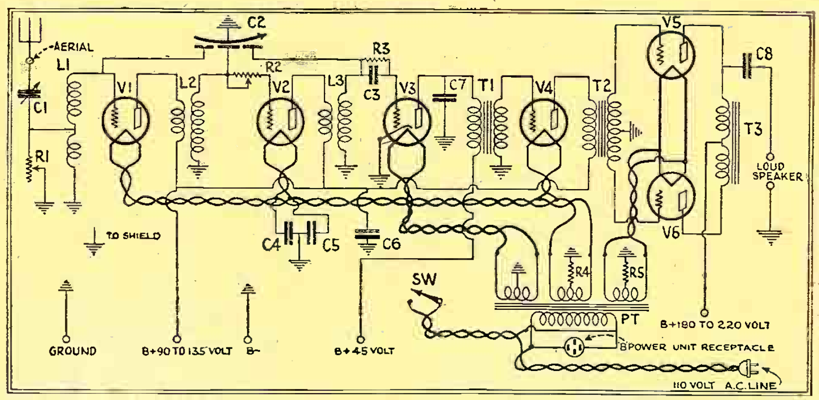


Fig. 1

The circuit of the receiver as assembled below gives all features of the standard R.F. set, with antenna tuning for sensitivity, push-pull output stage and filter to speaker.

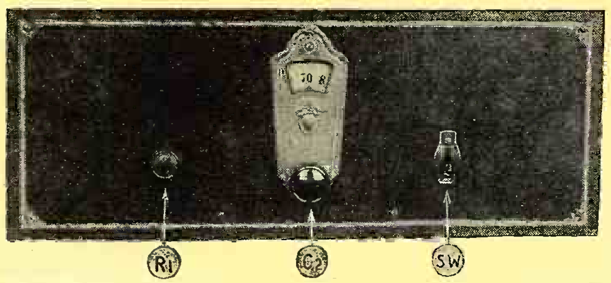


Fig. D

The metal panel has a neat appearance. It comes ready-drilled.

At the right of the condenser are three R.F. transformers of the tuning circuits (L1, L2, L3); the sockets for the R.F. tubes, (V1, V2); the antenna series condenser (C1); the oscillation-control resistor (R2); the filament-lighting transformer (PT); and a receptacle into which the plug from a power unit is inserted. The kit does not include the "B" unit, whose purchase is made optional; the manufacturer recognizing that many users of old sets already have "B" devices of some kind.

At the left of the tuning condenser are the components of the audio-frequency amplifier, which has two stages, the last push-pull. The detector socket (V3) is directly before the first stage transformer (T1). The sockets for the three A.F. tubes are mounted along the rear edge of the sub-panel. The push-pull input transformer (T2) and the output impedance (T3) fill the remaining space in the left section of the sub-panel.

The latter is braced to the front panel by means of two end brackets, additional rigidity being given to the assembly by the mounting of the tuning condenser.

On the underside of the sub-panel, which is shaped like a shallow dish, are the assorted fixed condensers and fixed resistors C3, 4, 5, 6, 7 and 8, and R3, 4, 5. The metal panels form the ground and the negative side of the "B" circuit, and many of the connections of the set are made directly to them. (Wherever a connection in the schematic diagram is shown running to a ground symbol, it actually goes to one of the panels.)

Electrically, the receiver is of the straight tuned-radio-frequency type, being perfectly straightforward without complicated controls. The three R.F. transformers are exactly alike in construction, each being tuned by a section of the triple condenser. The adjustable grid resistor R2 controls oscillation in the second R.F. stage, while the variable resistor R1, in shunt with the primary of the antenna coupler, controls the volume of the entire set and oscillation in the first stage. This control is a very smooth one, and is very effective; by limiting the incoming energy right at the antenna coupler, it prevents detector overloading, a serious cause of distortion.

The adjustable condenser C1, in series with the aerial, is very useful in suiting the receiver to its particular aerial; its setting is determined by trial, and once found is not disturbed.

Each section of the triple tuning condenser is fitted with a tiny midget condenser, by means of which the tuning stages are adjusted to exact resonance. The single-control feature works out very nicely, the set being sensitive and selective over the whole tuning range.

Alternating-current tubes of the 226 type are used in all R.F. and A.F. stages, while a 227 is used for the detector. The use of 226 tubes in push-pull for the last audio stage is rather unusual; but makes it possible to keep the price of the kit at a lower figure.

Practically any "B" power unit using a rectifier tube of either the 280 or the BH (filamentless) type, and designed to furnish the usual "B" potentials between 45 and 200 volts, can be used with the receiver to complete it. Grid bias for the tubes V1, V2 and V4 is furnished by the voltage drop across the resistor R4, (through which the plate current of these tubes flows) and bias for the push-pull stage by a separate resistor R5, in the filament circuit of the last tubes.

Manufacturer: *Pilot Electric Mfg. Co., Inc., Brooklyn, N. Y.*

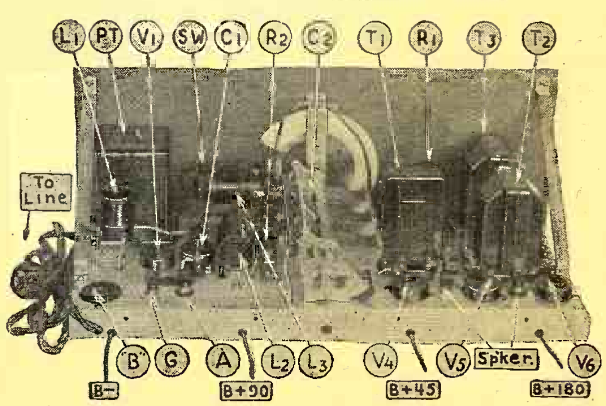


Fig. E

Simple, inexpensive, but strong construction is a keynote of the metal chassis, which makes assembly a quick process.

New A.C. Tubes Designed

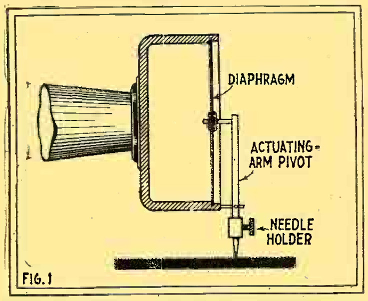
TWO new vacuum-tube types have been announced by a leading manufacturer, one a new A.C. screen-grid tube and the other a new power tube; the latter is of particular interest, because it provides a very satisfactory power output with a relatively low plate voltage. It will find ready application as a replacement tube, to be used in place of the 210; unfortunately however, its amplification constant value is less than that of the 210. The accompanying figures speak for themselves.

The A.C. screen-grid tube has a surprisingly low value of plate impedance, considering the high amplification-constant factor. This tube is of the heated-cathode type, utilizing raw alternating current on the heater filament; the cathode, as in the 227, is the source of electrons; a five-prong (UY) base is therefore required.

(*Continued on page 946*)

Pick-Ups—and How to Make Your Radio a Phonograph

MANY of our older readers would remember the debates which were waged in the pages of radio magazines during the years 1922 and 1923, with reference to the increasing vigor of the competition between radio and the phonograph as means of public entertainment. One article in particular (which appeared in the June, 1922, issue of RADIO NEWS) explained that, although radio was growing fast and was certain to become a great industry, it could never supplant the phonograph in public favor. One reason assigned was that the radio receiver cannot be called upon to reproduce any desired selection, chosen arbitrarily, at any time, but is governed by the station programs which are actually being broadcast at the moment within its range. Of course, we must recognize the truth of this statement, so far as the receiver alone is concerned.

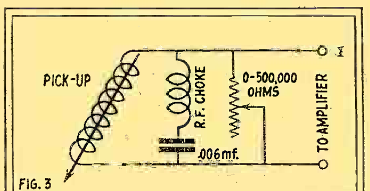


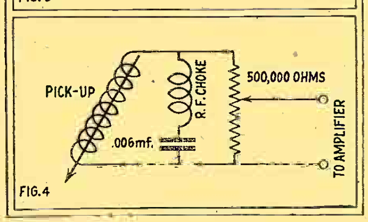
The old-fashioned phonograph unit depended upon mechanical leverage to produce sounds.

The same article voiced also some opinions as to the comparative fidelity of the tones reproduced by the radio and the phonograph, and evidenced some doubt as to whether radio reproduction could ever reach the perfection of phonograph quality.

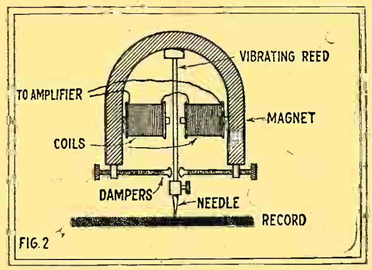
What a surprise a radio "Rip Van Winkle" of 1922 would receive if, after sleeping peacefully for seven years, he were awakened to be confronted by a modern phonograph equipped with an amplifier of the type used so extensively for radio reception! Who would have thought, a few years ago, that radio would not only soon reach the perfection of the phonograph, but pass it and even cause the phonograph to be modified to obtain radio's degree of "perfection"? Yet, this is just what has happened.

The same article discussed the outcome of the conflict between radio and the theater—and, of course, we all know that the vacuum-tube amplifier (the same, fundamentally, as that used in the new phonographs) is now being used in the new popular "talkies." The tables have certainly been turned; for the question now appears to be "Can the phonograph compare with radio in quality and fidelity of tone?" The best way to answer this question is to compare the two, draw your own conclusions. It is not very costly, nowadays, and not at all difficult to construct a really good electric phonograph.





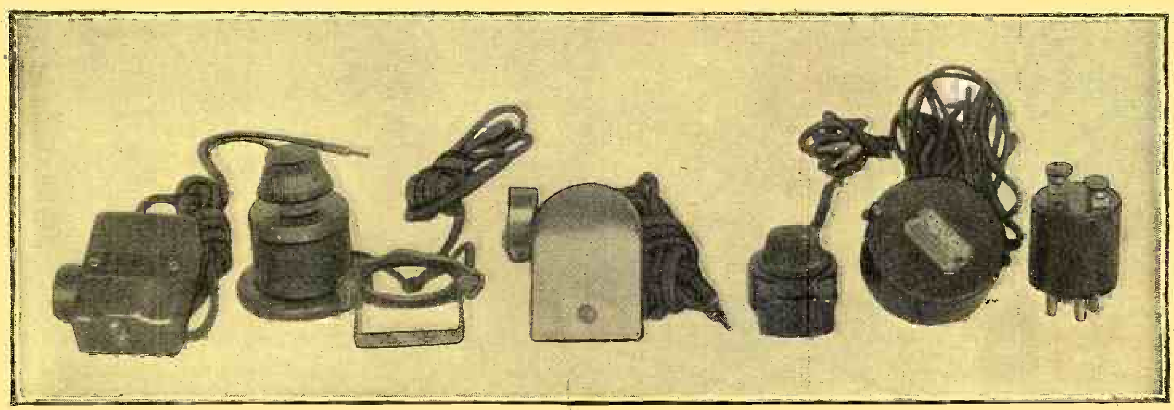
Optional connections for a volume control.



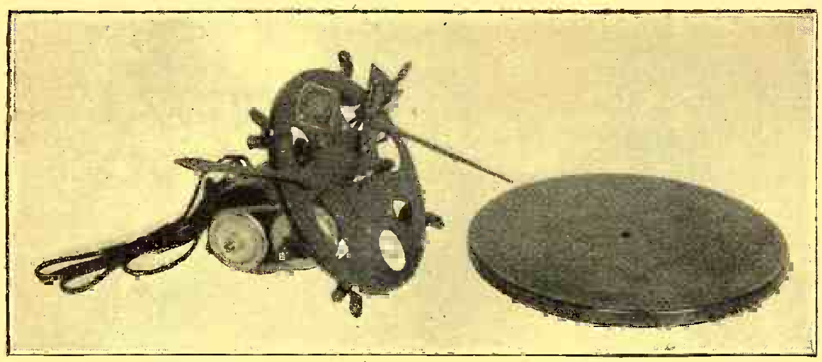
The electric pick-up vibrates more freely than the older unit; but its output may be amplified to any volume desired.

RADIO IN PHONOGRAPH PRACTICE

The question has been brought up, just what differences are there between the old and new methods of phonograph reproduction? The grooves in a phonograph record are so cut that the needle vibrates from side to side, as the record turns. In the old system, these vibrations are carried to a diaphragm by the mechanical motion of a lever and a suitable hinge. The vibration of the needle causes a corresponding motion of the diaphragm, which in turn sets up a vibration of the air in the horn. In this way the sound is transmitted to the ears of the listener. This system is both low in cost and reliable but, unfortunately, it causes a considerable amount of distortion. Both the



Commercial apparatus for converting a receiver to phonograph use. Left to right, a pick-up with control, an adapter making a detector the first A.F. stage, a pick-up, a remote-control device, a pick-up of a third type, and an adapter which replaces the detector tube in its socket. The latter is less used because of the greater advantages obtained by rewiring the receiver.

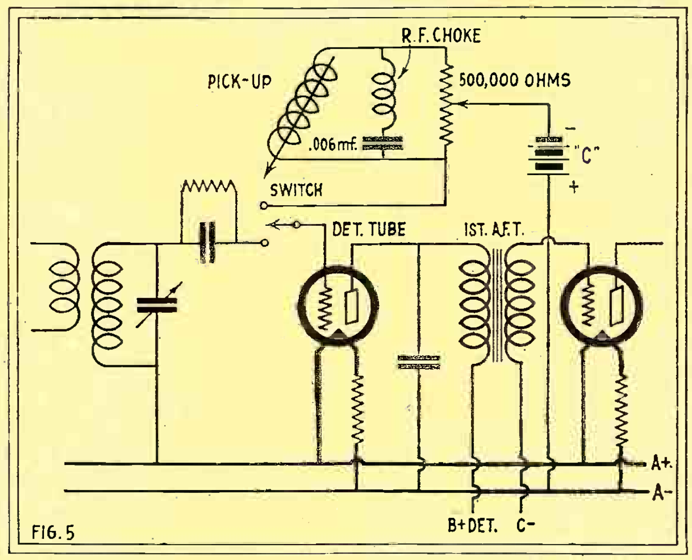


The owner of a radio receiver may convert its A.F. amplifier for phonograph reproduction, by building an electric motor and turntable like the above into the console.

horn and the moving mechanism have "points of resonance" and, of course, notes corresponding to these in pitch are brought out much louder than the others. The construction of the old-fashioned short horn, moreover, destroys some of the low notes.

The new system depends on changing the energy created by the vibrations of the needle into pulsating electric currents in a "pick-up" coil; this will be described more fully, later. The currents set up in the coil are transferred to an audio amplifier, a device well-known to all radio enthusiasts, and, finally, a loud speaker coupled to the amplifier brings out the notes which were originally impressed on the record.

"Pick-up" units of this type were introduced to the radio public about the middle of 1926 and, since that time, a dozen or more of good quality have been placed on the market. (The term "pick-up" is almost a misnomer, since the unit really does not pick up anything. The word "reproducer" or "converter" would be better; since the "pick-up" merely converts a mechanical motion into an electric current.) The difference between the two units is shown in Figs. 1 and 2; the first, the old phonograph "sound box"; the second, the magnetic pick-up for electrical reproduction, which gives also amplification.



The circuit shown in Fig. 5 gives the largest possible amount of volume from a given pick-up and amplifier, for it utilizes the detector tube of the set as an additional A.F. stage. The switch may be inside or outside of cabinet, as convenience dictates.

DEVELOPMENT OF SOUND DEVICES

The history of the electric pick-up (to adopt the common term) can be carried back as far as 1875, when Alexander Graham Bell first developed the telephone; the operation of the pick-up device is almost identical with that of the early microphones used by Dr. Bell. The first microphone consisted of a permanent magnet, around which was placed a coil of wire; a thin piece of *magnetic* metal (iron), placed in front of the magnet, was suspended by its edge so that the center could vibrate. By speaking directly in front of the diaphragm, it was caused to vibrate; and this caused to be generated in the coil a weak current, due to changes in the magnetic field around the permanent magnet. The fluctuating current in the coil was found to be almost identical in its "wave form," with the motion of the diaphragm and, in this way, an electrical equivalent of the sound was obtained. A similar magnet, coil and diaphragm were placed at the other end of the wire and the electric currents were re-converted into sound in just the reverse manner.

In the electric phonograph pick-up, a permanent magnet is also used, a coil, or several coils, is placed near the magnet and a thin bar of metal or "armature" is used instead of the diaphragm. The metallic bar is fastened to a phonograph needle with a suitable clamp, and the complete unit is placed over the record in place of the usual needle and sound-box assembly.

(*Continued on page* 956)

The pick-up devices illustrated opposite are designed to be used with a phonograph already in use, and to slip over its tone-arm. Those pictured above are complete in themselves, with the aid of a motorboard, to construct an electric phonograph suitable for incorporation in a radio set. The pick-up at the left incorporates its own volume control in the base.

Some Methods of Detection—and Their Respective Merits

What Takes Place When a Radio Wave is "Demodulated," and Why Detection is Always Accompanied by Some Distortion

By C. Walter Palmer

FOR the last few years, magazine articles and books on radio reception have emphasized the importance of reducing *distortion* in receivers. Long discussions have been written to urge the use of good apparatus and the correct application of certain principles in order to obtain the best results. For this reason, it has come as rather a shock to many set builders and fans, who have spent so much time and money, that their apparently-fine receivers will under no conditions receive without *some* distortion. This certainly appears to be a paradox, and it is necessary to make some explanation of such a broad statement. Fortunately, the explanation is not very difficult, and the statement is not as radical as it first appears.

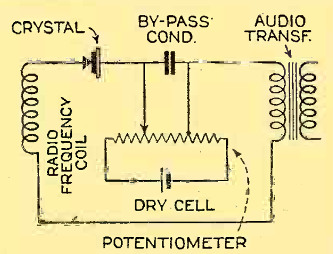


FIG. 4

A "fixed" crystal whose bias is regulated in this manner gives detection of very good quality; it does not, of course, amplify.

The articles usually written on the elimination of distortion apply entirely to amplifiers and are not concerned with *detectors*. The principles given for the reduction of distortion do not apply to the detector and it is at this point that we find an explanation of the statement made above. In order to understand exactly what happens, we must have a good idea as to just what is meant by detection.

MODULATION OF RADIO WAVES

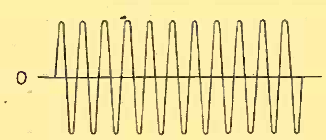
The signal sent out by a transmitter consists of two parts or "components"; first, the "carrier-wave," which is a very high-frequency alternation and, when unmodulated, can be represented as in Fig. 1. The second component consists of the variations of voltage caused by the microphone. When we speak or sing into the microphone, we cause a change in the current in the microphone, and the amplification of this by the "modulator" serves to change the carrier-wave to conform with these current changes. The changes in the current in the microphone, and the resulting wave form are shown in Figs. 2 and 3.

These modulated radio-frequency currents cause "waves" which are transmitted, picked up by the receiving antenna, in which they cause currents which are amplified by radio-frequency amplifiers. If a pair of headphones were connected to the R.F. amplifier, we could not hear the signals, for two reasons. In the first place, the diaphragms of the phones can not vibrate as fast as the variations in the current; and, in the second place, our ears would not respond to such high notes. The average human ear will not respond to sounds higher than 10,000 or 12,000 cycles, and the lowest carrier-frequency used by broadcast stations in the United States is 550,000 cycles.

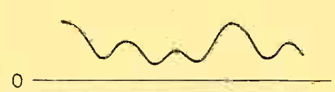
By referring to the form of the modulated waves, we find that their general lines correspond to the variations in the current in the microphone, except that the variations occur on each side of the zero potential line. If we could cut off one-half of the wave, along this line, and also eliminate the high-frequency variations, we would have a line exactly similar to the original changes in the microphone current. This is accomplished by the detector.

CRYSTAL DETECTORS

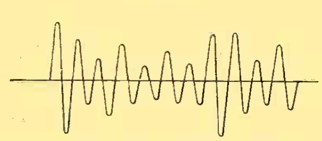
The crystal detector is a type of electric one-way "valve." The currents can travel in only one direction through the crystal and the impedance of the phones or amplifying transformer prevents the high-frequency variations from passing. The usual crystal detector uses a contact which presses on only one point of the crystal. Most crystals have sensitive spots over their surface and the sharp point of the "cat whisker" is necessary to find these points.



-THE CARRIER WAVE-
FIG. 1

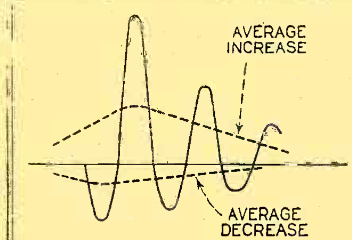


-CHANGES IN CURRENT DUE TO THE VARYING RESISTANCE OF THE MICROPHONE-
FIG. 2


-CARRIER WAVE MODULATED WITH CURRENT CHANGES AS SHOWN IN FIG 2-
FIG. 3

The unmodulated carrier-wave and the audio-frequency wave picked up by the microphone blend to form the complex wave of Fig. 3.

There is also a type of crystal detector which requires the addition of a battery in order to work properly. This type of detector uses a piece of carborundum, with a heavy spring contact. In itself, it is not nearly as sensitive as galena and similar detectors, but the operation can be improved by placing a small battery in series with the crystal. The conductivity of the crystal is greatly increased by a certain small voltage, and the lowered resistance produces a much greater signal strength. A potentiometer and condenser are used to allow a critical adjustment of the bias. This is shown in Fig. 4.



-PLATE-CURRENT CURVE-
FIG. 6

In detection, the wave is so distorted that one side is practically suppressed. The resulting current is largely audio-frequency.

DETECTING WITH A VACUUM TUBE

The discussion up to this point is rather off the track of showing why distortion in the form of the waves must be encountered when detecting with a tube; but it serves to bring to mind several facts and will help in understanding the action later. There are two common methods of obtaining a detecting action in a tube. One uses a "C" battery in the grid circuit and is known as the *plate-current* method. The other uses a grid-leak and grid condenser and is known as the *grid-current* method. The latter is the more common and we find this method used in almost every broadcast receiver made. The first is more suitable for large sets, because of some of its characteristics. However, the comparative merits of the two systems will be discussed later.

DETECTING WITH A GRID BIAS

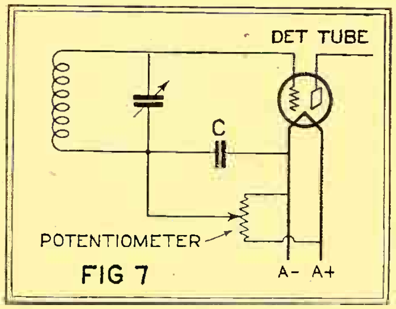
The tubes used for both methods are the same and most of the common tubes may be adapted to either, by several simple changes. The first system mentioned above, or plate-current rectification, is so called because of its unusual effect on the plate current at certain points, when the grid bias is varied.

To understand this more fully we will refer to a *graph* of the grid bias and the plate current. (See Fig. 5.) Most of us are familiar more or less with the uses of graphs. They are used wherever a direct comparison is desired between two varying figures or values. Graphs are made in a number of different ways, but in this case, a paper ruled with lines intersecting at right angles to form equal adjacent squares, is employed. At the top of the square thus formed, we mark off the various grid voltages which might be used. Since the bias may be either positive or negative, we use one line for a zero voltage and the others for voltages either positive or negative within the required range. (In a detector, the grid bias will rarely exceed five or six volts.) On the left side of the graph we mark the various values of plate current which may be encountered and, by measuring the actual plate currents for various grid voltages with an actual tube, we obtain a curved line or "characteristic" similar to the one shown. Of course, the line for a given tube does not always correspond exactly to the one shown, but it does follow a similar general direction.

If, now, we connect the tube in a radio receiver and tune in a signal, the grid bias will change in value, every time the current of the received signal changes. These changes are extremely fast; in short-wave reception, they occur several million times every second. However, we can indicate a few of these changes on a curved line similar to the one shown at the bottom of the graph.

CHANGE OF CURRENT FORM

If the correct plate and grid voltages are used, a line through the center of the curve representing the signal will strike the original curve in the graph, just at the point where it bends suddenly. If we draw vertical lines to the curve, and then record the corresponding changes in the plate current, we find that a curve somewhat similar to the original signal curve is obtained. There is one great difference, however, and on this difference depends the whole detecting action. If we look at the curve, we find that a line drawn at "X" at right angles to the vertical line at this point, divides the plate-current curve very unevenly. On one side of the line, the variations are very great, while on the other, they are comparatively small. The shape of the curve is undoubtedly distorted in relation to the incoming signal curve, and this is the distortion mentioned at the beginning of this discussion.



The necessary adjustment of grid voltage for plate-current rectification is most conveniently made with a potentiometer, as shown above.

If we make a second graph of the plate-current changes (Fig. 6) and mark the average variation, we find that the increases in the current greatly exceeds the decreases; and this average upward change will be sufficient to actuate a telephone receiver connected in the plate circuit of the tube. The extremely high frequency-variations in the current are blocked by the impedance of the phone winding and, when an audio amplifier is used, the impedance of the first primary winding, or the R.F. choke which follows the detector, serves the same purpose.

A condenser is usually connected in the plate circuit of the detector, and carries the high-frequency currents away from the plate. The condenser is connected to the filament lead or to ground, and these currents are disposed of in this way. The low-frequency variations are carried through the audio-frequency amplifier and are amplified in the usual way. If we refer back to Fig. 5, we find that the average variation in the plate current of the detector tube is larger than the average variation on one side of the incoming signal curve, and from this we can see the *amplification* which is obtained in the detector when using a vacuum tube. This amplification can be increased tremendously by using regeneration; but this is beyond the scope of the present article.

OBTAINING THE "C" BIAS

There are several ways of obtaining the required "C" bias and a satisfactory adjustment for the above method of detection. The first is shown in Fig. 7. A potentiometer is connected across the filament terminals, with the grid return leading to its adjustable arm. By moving the arm from the positive to the negative side, the bias will be increased and the best point can be found by experiment. This method is quite satisfactory for small sets where the signals are not very great. The grid-voltage "swing" is limited by the filament voltage and, if the signals are very strong (as they are when several stages of radio-frequency amplification are used), the grid voltage might change over the zero point to the positive side and cause an overloading of the detector. The potentiometer should have a resistance of about 400 ohms and a by-pass condenser of at least .001-mf. should be connected between the center arm and the negative side, to keep the *radio-frequency resistance* of the circuit low.

A second method of obtaining the bias is shown in Fig. 8. This method is better suited to larger sets, since the potential on the grid can be made as large as necessary by increasing the size of the "C" battery. The potentiometer is used in this case also to obtain a close control of the voltage, and a by-pass condenser is connected as described above.

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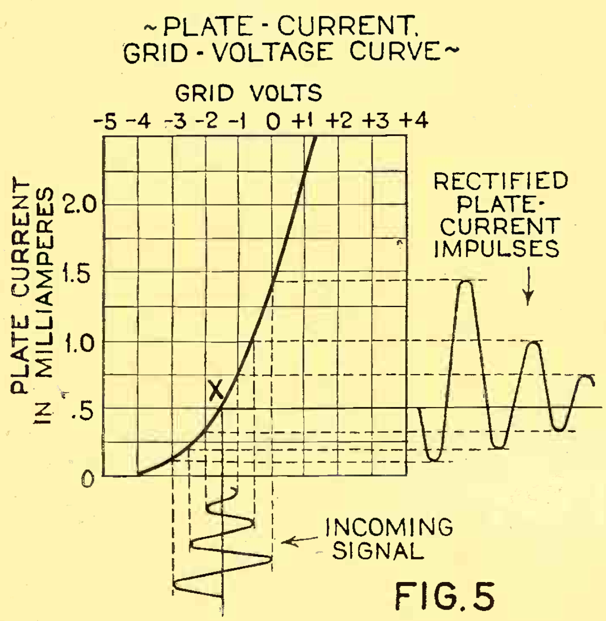
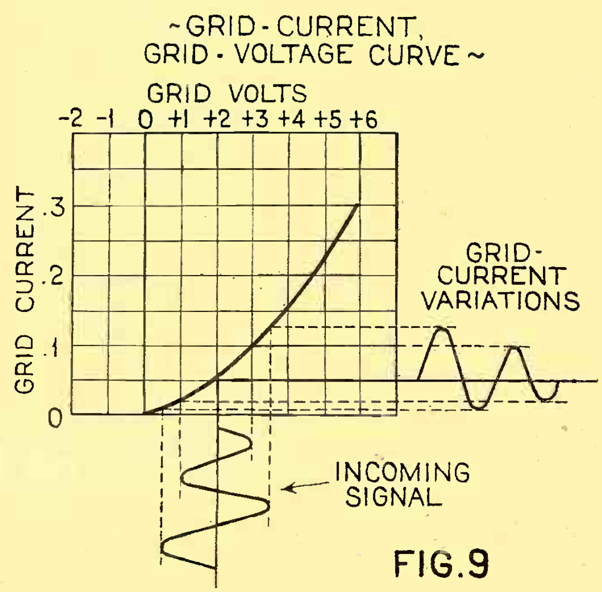


In the tube with a "characteristic curve" such as the above, voltage "swings" on the grid, corresponding to the vertical wave at the bottom, produce a distorted output wave-form like that at the right.



With a "+" voltage on the grid, a tube operates at a different slope of its "characteristic," and the "+" half of the signal alternation, increasing the total voltage, causes an increase in current flow greater than the decrease due to the "—" half. Result, distortion again.

Aerials and Grounds for Short-Wave Reception

Some Basic Principles Which Have a Bearing on the Efficiency of Antenna Systems for Reception on Varying Wavelengths

By Ashur Van A. Sommers

What Do You Need in Addition to a Receiver?

YOU have a short-wave receiver or an adapter and expect to receive, not only American short-wave broadcast stations, but also England, Holland, Australia, and other distant countries. While it is not possible to receive *all* short-wave stations from all points in the world, it should be possible to receive many of them if your location is at all suitable, and not subject to too much local interference. But, no matter how good your location, and how good your receiver, there is always something between you and the signals you want to hear. *That is your antenna.*

***How good are your aerial and your ground?* Are they suitable for the purpose under the new conditions of receiving short waves? What changes should you make in them?**

This article describes the principles underlying all aerial and ground systems, and the special modifications necessitated by change in wavelengths received. You should read it to see whether you are getting the most out of your short-wave set, and whether there is a possibility of improving reception. No matter how good your receiver, the results you will get from it are no better than your antenna; for that provides the "raw material" (signals) on which the set must operate.

A study of the following is recommended to every new short-wave fan, whether he is operating a short-wave set with moderate satisfaction, whether he is still disappointed in the results, or whether he is just hoping to obtain them.

THE short-wave broadcast listener who begins with too much enthusiasm is apt to be disappointed, particularly if he is one of the many not blessed with an exceptionally good location for reception. He has read with interest about those who can count on Australia for breakfast, England for dinner, and television movies before retiring; and, after he has built a "junk-box" set, or plugged a short-wave adapter into the handsome A.C. receiver which adorns his parlor, he expects to hear Eindhoven or Bandoeng come booming in when the dial is turned. If he has no results, or if he hears only code stations—unintelligible to him, but at the least proof that his set is operating—he may murmur that short waves are a "lotta baloney," and that something has been put over on him. In other words, he will be repeating the emotional experience of many a fan of the old days who toiled all evening in the hope of finding the right spot on the galena, and concluded that radio was "the bunk."

Not so: short-wave broadcast technique has not reached perfection, though it is improving. It must be regarded as to a certain extent experimental, even yet; but it is based on a foundation of solid performance, especially appreciated by thousands living in parts of the world outside the normal range of any long-wave broadcast station. To these the great short-wave stations are their "locals;" as many of the letters received by RADIO NEWS testify.

It is true, of course, that short waves are capricious; they are easily turned aside by obstacles in their path. A listener in the congested district of a large city, surrounded by steel construction, may readily be disappointed of short-wave reception; but then, too, he may also find it impossible to get his nearest local on the upper broadcast wavelengths.

What is even more fundamental is the nature of the "skip-distance," explained later in connection with Fig. 6. There are great rings on the earth's surface where even a powerful short-wave station cannot be heard. These vary in position with the hour of the day, and the conditions as to sunlight, etc., between them and the station. Especially when the sun is rising or setting between transmitter and receiver do these belts of no-reception shift quickly; thus producing rapid fading of the signal. Each "skip-distance" varies with the wavelength, as well as with the condition of the atmosphere. It is possible that this trouble will be overcome, by means of beams directed at varying angles against the "Heaviside Layer." For point-to-point transmission between Europe and South America, experiments of this kind have been conducted. For the present, however, we must fall back on the amateur's analysis of reception conditions: "Either you get 'em, or you don't."

AERIAL TYPES

However, assuming that our listener is so located that some signals from short-wave broadcasters are passing in his vicinity, he must take some steps to intercept them and to feed them into his radio receiver, before he can operate the latter. The conventional idea of an aerial-and-ground system at once occurs; and it is probable that he has already taken some steps to utilize the antenna which is bringing in local long-wave broadcasts very successfully. Perhaps it will be quite successful with the short waves: in which case his problem is concerned with proper operation of the set to extract the greatest possibilities out of every squeal. On the other hand, there may be conditions which make the present antenna system less efficacious for waves one-third to one-fortieth of the length of those for which it was designed. Let us consider the nature of an aerial.

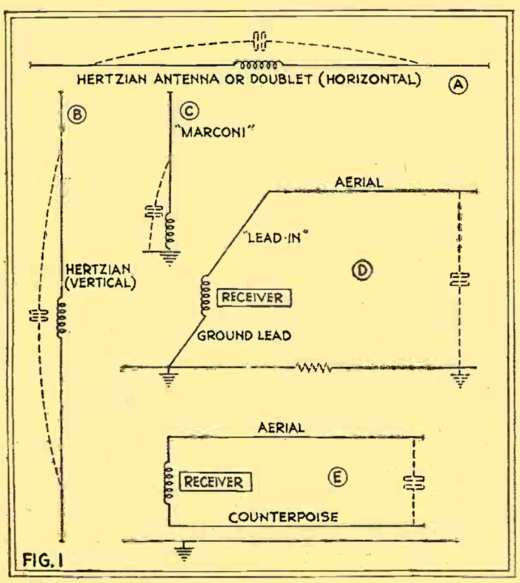


FIG. 1

Left, the fundamental aerial types; it will be seen that the ordinary receiving aerial is an adaptation of the Marconi type, and that capacity and resistance figure in the circuit. Right, a view of a transmitter's field in one cross-section at one instant.

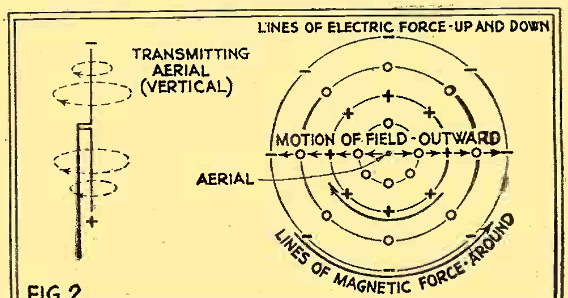
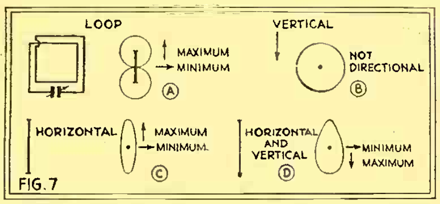
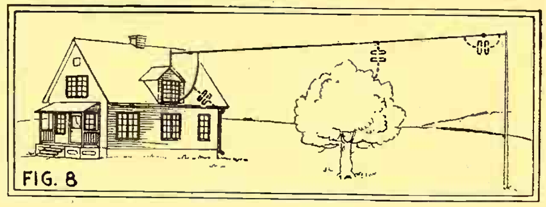


FIG. 2



Theoretically, a vertical aerial would be best for broadcast reception. Practically, however, a horizontal one is more convenient. With short waves, remember, small capacities, as shown at the right, make important losses.



The first radio system devised by the experimental genius of Heinrich Hertz comprised simply two rods with capacity sufficient to carry an electric charge, by which an oscillatory flow of very high frequency could be maintained between them. A Hertzian antenna, therefore, is one which has two equal and opposite members, theoretically in line with each other. Between the two there exists a certain slight capacity, as indicated in Fig. 1 at A and B.

It is obvious that we must have two parts in the antenna system, in order that the electricity which flows out of one may have some place to store itself during half a cycle. The same condition, however, may be obtained if we simply connect the half-antenna to the earth, as in the "Marconi" type aerial at C.

These were evolved during the first period of development in radio, and with the idea of getting a wave *into* the air. Corresponding antennas for reception, of course, may be constructed. Either of them, however, would have certain practical difficulties connected with its use in connection with the ordinary broadcast receiver. We may see the fan's usual equipment in schematic form as at D. His lead-in is a part of the aerial, and gives the latter, electrically, vertical height as well as extension. On the other side of the set from the aerial is the ground lead and the ground.

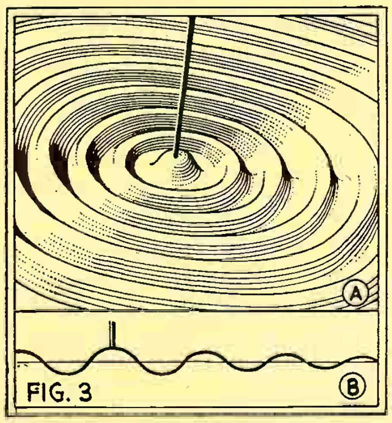
WHERE DOES THE GROUND BEGIN?

The poet has told us where the West begins; but where the ground begins is another question. The simplest radio calculations are based on the idea that the earth is a perfect conductor, charged at a certain, *very negative* potential. For certain purposes, it might be said to be such; but when radio frequencies are considered, the earth is decidedly far from a perfect conductor.

As a matter of fact, if we connected to the ground post of our set by a large copper cable some very extensive sheets of metal and sunk them into the deep sea, we would have what might be called a "ground" to about four-fifths of the earth's surface. It would not, of course, be a perfect conductor, even at that; but we may see why the nearest thing to a true "ground" may be obtained on a ship at sea.

We may, however, do away with the ground and substitute a "counterpoise," of wire as a rule, which is for our purpose an artificial ground, and gives us a Hertzian system folded over, as we may say. The counterpoise should be some distance above the actual ground, and between the latter and the aerial.

We have now, as one might say, a net to catch not fish, but waves. What are these



A diaphragm churned up and down into waves radiating with decreasing height is the usual illustration of an electric field.

waves, and what do we do with them after we get them?

In a rod (which, for convenience, we will show as vertical, like many short-wave transmitting aerials), we cause an electric current to flow up and down very fast. As the current alternates more frequently, the sharpness of the disturbance to the surrounding medium (whatever it may be, "ether" or "curvature of space" or what you will) increases. At 60 cycles a few watts of current will hardly cause a ripple a few feet away. At 15,000,000 cycles, a receiver on the other side of the world may respond to the pulsations. (Fig. 2.)

(Someone—Darwin or other great authority—said that the brain of an ant seems to be the most remarkable bit of intelligent matter in the world. Certainly, the most sensitive bit of matter is the tuned circuit (antenna or otherwise) of a short-wave receiver, which will respond at 12,000 miles to no more power than there is in a Christmas-tree bulb.)

THE "WAVE" STARTS

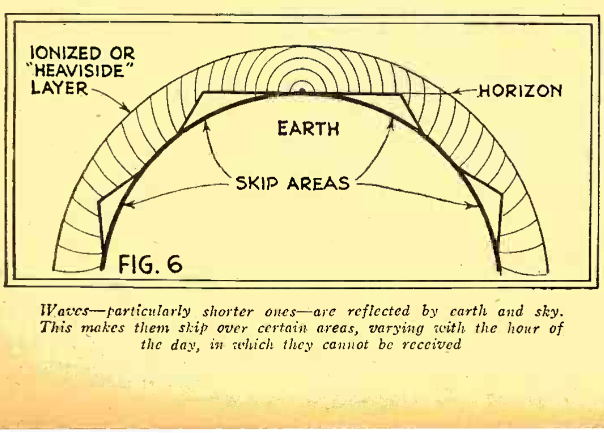
With the flow of current from one end of the aerial toward the other, "lines of force" build up around it with incredible swiftness. They bulge out, they sink in again as the current (at every half cycle) falls to nothing. But, as the field of force caused by the previous current collapses, it meets halfway the force of the current building up in the opposite direction, and is forced outward again. The result is that a part of the energy in the aerial escapes at every alternation of current, and goes outward in all directions, forming a "wave." We can compare this to a wave of water, except that the latter is formed almost entirely on the surface, while the radio wave moves in *three dimensions*, so that we cannot make a satisfactory picture of it on a sheet of paper. If we modeled it in glass, it would be not unlike half an onion in shape, above the earth.

How far the wave enters into the earth is another question. If the latter were a perfect conductor, as assumed in the theory of ground, the wave would be reflected from it, like light from a sheet of silver. On the other hand, it has been proved by experiment that radio reception can be had quite successfully from a buried aerial, and even at a considerable depth in the earth. The grounded wave must, therefore, travel for some distance in the earth, especially where the latter is a poor conductor.

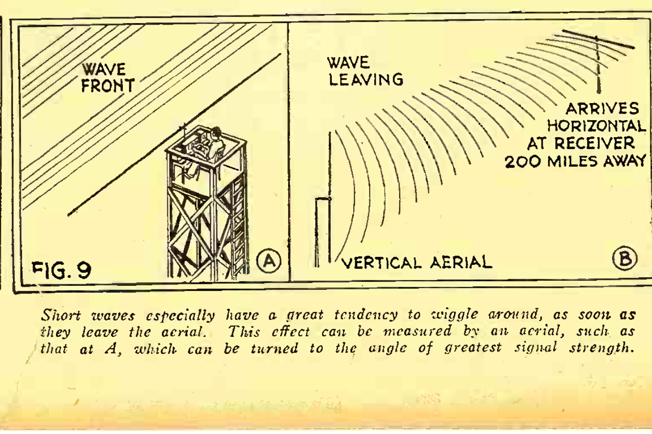
WAVES ARE NOT CURRENTS

It must be borne in mind by the reader that a *wave* is not a *current;* a wave travels in a *non-conductor*, a *current* in a conductor of electricity. When a wave reaches a conductor, such as an aerial wire, it causes a current to flow in the latter; thereby losing energy. A wave thus makes a current, as a current makes a wave in the first place. The current is the actual motion of free electric particles, or electrons; the wave is the changing position of the "lines of force" connected to these electrons—in other words, a rearrangement of the equi-

(*Continued on page 963*)



Waves—particularly shorter ones—are reflected by earth and sky. This makes them skip over certain areas, varying with the hour of the day, in which they cannot be received



Short waves especially have a great tendency to wiggle around, as soon as they leave the aerial. This effect can be measured by an aerial, such as that at A, which can be turned to the angle of greatest signal strength.

Popular Handiwork

How to Make a Handsome Radio Console*

By H. L. Weatherby

EVERYONE who has a radio wishes to house it in a suitable piece of furniture; while radio consoles are becoming more and more beautiful and expensive, as the radios themselves are becoming more efficient. The amateur who builds his own set need no longer feel that he cannot have a beautiful cabinet for it—nor the set owner who has purchased his set in a box—for the building of a console, in either case, is a comparatively simple matter.

The radio console illustrated in this article is not as difficult to build as it may look. To the average worker, in his home shop, it will present no unsurmountable obstacles; he need not let the carved mouldings scare him, for they can be purchased in any variety of designs from the finer cabinet shops. The legs may be taken to the mill for turning, if one does not have a lathe; and the wood is largely plywood which comes already sanded. The joints themselves are all of the simplest sorts; and to have a truly beautiful radio console means only to secure suitable wood and then to work it up with a reasonable degree of accuracy.

Mahogany or walnut is recommended, but one of the cheaper woods will finish well and will be a very good imitation of the harder and more expensive wood. Painted furniture is quite the vogue now and any close-grained wood will paint well.

Having selected the wood and cut it out according to the material list below, construction operations are in order.

CONSTRUCTION

The cabinet part and the table are constructed as two separate and complete units. It is suggested that the table be built up first. The legs may be made from $1\frac{1}{4}$-inch square material, in which case, slabs to make up the desired thickness of 2 inches must be glued on at the wide part near the top, and enough to make $1\frac{1}{2}$ inches at the bottom. The legs are turned

A New Departure!

RADIO NEWS HANDIWORK BLUE PRINT

No. 1A

A MAJORITY of the readers of RADIO NEWS (as a recent survey among some 25,000 of them indicates) do constructional work of one kind or another, whether radio set building or other forms of craftsmanship. If you have a flair for mechanics, and skill with tools, there is no reason why you should confine your activity, for either pleasure or profit, to radio alone.

To make broader activities by our readers more readily possible, RADIO NEWS will therefore present each month one or more Handiwork articles (of which this is the first) of a nature not confined solely to radio. While our first article gives details for the construction of a handsome radio console, and the second will be devoted to a combination radio-and-phonograph cabinet, we intend in the future to publish in RADIO NEWS other Handiwork Blueprint articles along non-radio lines. For those who enjoy cabinet work, we may say there is a tremendous demand today for the angular, so-called "modern" furniture, as well as in the old Colonial designs. Then, too, there are possibilities in work beyond the scope of furniture, such as metal work, airplanes, telescopes, and many others alluring to the enterprising home constructor.

The important message we wish to convey is that we have found, by past experience, in the vast majority of cases, the man who has completed an attractive piece of work at once finds a demand from friends and others who wish to purchase it or another like it. It has taken him some time and trouble to learn how to make the first; but thereafter it is much easier to make duplicates *which may be sold at a handsome profit.* We can therefore recommend to the versatile radio set builder to consider as a side line the construction of other utilities which will, often, net him more money than the sale of home-made sets.

We have engaged a number of expert authorities on different forms of craftsmanship to prepare for us a series of articles along their special lines, and we shall publish, in the Handiwork Blueprint series, the best of designs, instructions, and advice that brains and money can obtain. The blueprints will be particularly elaborate and so prepared that it will be easy to build from them.

Important!

Note that it is unnecessary to do your own lathe-work, cut your own veneer, make your own friezes and cut-outs, or perform other work requiring special machinery; any more than to make your own condensers, tubes or A. F. transformers, when you build a radio set. The designs presented in these pages will lend themselves to simple assembly and, with few exceptions, any materials required can be bought, when desired, in the open market.

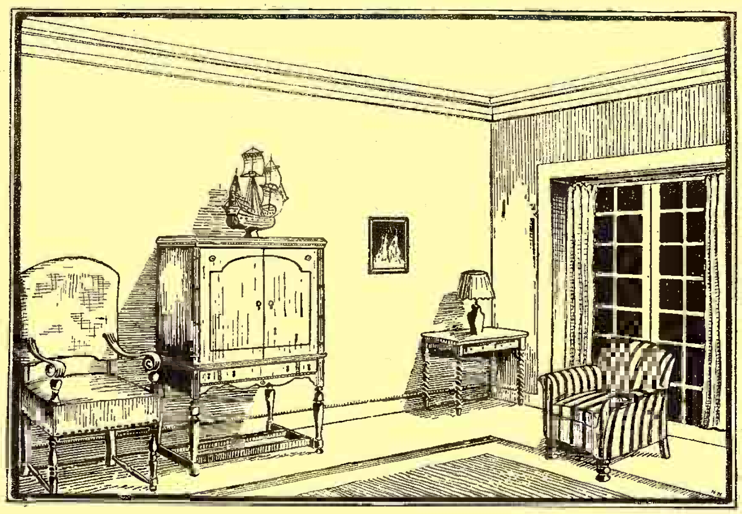
Thus you can obtain practically all the material required for Radio Console No. 1, described here, from a number of houses such as are found in every large city. (For those who do not know them, names and addresses of firms will be found on the specification sheet which comes with the blueprint.) Wooden material usually comes in the natural finish, and will have to be stained and varnished; but this is comparatively simple. You will be surprised to note how low the cost of building such a console as that shown here—only a small fraction of the price you would pay for the completed furniture. Of course, some of your time will be required; but it will be well paid, as you are saving the cost of a high-priced factory worker's labor.

We would especially like very much to hear from our readers as to what they think of our new departure, and we particularly ask you to fill out and send in the coupon printed on page 971. It will help us a good deal to shape our policy, and to give you what you most desire to see, in the Handiwork Department.

H. GERNSBACK, Editor.

* RADIO NEWS *Handiwork Blueprint Article No. 1A (see page 973).*

from the rail section down, and mortises are made for the rails. The decorative grooves at the top should be cut before gluing the slabs to the legs. The rails, as indicated, and for which patterns are furnished on the prints, are to be shaped with the band saw and then filed and sanded. The table top may be of a cheaper material, since very little of it will show; and after gluing the legs and rails together, the top should be fastened securely to the frame with screws, either from above or below. The drawer slides and partitions are then placed; after which the table section should be set aside while work is continued on the upper part.



CABINET SECTION

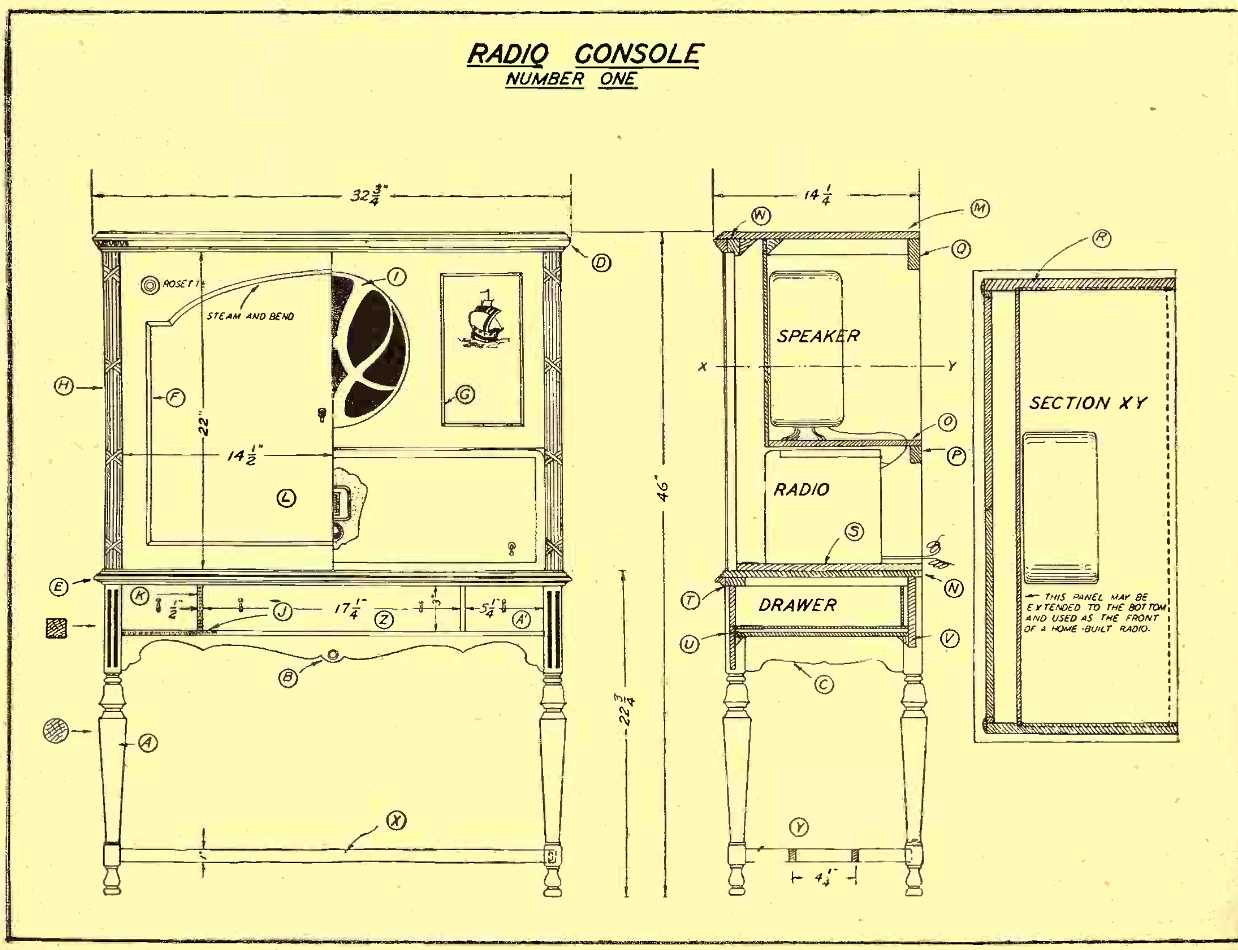
The cabinet or upper portion is made up as one would construct a box, open front and back, with exception of braces. It may be fastened together securely with nails, after which glued corner blocks are used to reinforce the corners. The nails, of course, are to be set and the holes filled later.

THE console, shown in the illustration above, will cost for raw materials from ten dollars up to fifteen, depending on the locality. The mouldings, handles and turnings, which it would not be profitable for the constructor to attempt, will cost around eight dollars. Such cabinets, when finished, retail up to as high as $75.00. The set builder will find a source of profit in supplying consoles of high quality in which his own labor saves a considerable cash investment.

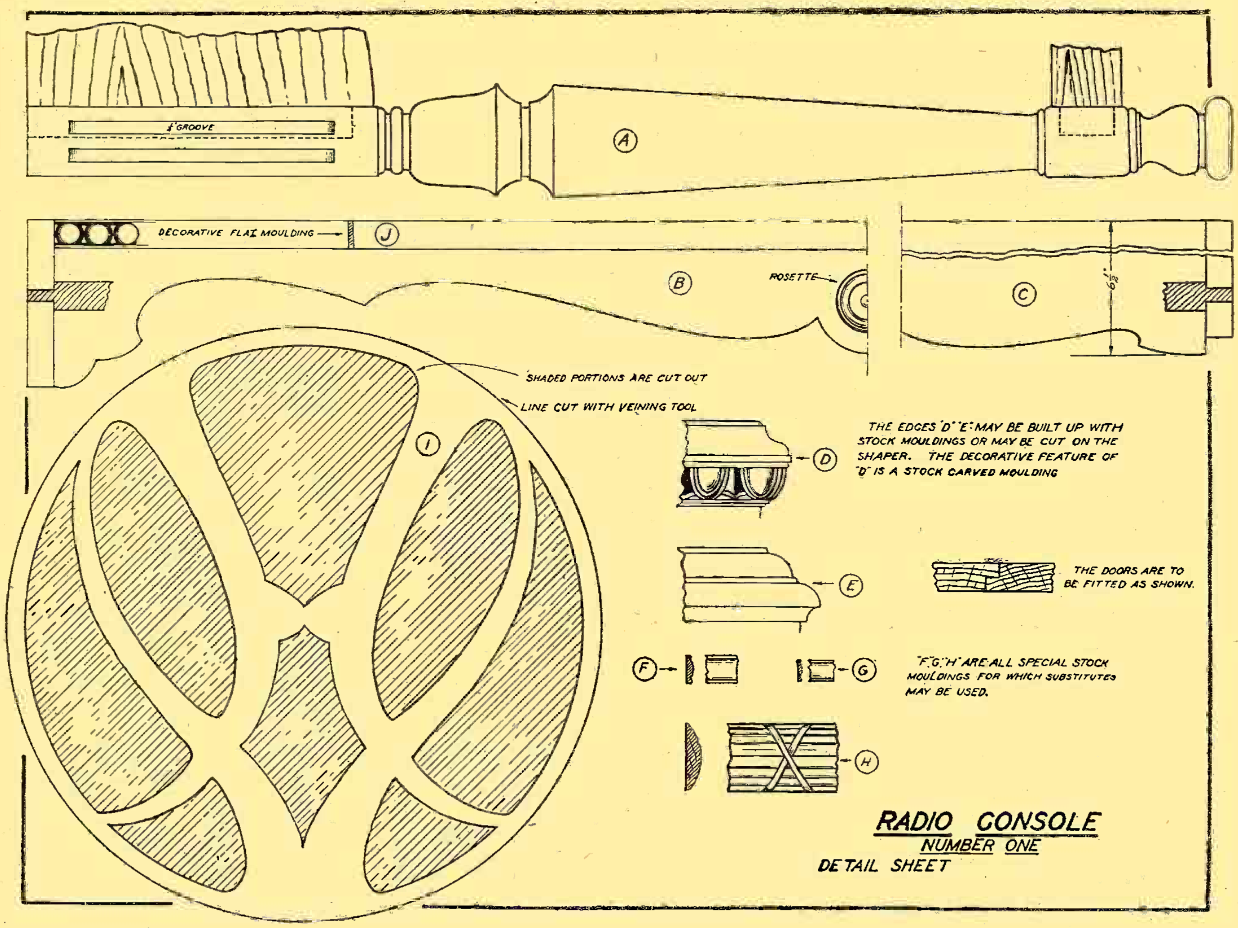
This cabinet was planned to fit a popular radio receiver and is suited to the average A.C.-operated set. It is suggested that one plan the radio compartment to fit his individual needs. If a home-built set is planned it should be made to fit the compartment; while, if a set is purchased, the size of the compartment may be altered to suit. The dimensions given will be found to be ample for most of the sets on the market.

The speaker compartment is of a size sufficient to care for batteries, if batteries are used, or for power units. Where neither is used, doors may open out to the front on either side of the grille, thus providing book space.

The grille should be cut out with jig saw or hand coping saw; after which the front panel slides into position in grooves already prepared for it. This front panel should be figured grained plywood. It is also reinforced with glued blocks; the moulding



Above, front and side elevations of the console, giving dimensions. The finished cabinet appears as shown in the picture at the top of the page; it will grace any surroundings.



is tacked and glued in place, forming the panels, and we are ready for the doors.

FINISH IMPORTANT

Since the doors are the most noticeable portion of the cabinet, the wood for these should be selected for its beauty, and matched figured-grain panels are recommended. They should be very carefully fitted, and hinges of the type illustrated should be used. If anything but plywood is used, warping is likely to occur. The moulding on the front completes the doors. The curved portion of this must be steamed before attempting to bend it.

As a final step in construction, the decorative mouldings should be tacked and glued in place to the front and ends of the table and cabinet tops. Great care should be taken to get carefully-fitted mitered corners.

The finish should be natural, if real mahogany or walnut, or stained first if a substitute is used. A good finish is essential for the good appearance of the console and great pains must be taken. A filler rubbed into the open grain should be followed by one or more coats of white shellac thinned down with equal parts of alcohol. This in turn should be followed by several coats of rubbing varnish; each coat should be rubbed lightly with sandpaper until the last, which should be rubbed with pumice stone and oil on a pad.

We have called this Radio Console Number 1. Next month we will give the readers of this magazine complete directions for constructing a cabinet for combined radio and phonograph, both using the same speaker and with an electrical pick-up on the reproducing machine.

This entire radio console can be built complete for from

$10.00

to

$15.00

depending on locality. It can be sold at a profit of from $20.00 to $30.00.

RADIO NEWS, until further published notice, will pay $50.00 for every constructional article used in POPULAR HANDIWORK Department; from which, however, articles of a strictly radio nature are EXCLUDED. The article must lend itself to blueprint purposes and, in order to be acceptable, it should preferably describe constructional work that has actually been done by the author.

Photographs showing the progress and completion of the work should accompany the manuscript. Complete drawings (showing all dimensions, material used, etc.) should be included.

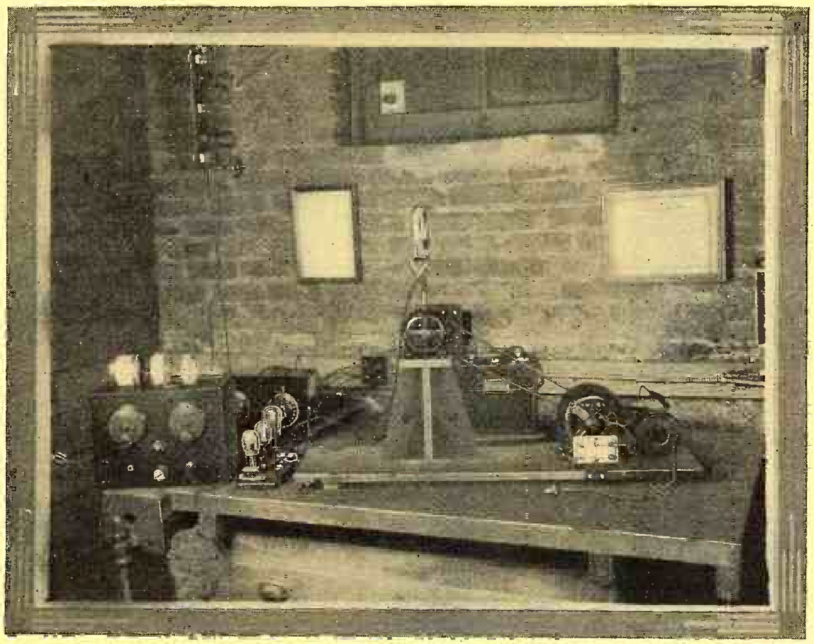
Address all communications to POPULAR HANDIWORK DEPARTMENT.

MATERIALS

Four legs, 2 x 2 x 21½ inches; turn by pattern given; grooved with circular saw, mortised for rails (A);
One front rail, ½ x 2⅜ x 30 inches (B); and
Two end rails, ½ x 6½ x 11¾ inches, cut to shape with band saw (C);
One egg and dart moulding, ¾ x 1 inch x 6 feet; if difficult to secure, another moulding may be used (D);
One moulding, ¾ x ¾-inch x 6 feet (E);
One moulding, ⅛ x ½-inch x 7 feet (F);
One moulding, ⅛ x ⅜-inch x 6 feet (G);
(These mouldings may all be hand-made, or purchased made-up.)
One moulding, special, ⅛ x 1⅛ inches x 4 feet (H);
One front panel, ¼ x 14¼ x 30¼ inches; with transfer designs (I);
One flat moulding, ⅛ x ½ x 38 inches, to face front edge of partition rails and front rail (J);
Two partition rails, ½ x 3 x 12¼ inches, running from front to back (K);
Two doors, ½ x 14½ x 22 inches, figured, matched-grain plywood (L);
Two tops, ½ x 14 x 32¼ inches, glued up from well-seasoned wood (M, N);
One shelf, ½ x 10½ x 30¼ inches, for speaker; the compartment on either side of the speaker may be utilized and doors opening from the front installed (O);
One support, ¾ x 1¼ x 30¼ inches, mortise into sides (P);

(Continued on page 967)

A "ham's" station, with receivers, transmitter and, latest of all, a television receiver in working order. The disc removed for this photo will be seen in that on page 942.



Anton Demikis, Jr., of Chicago, is the owner of this equipment. Among the ideas he is trying out is that of a coil of adjustable high impedance as a speed regulator on the television receiver.

Successful Television Experiments in the Home and Workshop

THE television apparatus illustrated in the photographs reproduced on this page is that constructed by Anton Demikis, Jr., a Chicago amateur (W9EYK) and operated by him with some success. A point of novelty will be found in the control of disc speed; the motor, which is not of the synchronous type, is coupled to a reactance coil (instead of a condenser, as in some models used for television).

Two receivers have been used in this work, to detect the transmissions from station WCFL, Chicago, and on W3XK, the Jenkins Laboratories in Washington. At the distance of the latter, however, fading was conspicuous on the 45-meter wavelength and, with signals at R-3 (new standard), satisfactory images were not obtained with a three-stage resistance-coupled amplifier. The local television, however, was received with good quality on a variety of receivers and with several types of amplification.

A high-quality six-tube commercial receiver, with two transformer-coupled audio stages, did not give an image equal to that obtained with three of resistance coupling and a short-wave receiver. This set, shown at the left in these views, was fitted with a plug-in coil for the broadcast band in order to bring in WCFL at 309 meters. (Behind it will be seen Mr. Demikis' short-wave transmitter.)

The circuit diagram of the apparatus (omitting the standard "B" power unit) is given. The output stage comprises a CX-310 with 450 to 500 volts maximum available from the unit; its output, and the consequent illumination of the neon television-lamp, are controlled by varying the grid bias, which may be as high as 80 volts. Phones are used to enable the operator to tune the receiver to best signal strength, as well as follow announcements made at the station in the interval between image broadcasts.

SYNCHRONIZING THE DISC

With the motor, which operates from the light line, loaded by the reactance coil, the voltage across it is 102; giving 920 revolutions per minute. With an iron plunger inserted into the center of the coil, the voltage may be reduced until the revolutions fall to 890. However, this method is still experimental, as it is difficult to obtain a plunger to work smoothly.

On the other hand, by friction it has been found possible to maintain an image "in frame" for a good period; pressure is applied lightly to the edge of the disc, whose speed is known to be slightly above standard. As the friction becomes more pronounced, the image will be seen to take form and move rapidly downward in its frame. A very slight increase of pressure, now applied, will fix the synchronism. If the image is divided, it may be restored

(*Continued on page 942*)

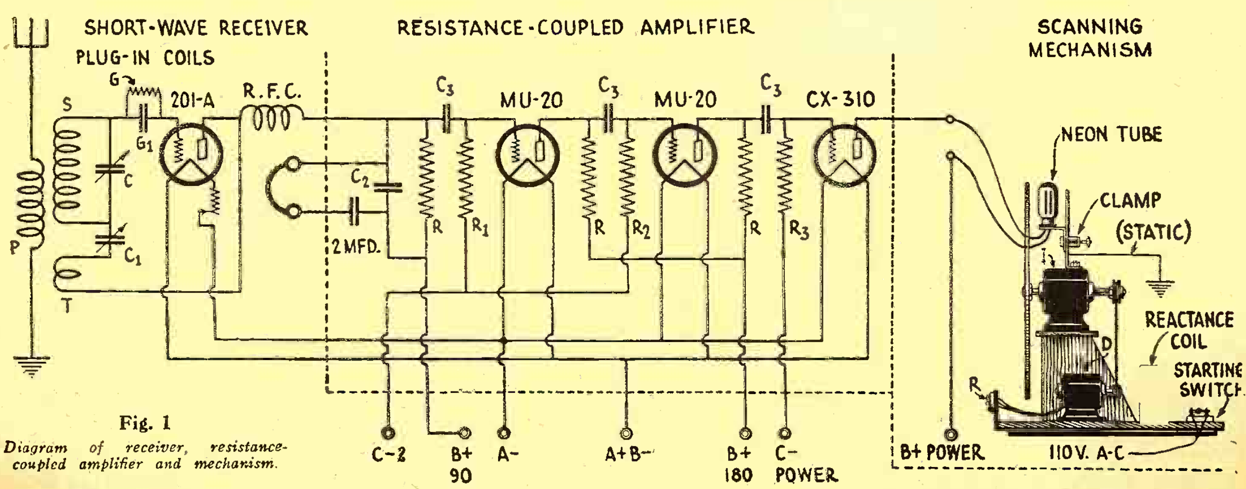


Fig. 1
Diagram of receiver, resistance-coupled amplifier and mechanism.

The "Home-Builder's Seven"—A "Super" Set*

A Receiver Meeting All Requirements and Which May be Built by the Constructor Himself in Largest Measure

By B. B. Bryant

THE development of modern radio receivers has been steadily toward a greater degree of complexity; and this, no doubt, has led many builders who are not in the veteran class to approach gingerly the job of constructing larger sets. The necessity of a high degree of selectivity, the desire for increased fidelity of reproduction and larger output, the vogue of all-electric operation, and the problem of producing a set to rival the appearance and performance of the commercial receiver—all these things have caused too many radio fans to forsake their hobby. Many still have the itch for distant reception but, while ready enough to undertake a four- or even five-tube job, are cautious about tackling the job of building a larger and more complicated receiver, even though the above desirable qualities are assured. Others find in ready-made, elaborate kits the possibility of building a powerful and finished-looking set in which the work of assembly has been reduced to a routine, but miss the pleasure of actually preparing the essential parts of the apparatus with their own hands.

With a view to the needs of several classes of both custom set builders and fans, the writer set about the task of designing a receiver of moderate cost (its merits considered) which should embody the desirable requirements listed above, be comparatively simple to build, and in which as large as possible a number of parts should be within the resources and skill of the home constructor to make for himself. After the construction of a series of five successful receivers, the somewhat simplified model described here was determined upon. While, if the directions are followed, it should equal in appearance and performance the finest of commercial receivers, only a few tools are required for the work—pliers, a wire-cutter, a hacksaw, a hand drill with a suitable selection of sizes, a hammer, screwdriver and soldering iron are sufficient.

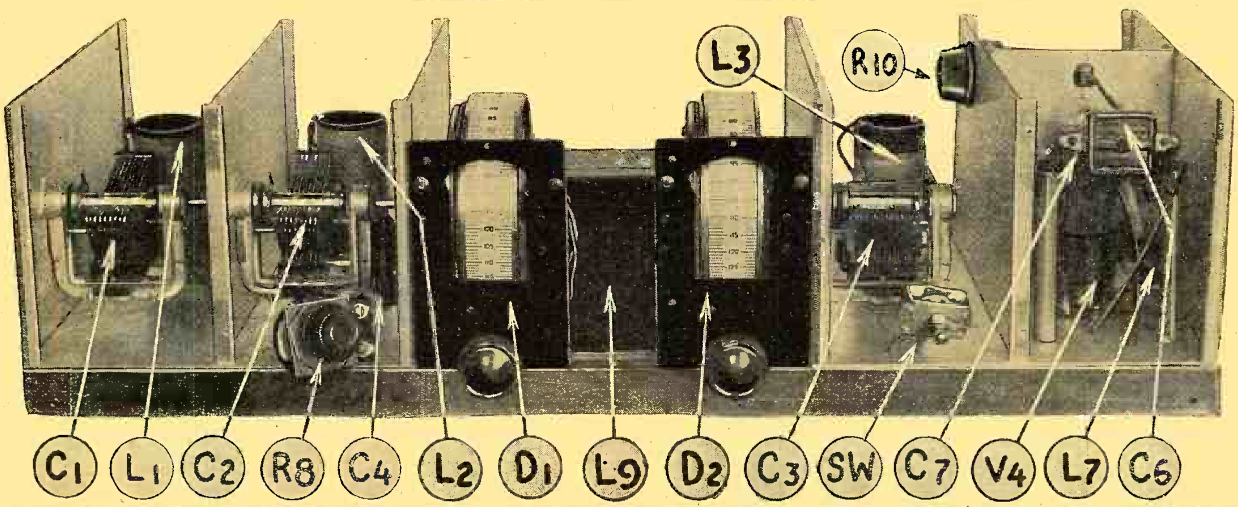
RADIO NEWS BLUE PRINT No. 78

"THE HOME-BUILDER'S SEVEN" is a superheterodyne set which has been designed especially for those who like to build their own receivers, as completely as possible. Its intermediate amplifier is a single screen-grid stage which, however, utilizes a new arrangement to increase its amplification until it equals that of nearly three general-purpose tubes; while an additional tuned R.F. stage before the modulator gives added selectivity now much needed. The quality also will be found eminently satisfactory to the most critical listener. In addition to the battery-operated set described here, an alternative circuit is provided, carefully worked out to give equal results with the convenience of A.C.-operation. In either model, this set will be found attractive by the custom builder as a receiver worthy of selection by discriminating purchasers who are willing to pay for quality, yet which can be produced by him with a low outlay for components. It presents also to the home builder a circuit giving high amplification, with excellent appearance and worthy of being housed in an attractive cabinet; but which will not be a task requiring more than a moderate amount of experience and constructive ability. Blueprints of large size have been prepared for the "Home-Builder's Seven," and may be had for the customary price of 25 cents, postpaid. A convenient order blank will be found on page 973. Specify No. 78.

THE CIRCUIT

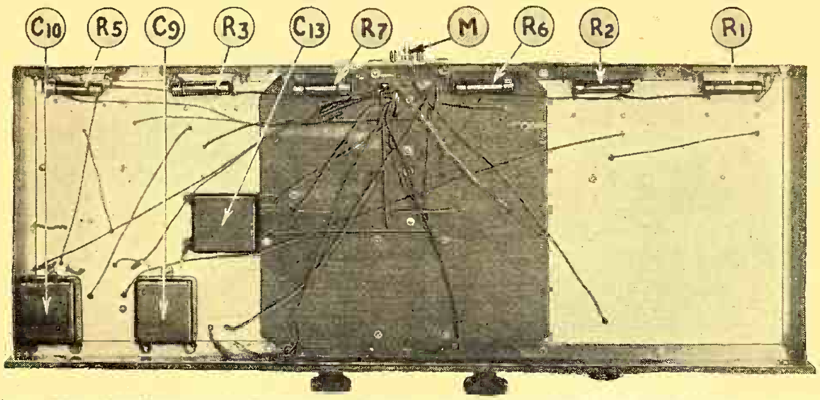
An inspection of the schematic diagram (Fig. 1) will show that three elements have been adopted in the system of radio-frequency amplification. The well-known and efficient Ultradyne frequency-converter, preceded by a tuned radio-frequency stage which is controlled by a plate resistor, is followed by a single stage of intermediate frequency (1,400 meters, or 214 kilocycles) in which, however, the use of a screen-grid tube gives a high degree of amplification. The regenerative detector following is used (with the peculiar arrangement which will be noted), not so much for the sake of added amplification as for the purpose of affording a suitable high-impedance load, required by the 222-type tube. A conventional two-stage transformer-coupled amplifier, with a 171A in the power stage, completes the hook-up, and provides sufficient amplification for any reproducer adapted to the home. The result thus obtained is great sensitivity, with selectivity enhanced by the additional tuned R.F. stage, and quality which does not suffer in the inductively-coupled intermediate band-filter. It will be found that more amplification is thus obtained than from the conventional superheterodyne circuit, in which a first-detector stage coupled to the antenna is followed by 201A tubes in three I.F. stages and a non-regenerative detector.

After some consideration, it was decided to feature here the circuit using direct-current (storage-battery) tubes; while, in order that those who prefer alternating-current operation may be able to proceed with that type of construction, an alternative circuit is given in Fig. 1A. The latter uses throughout heated-cathode or 227-type tubes, except an A.C. 22 in the I.F. stage and the power tube; the necessary alterations in the



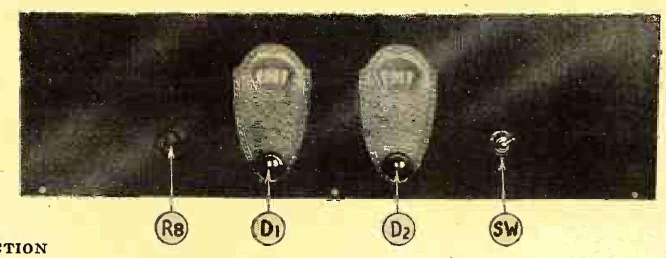
A front view of "Home Builder's Seven," with its panel removed and the shield cans partially disassembled, to show the simplicity of its construction. The first shield at the right is partitioned to screen the detector circuit from the intermediate-amplifier stage.

*Radio News Blueprint Article No. 78. (See page 973.)



The central sub-panel, of insulating material, and the bottoms of the shield cans on either side, carry the limited apparatus shown on the under side. The wiring which comes through should be carried direct from point to point, and be well insulated.

circuit and the values of the additional parts required are indicated in the diagram. On the other hand, those who adhere to D.C. set operation, whether from choice or necessity, will find the receiver first described highly satisfactory; while a good "A" unit will give equally convenient lamp-socket service with these tubes, and a "B and C" unit presents exactly the same features with either A.C. or D.C. tubes in the similar circuits shown.



The neatly balanced panel with its two illuminated vernier tuning dials, the volume control R8, and the switch.

MECHANICAL CONSTRUCTION

The use of a chassis, or metal frame, to support a receiver's parts, marks the third and latest stage of design in radio sets. The original "breadboard," used for convenience by the experimenter, was long kept in use even when hook-ups had become both more permanent and more elaborate. Yet it was in many ways inconvenient and inefficient because of the great lengths of wire required by the fact that all components were in one plane and it was necessary to loop and dodge the wiring about them.

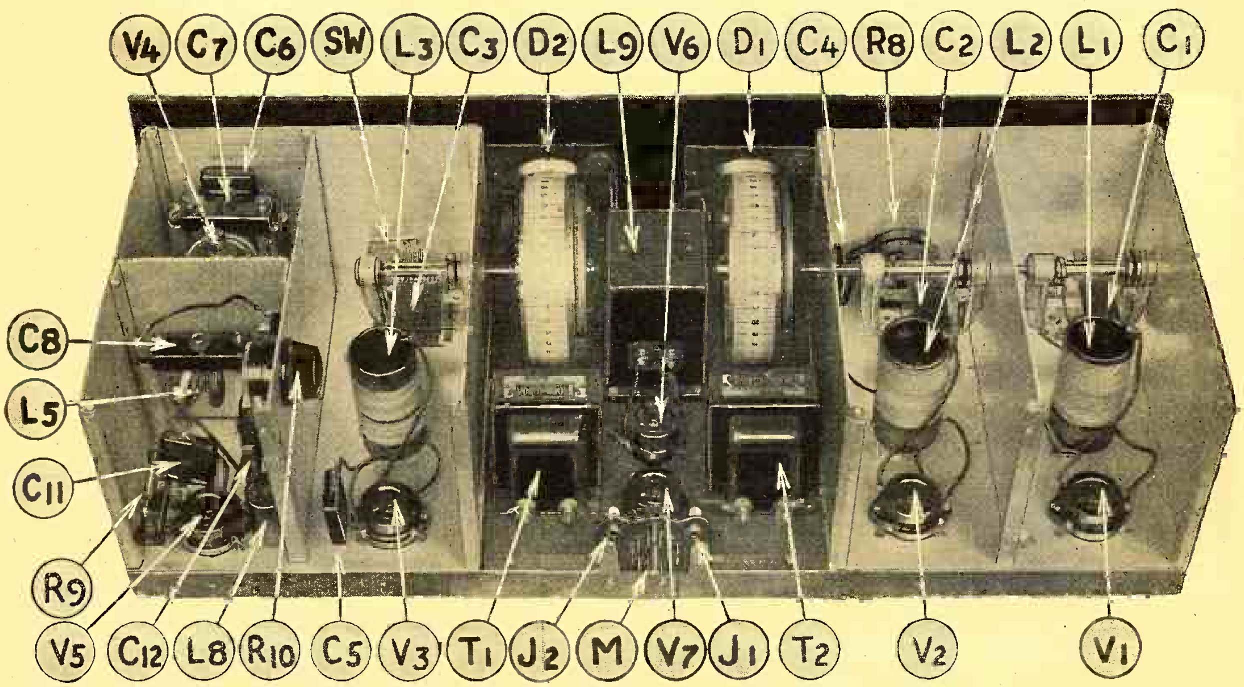
Complete insulating sub-panel mounting, the second stage, presented a great improvement in neatness, as well as in operation; because it made wiring more direct and gave greater freedom in the arrangement of components. It is, however, more costly, and requires much strengthening to present a good appearance and rigid construction.

The metallic chassis enhances at once appearance, firmness of assembly and, owing to its conductivity, ease of wiring. With the vogue of shielding all high-frequency stages, it has become almost necessary. As used in this set, the chassis may be made by the constructor with slight expense and labor, and will lend a professional touch to the assembly. The metallic shielding cans, needed by every receiver of high sensitivity under present-day conditions, add to the ease of wiring and form an integral part of the construction. The audio stages are supported by a small sub-panel, just sufficient in size to accommodate the necessary parts, which may be of metal or insulating material as preferred.

COMPONENTS NEEDED

Any equivalent components may be substituted in this circuit, with the exception of the four special coils used in the I.F. stage, detector circuit and the oscillator. The symbols appearing below and in the schematic diagrams, in connection with the respective components, correspond with those used throughout the text and illustrations. Those required are:

Two variable condensers, removable-shaft type, .00035-mf. (C1 and C2);
One variable condenser, .0005-mf. (C3);
Two semi-variable condensers, mica type, .0001 to .0005-mf. (C7 and C8);
Two mica fixed condensers, .001-mf. (C4 and C5);



The detector-intermediate amplifier compartments at the left contain the "heart" of the circuit. In the rear compartment are the detector components; in the front one, the intermediate transformer, L5, its compensating capacitor C8, the regeneration control R10, R.F. choke coil L8, and grid leak R9. The top terminal of the screen-grid tube V4 may be seen above the shielding.

Two mica fixed condensers, .0005-mf. (C6 and C12);
One mica fixed condenser, .00025-mf. (C11);
Two by-pass condensers, paper type, 0.5-mf. (C9 and C10);
One by-pass condenser, paper type, 1-mf. (C13);
One antenna coupler (commercial or home-made) to tune over broadcast band with .00035-mf. condenser (L1);
One R.F. transformer (commercial or home-made) to tune over broadcast band with .00035-mf. condenser (L2);
One oscillator coil, home-made (L3);
Four intermediate coils, home-made (L4 and L5);
Three R.F. chokes, 80-millihenry or more (must not be of smaller value) (L6-L7-L8);
One 30-henry iron-core choke coil (L9);
Five 1A amperites (R1-R2-R3-R5-R6);
One power-tube amperite (R7);
One 25-ohm fixed resistor tapped at 10 ohms for shield-grid bias (R4);
One 0- to 500,000-ohm variable resistor for volume and R.F. oscillation control (R8);
One 2-megohm grid-leak resistance and mounting (R9);
One 0-to 2,000-ohm variable resistor for regeneration control (R10);
Two audio transformers 2:1 ratio (T1 and T2);
Seven UX sockets—not more than 3/4-inch high (V1 to V7);
One 12-wire cable and terminal (M);
One filament snap switch (SW);
One bakelite panel, 7 x 24 x 3/16-inch;
Two aluminum double cans, size 8 3/4 inches long, 7 3/4 inches wide and 5 3/4 inches high, with two equal compartments (S1, S2);
One piece of sheet aluminum 4 1/2x5 1/4 inches;
Two drum dials, with knob immediately under scale (D1-D2);
Two cord-tip jacks (J1 and J2);
Two binding posts, aerial and ground;
Six feet angle brass, 1x1/2x1/32-inch, for chassis;
One piece of 1/32-inch aluminum (or 3/16-inch wooden board, hard rubber or bakelite) 8 3/4x9 inches, to form a subpanel support.
Ten-inch 1/4-inch brass shaft for condensers;
Two 25-foot rolls hook-up wire, single-strand push-back type;
Two lengths spaghetti tubing;
Four 1/2-inch wooden dowels, 3 3/4 inches long;
Screws, nuts and other small hardware.

CONSTRUCTING THE I.F. COILS

Most receivers of the superheterodyne type offer difficulty to the home builder in the construction of the intermediate transformers or coils. The construction of the coils L4 and L5 used in this receiver is simple and offers no difficulty. They are efficient and, while reasonable care is necessary, they need not be exactly the same. Exact matching of their inductance is not necessary; as two are adjustably tuned.

For their construction, a small form is required; this is made of three wooden discs held together by a screw as shown in Fig. 4. The wire is wound in the resulting slot. The central disc is 1 inch in diameter and 3/16-inch wide; the side discs are 1 1/2 inches in diameter and of such thickness as to be rigid. The central disc may be sawed from a broom handle. The side discs may be made from a cigar box and need not be round; three slots are sawed in them, at equal distances around their circumference; these slots should be 1/4-inch deep. A hole is drilled through the center of each disc. They are then assembled with the 1-inch disc in the center, and held securely together with a long 6/32 or 8/32 bolt and nut. After assembly the slots are aligned and a length of strong linen thread placed in each slot across the surface of the central disc; these are tie strings to hold the winding in shape when the form is taken apart.

Three coils are now wound, each with 200 turns of No. 32 D.S.C. or D.C.C. wire in the large slot. The ends of each tie string are then tied around the winding, after which the nut and bolt are removed. The side discs will now fall aside, leaving the tied winding with the central disc in the center. The latter is now pushed out, taking care to preserve the shape of the coil.

The fourth coil is made in the same manner, but with 75 turns of No. 28 D.S.C. or D.C.C. wire.

No particular care in winding the wire in the slot is used; as a matter of fact the greater the "scrambling" the better, as this will result in lessened distributed capacity. Highly distributed capacity would result in high resistance and broad tuning. When all the slot-wound coils are finished they are soaked in airplane dope or celluloid

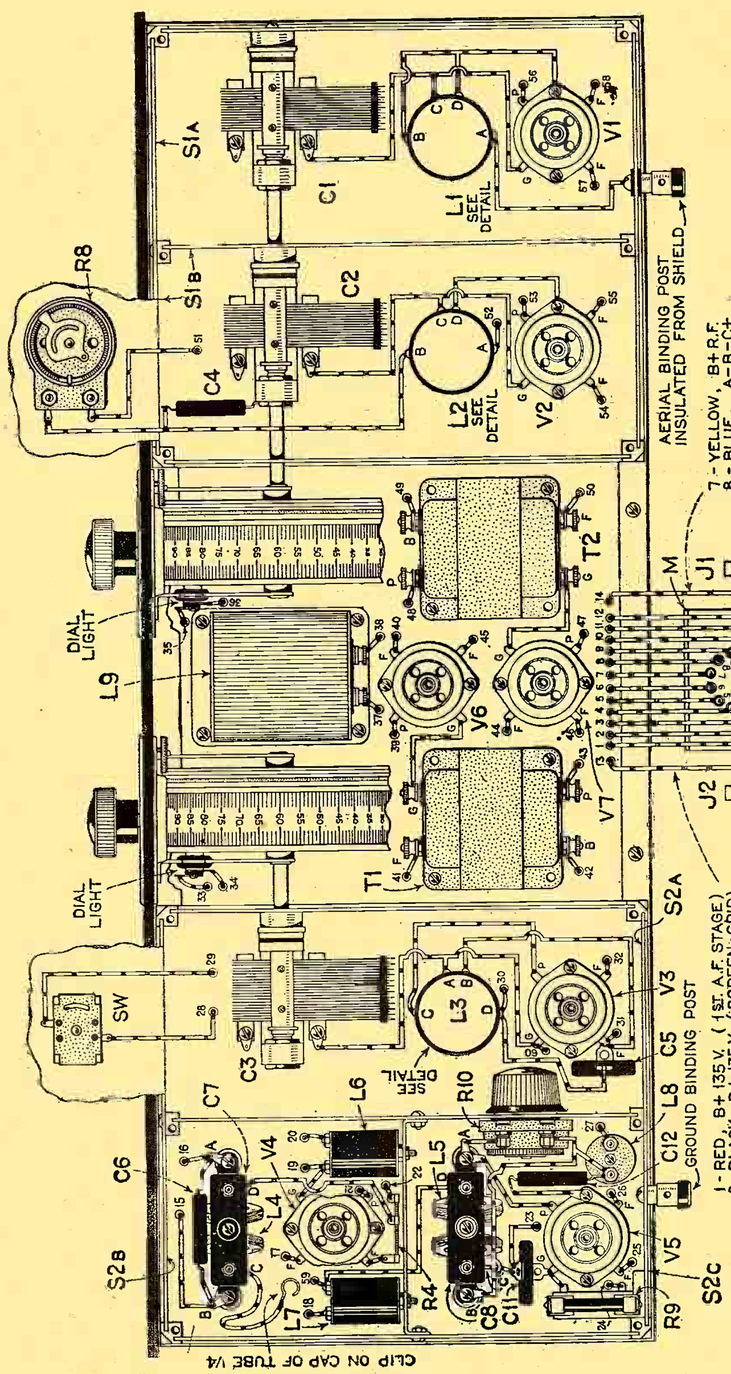


Fig. 2

cement; after removal they are pressed between two boards to remove the excess dope and to make them flat. They are then put aside until hard and dry.

ANTENNA, R.F. AND OSCILLATOR COILS

While commercial coils may be used for the antenna and R.F. couplers, they are easy to make. The secondary windings of L1 and L2 consist of 100 turns of No. 28 D.S.C. wire wound on pieces of 1½-inch tubing 3¼ inches long. The primary of L1 consists of 20 turns of No. 28 D.S.C. wire wound at the filament end of the secondary with a separation of ⅛-inch. The primary of L2 is wound in the same manner as the antenna primary, but consists of 30 turns of No. 32 D.C.S. wire. (See Fig. 5.)

A thick coating of airplane dope or celluloid cement is applied to these windings, and immediately wiped off with a clean cloth. When it is applied and removed in this manner, sufficient dope remains for protection and adhesion of the windings.

Terminals for connection are provided by drilling small holes around the base for anchoring the beginning and end of each winding. The insulation is scraped from the free ends of the windings, which should be left about 5 inches long, and looped several times through the small hole near the base. If done properly, this will provide a soldering contact ¼-inch long and 1/16-inch wide.

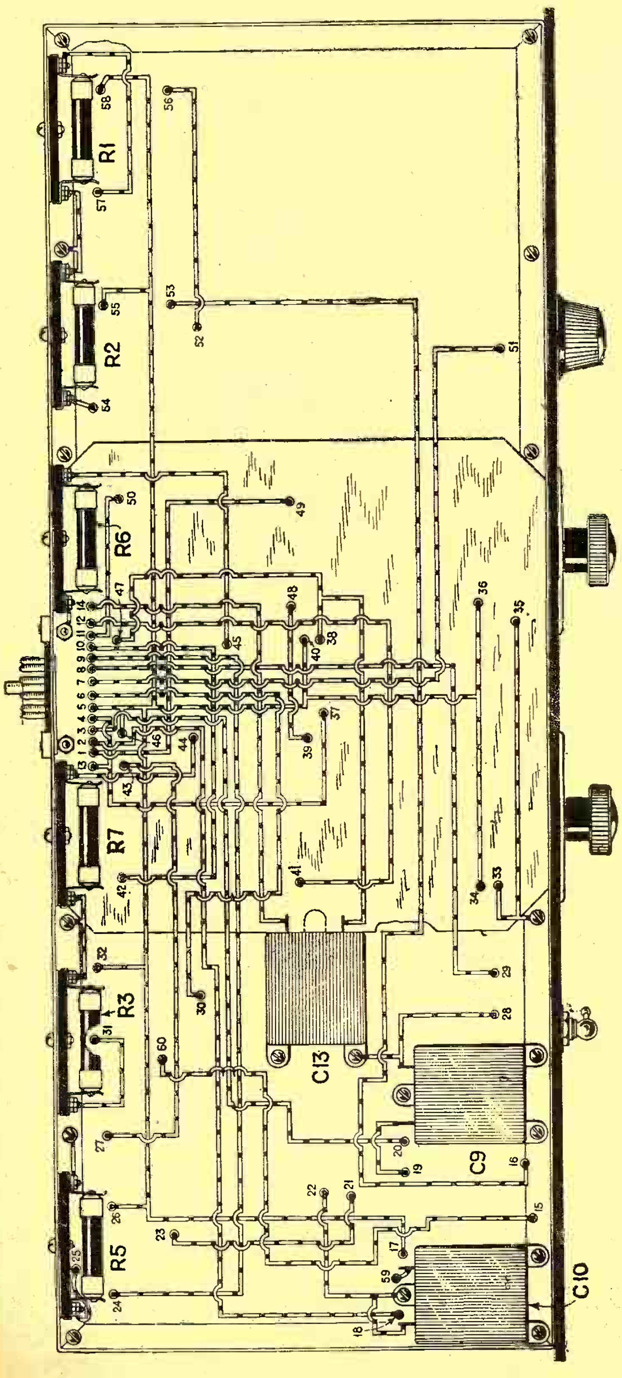


Fig. 3

The layout of all parts, and all wiring connections of the "Home-Builder's Seven," are shown in these two views, of the upper and the lower sides of the sub-panel and the two shields which support the apparatus. The wiring, though shown quite square here, is actually run in the most direct lines between its terminals. Holes are numbered correspondingly in both upper and lower views. The constructor who follows the usual precaution of crossing out each lead on these diagrams after its connections are soldered will avoid any possible error in constructing this receiver.

The oscillator coil L3 is made in the same manner. The secondary or grid coil consists of 48 turns of No. 28 D.S.C. wire wound on 1½-inch tubing; the plate or primary coil consists of 35 turns of No. 28 D.S.C. wire wound at the filament end of the grid coil. The windings are spaced ¼-inch; soldering terminals are provided as for the antenna and R.F. coils.

All the various windings are wound in the same direction.

MAKING THE CHASSIS

Six feet of angle brass 1 inch by ½-inch by 1/32-inch thick, is obtained. Measuring on one side from the center, points are marked at 11¾ inches, 20½ inches, 32¼ inches and 33¾ inches. On the other side from the center, points are marked at 11¾ inches, 20½ inches, 32¼ inches. The length is sawed off at the ends (at the 32¼-inch point and 33¾-inch point). The 1½-inch section next the 33¾-inch mark is sawed off on the ½-inch side, leaving on the 1-inch side a tongue 1½ inches long, for a lap joint. Right-angle wedges are now sawed out at the 11¾- and 20½-inch marks, also on the ½-inch side of the angle brass. The apex of each right angle should be directly on the points marked at the edge of the 1-inch width.

After the angle brass strip is prepared as explained above, it is shaped into a rectangular frame, 8¾x23½ inches, by bending at the apex of the "V" shaped notches made by the removal of the wedges. The tongue prepared for the lap is placed on the inside. The top of the frame, which is formed by the ½-inch side of the angle, is made to butt closely. While it is in this position, holes are drilled through the top angle and through the tongue. Screws are then inserted into the holes, nuts placed on the inside and tightened. The chassis is thus formed.

ASSEMBLY OF CANS

The bottom plates of the cans are now placed flat on top of the brass frame, with their sides even with ends of chassis frame. With a pencil, the positions of the holes in the can bottom are marked on the chassis. The points indicated are then drilled through to pass 6/32 screws, ½-inch long. The screws should extend through the can bottoms and should turn into the corner and center pillars of the cans.

The sides and front of the cans are slipped into their grooves temporarily; the 8¾x9-inch strip of aluminum, wood or bakelite is now placed in position in the open space of the chassis between the cans, fitted underneath the ½-inch flange, and fastened in position by 6/32 screws and nuts.

MOUNTING CONDENSERS AND DIALS

For mounting the variable condensers, four of the side pieces of the cans are drilled for ⅝-inch holes, at proper places. The condensers are now fastened to these plates with the large bushings provided, and the sides are now replaced in their regular positions.

The 10-inch shaft is placed through the two .00035-mf. condensers C1 and C2; it should protrude about two inches for the drum dial D1. The shaft of the .0005-mf. oscillator condenser C3 is made to extend out to the same length. After loosening the set screws of the hollow shafts of the drum dials, D1 and D2, they are slipped

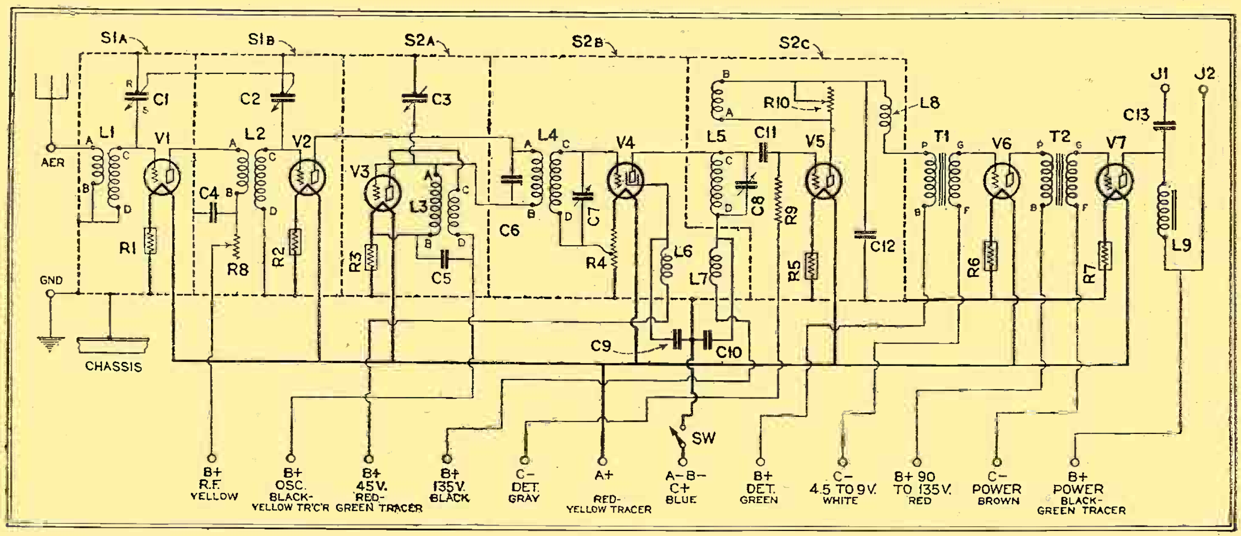


Fig. 1

The circuit diagram of the "Home Builder's Seven" for use with D.C. tubes. The changes necessary to adapt it to A.C. tubes can be determined readily from the corresponding diagram, Fig. 1A, on page 968. The shielding used saves much of the wiring.

over the extended shafts of the condensers. The edge of the drum-support frames should be flush and against the edges of the cans. Mark on the chassis positions of the holes in the turned-over edge of the drum-support frame, and drill holes for 6/32 screws. Pass the screws through holes of the chassis and fasten the frames of the drums rigidly to the chassis; after which all set screws of the condensers and drums are tightened.

The choke L9 is now placed in position at the front edge of the chassis between the drums, and the audio transformers T1 and T2 are fastened in position back of the drums, close to the sides of the cans. This leaves a rectangular space in which the two audio sockets, V6 and V7, are equally spaced and fastened to the sub-panel. In the exact center of the rear edge of the chassis frame, the cable-plug receptacle is mounted. The cord tip jacks J1 and J2 are then put in the holes provided on the cable terminal.

MOUNTING THE COILS

L-shaped brackets, 1¾ inches long, are used to mount the antenna coil L1, the R.F. coil L2 and the oscillator coupler L3. After the brackets have been fastened to the coil forms as shown in Fig. 5, the coils are mounted in their respective shield cans; L1 in S1A, L2 in S1B, and L3 in S2A. When mounting the coils, sufficient space must be left for the socket and tube at the rear of each compartment; the sockets in these three compartments may be mounted at this time.

Mounting of the I.F. coils is equally simple, although care is required. The ½-inch dowel is now cut into 3¾-inch lengths. Small holes are drilled, ½-inch in depth, in the exact centers of their ends. These are for the wood-screws used in mounting the semi-variable condensers.

Most small semi-variable mica condensers have two holes, provided for fastening to the baseboard. On the under surface of the molded bases are seen the flat heads of the condenser's terminal screws. To these heads are soldered the flat heads of 6/32 brass screws, 1-inch long. Four bakelite strips ⅛-inch thick and ½-inch wide, are cut to such lengths that, when holes are drilled near their ends, they will slip loosely over the screws. These pieces serve as clamps for the special coils already described.

To assemble, one strip is placed over the screws and the coil is held in position while another strip is passed through its center and slipped into place over the screws; nuts are then screwed down over the clamping strips and tightened until the coils are held firmly in position. Care should be taken that the windings are placed so that they run in the same direction.

The entire assembly as shown in Fig. 5 is fastened to the bottom of its respective can compartment (S2B and S2C) by passing wood-screws through the metal bottom and screwing them into the lower ends of the wooden dowels.

FINAL ASSEMBLY

The sockets are placed in compartments S2B and S2C as shown in Fig. 2; after which the partition is placed in position and the positions of holes for mounting the chokes are marked. One hole for the "B+135" lead to the I.F. plates is drilled above the choke L7; the partition is re-

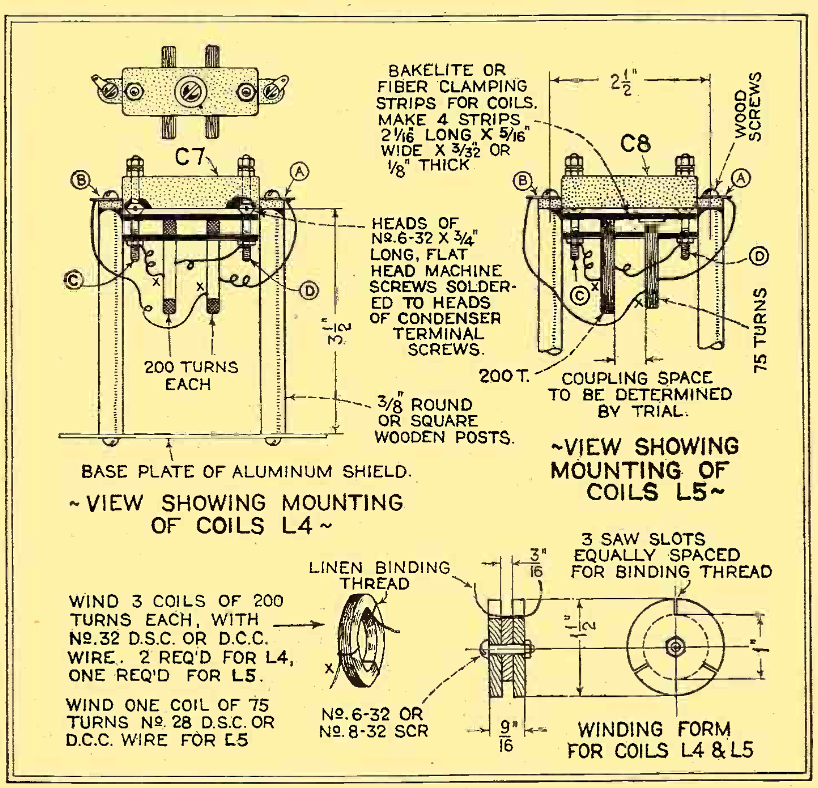


Fig. 4

The details for making and mounting the 214-kc. intermediate transformers required.

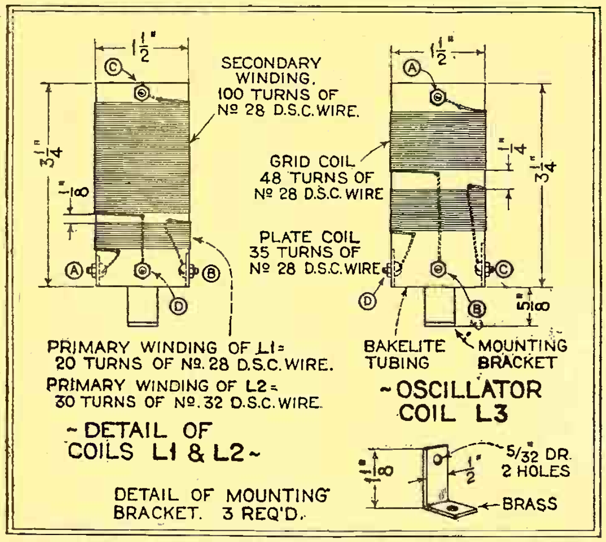


Fig. 5

Data for construction of the two R.F. coils and the oscillator coil of the "Home-Builder's Seven"

moved and the chokes L6, L7 and L8 are mounted in their respective positions.

The holes for mounting the volume control R8; the regeneration control R10, and filament switch SW are marked and drilled in the can fronts and the central partition of the S2 can (the latter for R10). The can fronts and partition are again placed in position, and the respective parts are mounted; care should be taken that R8 and R10 are insulated from the cans, as otherwise a short will result.

The by-pass and output condensers C9, C10 and C13 are fastened into the positions as shown in Fig. 3. At this time the amperite holders are mounted on the inside of the vertical section of the chassis frame as shown. The element R4 is soldered to the "A—" prong of the socket in compartment S2B, as shown in Fig. 2. The vertical grid leak mounting is fastened to the back of S2 in compartment C; conveniently close to the detector socket. The grid condenser C11 is soldered to the socket "G" terminal of V5 at the same time the lead of the mounting is soldered.

WIRING AND ADJUSTMENT

Wiring of the receiver is simple. The method recommended is that of "point-to-point," marking out the lead on the wiring diagram when the connection on the set is completed. When passing each lead through the hole drilled in the bottom of the cans for that purpose, a ¾-inch length of spaghetti tubing is slipped over the wire and through the hole. This procedure will prevent abrasion of the wire by the cans and possible short circuits.

For those who prefer to wire from the schematic diagram (as the writer does) it is recommended that all grid leads, plate leads, grid returns, plate returns, "A+," "A—," and the remainder of the connecting leads be wired in the order given.

After the builder has tested the various circuits for shorts and is sure that everything is in perfect order, the various tubes are placed in their proper sockets. A tube of almost any type may be used at V5 as a special bias lead is provided; in a great many cases, locals will be of such strength that overloading the detector can be prevented only by the use of a negative bias, resulting in plate rectification. Otherwise, on distant stations greater sensitivity and volume will be obtained by the grid-leak-and-condenser, or grid-rectification, method.

When the tubes are in their sockets, the cable M, which previously should be connected to the "A," "B," and "C" supply, is now plugged in. The aerial lead-in and the ground wire are connected to their binding posts, and the speaker cord tips to J1 and J2.

The filament switch SW is turned on and, while rotating the drum D1 slowly over the scale, the drum D2 is worked back and forth over its scale until a signal is heard. If possible, a signal should be selected at a condenser setting that will allow the builder access to the set screws C1 and C2, which may now be loosened. Slowly turn the rotor of condenser C1 until the signal is loudest. Keeping this preliminary adjustment, the adjusting screws of condensers C6 and C8 are adjusted in turn for loudest signal strength. After this adjustment, regeneration in the detector circuit may be too great. Regeneration control is obtained by adjusting R10 to a point just under sustained oscillation of the tube, or until the audio beat-note disappears and the signal becomes loud and clear. The controls D1 and D2 are now readjusted. When tuned to a station, the R. F. stage V1 should oscillate; if it does not, readjust the rotor of C1. Should the aerial be too long, or if the signal is from a powerful local, it may prove difficult to make the R.F. stage oscillate. In this case, the aerial should be

(*Continued on page 967*)

RADIO NEWS BLUEPRINTS

New Terms of Our Offer to Readers

(*Read This Before You Write*)

BEGINNING with the publication of RADIO NEWS for March, we announced a new policy with respect to the distribution of blueprints to our readers. A charge of 25 cents for each set furnished will be made; the filling of this order will be expedited by using the coupon printed on page 973 of this issue.

This will apply to all blueprints (from No. 52 up) issued by RADIO NEWS, except those called for by the Free Blueprint Coupons printed in our December, 1928, January and February, 1929, issues; these will be sent free, in exchange for these coupons, *until our present stock on hand is exhausted*. All other blueprints which we have issued in our free distribution series will be charged for at the rate of 25 cents a set. (Those made up prior to April, 1928, were produced by a more costly individual process and cannot be furnished at the above price.)

We believe that our readers are entitled to a frank explanation. During the past year we have distributed to them more than 68,000 blueprints—over 12,000 of the well-known "Junk-Box" alone. This has necessitated frequent reprints of the blueprints, and the maintenance of a large staff whose time is given up to this alone. The postage bill has been very large, as may be imagined. As RADIO NEWS has no apparatus for sale, it cannot recoup the outlay in this manner, like a manufacturer who sells kits at from $20 to $200. The price which we have established, 25 cents, is our average cost of a set of blueprints—a low figure obtained only by quantity production. The free distribution has entailed a huge expense, which has increased from month to month; and there is no doubt that thousands who are not regular readers have been taking advantage of it.

We have therefore decided to charge a uniform price of 25 cents for each set of blueprints; not with the expectation of making any profit from them, but with the intention of breaking somewhere near even. Those desiring previously-issued blueprints, not specified in any of the three "Free" coupons we have mentioned, must send this sum with their orders; which will be filled more promptly if the form printed on page 973 is used, as we have said. Other requests will not be supplied; nor will our "I Want to Know" department send any longer free hook-ups, diagrams, or other circuit information by mail.

We have said many times before that we have *no blueprints of commercially-manufactured apparatus for sale at any price;* nevertheless, ten or fifteen letters asking for them are received every day. Neither can we furnish blueprints to use the particular set of parts the constructor has in mind; it costs several hundred dollars to prepare a set of blueprints; and we cannot undertake to do this to order for a nominal sum.

We shall, however, continue to issue blueprints of sets of our own design that will, we think, appeal to our readers; and to publish full circuit and wiring diagrams in the pages of RADIO NEWS, as we have done. Those of our readers who wish, in addition, full sized blueprints of these sets may obtain them by sending in a Blueprint Coupon with 25 cents for each set requested. This applies to Blueprints Nos. 78 and 79, the "Home-Builder's Seven" and the "Space-Charge Autodyne," published in this issue, and to all later sets for which blueprints will be prepared.

The "Space-Charge Autodyne"

A Short-Wave Receiver Employing the High Amplification of Screen-Grid Tubes in Both Detector and R. F. Stages

By Joseph Riley

Fig. A

The compactness of the receiver is evident by comparison with the tube beside it. Yet, with the layout given, it works perfectly. Plug-in coils like that at the right are used.

THIS receiver has many features which will recommend it to the constructor who has become interested in the remarkable possibilities of short-wave work. It is very efficient, very compact, draws very little battery current; and is well adapted to the use of those far from the cities. But, while it is just the set you would want to take to a desert island, it is also a set to give maximum satisfaction in a big city. Completely shielded, it is very sensitive to signal pick-up, and produces very high amplification through its two 222-type tuned stages. It is capable also of loudspeaker output with its 120-type power tube.

RADIO NEWS BLUE PRINT ★ No. 79

IMPROVEMENTS in design of short-wave receivers are not unlike those which we look for among sets covering the broadcast range. Previous to the inception of short-wave broadcasting, when the channels below 200 meters were used solely for the transmission of code, little attention was paid to the tone-quality factor of an audio-frequency transformer in a short-wave receiver. If it amplified, that was sufficient for the experimenter or the transmitting amateur who desired nothing more in a receiver than ability to reproduce readable dots and dashes. If they happened to be received slightly off-key, the operator was unaware of this musical discrepancy, which was, after all, utterly unimportant. Signal intensity was the one and only goal.

However, with the advent of short-wave broadcasting, faithful reproduction is becoming as desirable on the high-frequency band as it has become on the broadcast channels. Whereas code reception required nothing more than a definite degree of amplification, it was found that such amplification was practically of little avail if it aided the phones or speaker only to reproduce a blurred mess of unintelligible syllables. And so faithful reproduction of short-wave broadcasts became an absolute necessity.

Similarly, a change in the design and layout of a short-wave receiver has been found essential for the benefit of the broadcast listener who, while desirous of lending an ear to short-wave radiations, finds that his limited knowledge of technical radio somewhat hinders him in entering the new field. The earlier types of short-wave receivers were acceptable to the transmitting amateur; for the simple reason that he knew what it was all about, what he wanted, and required no technical guidance in laying out and designing his own receiver to suit his own needs. As a rule, his set was spread out, bread-board fashion, and possessed a multitude of controls of which only he knew the idiosyncrasies.

Today, the short-wave receiver must be compact, easily controlled and operated, must be sufficiently sensitive to answer the needs of very distant reception, should not offer too difficult a constructional problem to the beginner, and must be capable of reproducing voice broadcast with a fair degree of fidelity.

THE "SPACE-CHARGE" DETECTOR

A short-wave receiver meeting these qualifications has been assembled in the Radio News laboratories and is herewith offered to the broadcast listener who desires a separate receiver for his short-wave travels into far countries; so that the rest of the family may enjoy their programs in peace.

Its tuning circuit is somewhat similar to that of the "Copper-Clad Special" (which was described in the February issue of

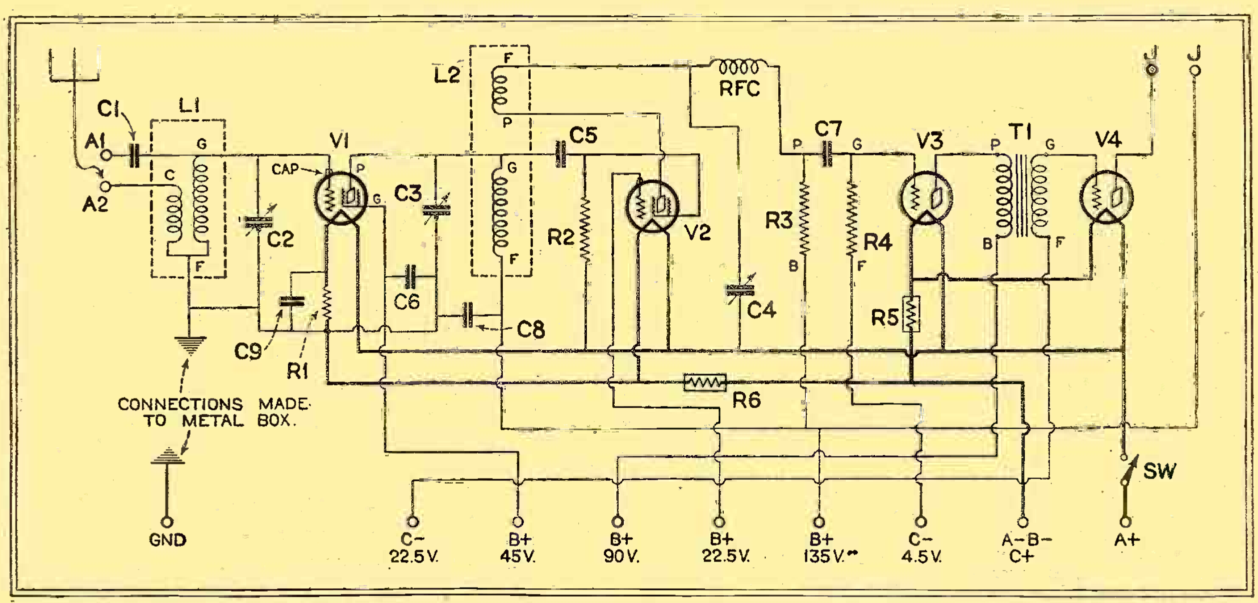


Fig. 1

The circuit diagram shows clearly the distinctive point of its operation—the screen-grid detector tube V2 has a "space-charge" on its control-grid which enables it to function as an oscillator, giving very high amplification under control.

* Radio News *Blueprint Article No. 79.* (*See page* 973.)

RADIO NEWS) in that it comprises a screen-grid tube in a *tuned* stage of radio-frequency amplification preceding a regenerative detector; however, in place of the usual 201A-type tube in the detector socket, another screen-grid tube (222-type) is employed. The additional sensitivity obtained from the use of this four-element tube, in place of the conventional "triode," amply repays the constructor for the difference in the initial cost.

Before proceeding any further, it might be best to glance at the circuit diagram of this receiver and note the difference in hooking up the two screen-grid tubes even though both are identically the same type.

It will be noted that the first screen-grid tube, V1, is wired in the usual manner called for when this tube is employed as a radio-frequency amplifier; that is, the inner control-grid (which is connected to the metal cap on top of the bulb) functions just as does the grid in the triode. In this circuit, the tube is functioning in the customary manner. The outer or screen-grid is connected to a positive potential of 45 volts. As the prong of the second grid makes a connection to the usual grid contact in the standard UX socket, care should be taken to avoid the possible error of thinking this post to be the regular control-grid and wiring accordingly.

However, on observing the wiring of the screen-grid detector, V2, we find a reversal of the grid connections; that is, the grid which has a metal cap is connected to the positive potential of 22½ volts, and the grid leading to a prong in the tube base is wired to the plate of the preceding radio-frequency amplifying tube. In other words, the connections at the socket terminals are those of the usual detector, except for the 22½-volt potential on the metal cap. When functioning in this capacity, the screen-grid tube acts as a "space-charge detector."

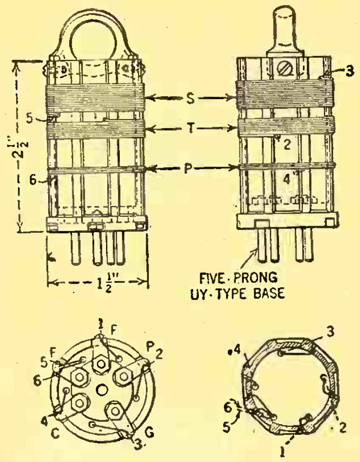
These differences should be carefully noted; so that there be no errors when wiring the receiver.

LOW VOLTAGE REQUIREMENTS

Following the detector are two stages of audio-frequency amplification; the first, using a 199-type tube and resistance-coupled, is followed by a stage of transformer-coupling employing a 120-type tube. This may serve to bring up another feature of this receiver; because of the low filament-voltage demands of the screen-grid tubes, it is possible to operate the set with either dry-cells or, if the constructor desires, a storage battery.

As specified in this article, the receiver functions with dry cells; however, in order to change over to 5-volt tubes (it is desirable to change only the two audio-frequency tubes), it is necessary merely to substitute the proper amperite, and, of course, substitute a storage battery for the dry cells.

Incidentally, the dry-cell feature makes this set ideal as a portable for the traveller, camper or tourist; employing the smaller type of plate batteries, it is possible to pack all the necessary batteries into a box no larger than the receiver itself.



COIL	WAVE LENGTH RANGE MIN	WAVE LENGTH RANGE MAX	PRIMARY TURNS	SECONDARY TURNS	TICKLER TURNS	SIZE * WIRE
A	17	30	2	3½	5	24 D.S.C.
B	30	52	2	7	9	24 D.S.C.
C	48	105	3	18	10	24 D.S.C.
D	93	203	4	44	17	24 D.S.C.

* SAME SIZE WIRE USED ON ALL WINDINGS

Fig. 3

Plain tubes may be used, or the ribbed forms obtained, with or without windings as shown.

COMPONENTS

The following parts make up the receiver:

Two midget variable condensers, .0001-mf. (C2-C3);
One A.F. transformer, 6:1 ratio (T1);
Four UX and two UY (5-prong) sockets;
One resistance coupling unit (incorporating R3-R4-C7);
One R.F. choke coil, 1½-millihenry (RFC);
Two amperites, ¼-ampere type (R5-R6);
One variable condenser, compression-type, .00025- to .001-mf. (C4);
Two sets of short-wave coils, five-prong plug-in type, to cover from 17 to 230 meters (L1-L2);
One 2-megohm grid-leak with mounting (R2);
Three fixed condensers, .006-mf. (C6-C8-C9);
One fixed condenser, .00025-mf. (C5);
One resistor strip, 10-ohm (R1);
Two bakelite vernier dials;
One filament switch (SW);
One shield-can, aluminum, 8½x7¾x5½ inches, with dividing partitions;
Two pin-tip jacks (J-J);
Three binding-posts, bakelite top (A1-A2-G);
Two test clips for screen-grid caps;
Two screen-grid tubes, 222-type (V1-V2);
One vacuum tube 199-type (V3);
One vacuum tube, 120-type (V4).

While the layout of this receiver was being planned it was found that a manufactured shield-can made an ideal combination cabinet and shielding arrangement for the receiver; the one chosen is of the knock-down type. When assembled, it makes up a very good-looking shield (or, in this case, cabinet), measuring 8½x7¾x5½ inches; there is no danger of bending or denting the sides of the "can" as heavy aluminum is used in its assembly. The constructor who desires to assemble his own shield unit is strongly advised to use heavy stock so that no trouble be experienced when mounting the components; this is especially important for the section of the

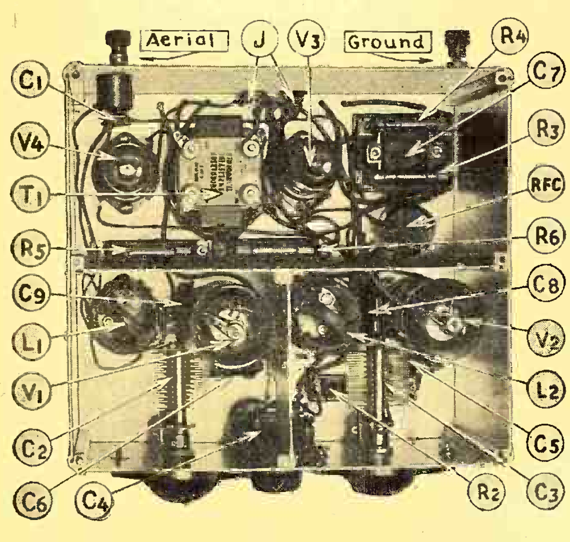


Fig. B

The "Space-Charge Autodyne" from above, showing the compact layout inside the compartments. Care is necessary to make everything fit.

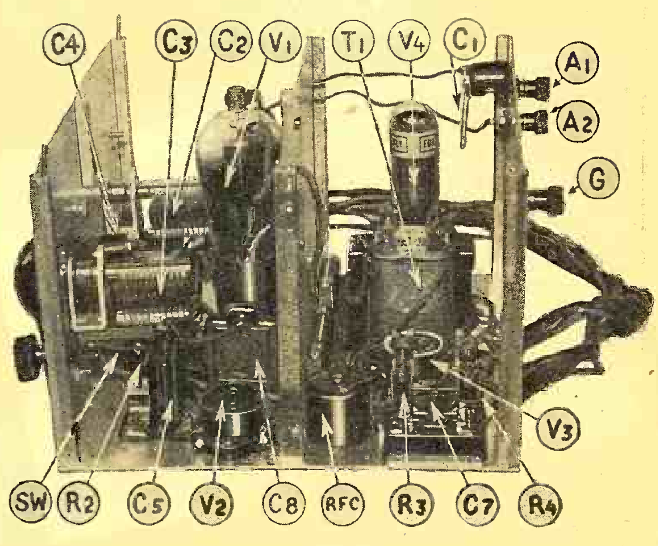


Fig. C

Another view of the receiver, without the sides of the shielding cans, showing more fully the placement. Note C1, at the upper right.

shield upon which are mounted the tuning dials, the filament switch and the oscillation condenser.

Of course, the builder need not adhere to the shield specifications given here; as with many other home-built receivers, the layout of this one may be altered to confirm with the ideas and the material of the constructor; providing always that proper shielding is employed and the circuit diagram followed.

ASSEMBLY

The first step in the construction of this set is to lay out the bottom section of the shield; before drilling any of the mounting holes for the components it is advisable to assemble the entire shield, including partitions, and draw pencil lines along the bottom section to indicate the position of the partitions. This should be done to prevent the mounting of a socket in a place later to be occupied by a partition.

(*Continued on page 948*)

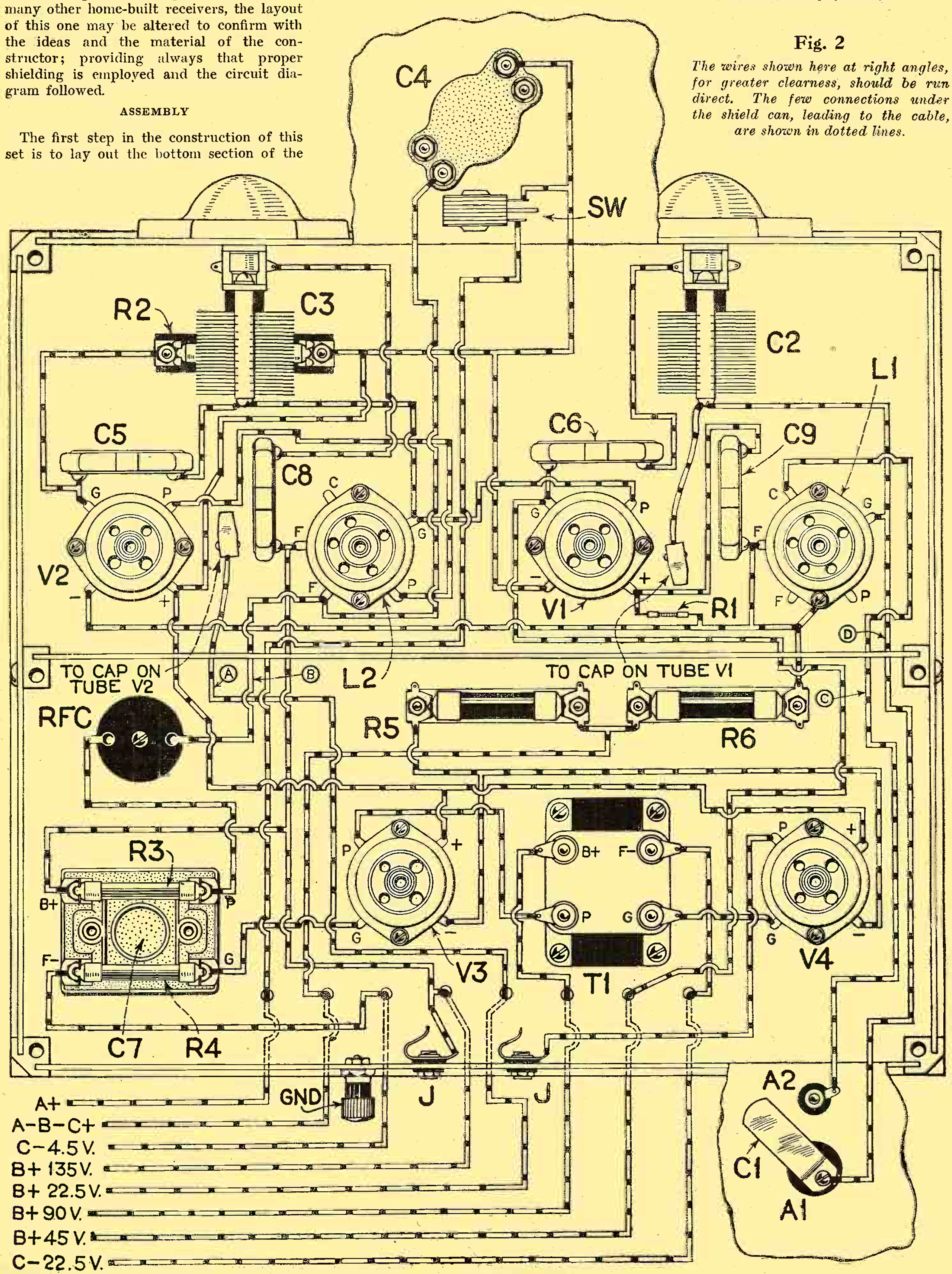
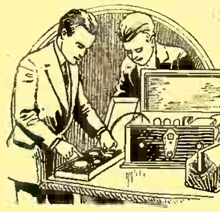


Fig. 2

The wires shown here at right angles, for greater clearness, should be run direct. The few connections under the shield can, leading to the cable, are shown in dotted lines.



The Service Man

How to Locate Interference

Editor, Radio News:

Can you supply information regarding a hook-up or instrument for "trouble locating?" We have all kinds of noises in our sets here and as the city (which owns the power service) does not seem to care, we are trying to work out a portable set that will locate some of the trouble.

G. R. McClure,
McPherson, Kansas.

Radio dealers and servicemen in all parts of the country continually encounter cases of interference from local electric apparatus, defective power transmission apparatus and lines, radiating radio sets and other sources. The construction of a small radio set which will help locate these noises should be of interest to a great number of custom set builders, radio clubs and dealers, and for this reason, we print the diagram and constants of such a set (Fig. 2).

It consists of one R.F. stage, a detector and one A.F. stage. The "noises" are picked up by a small loop coupled to the input to the radio amplifier. The other apparatus in the set, including the battery supply, is enclosed in a metal shield, to prevent pick-up through this apparatus, which would spoil the directional effects of the loop.

The operation of the "noise finder" is as follows: It is carried by hand or transported in an automobile to the general neighborhood of the source of interference. The loop is then rotated and the set tuned until the interference is picked up with the greatest volume. The direction of the loop is noted and the set is moved to another position; the experiment is then repeated. Three positions at a sufficient distance are usually sufficient to find the location of the offending apparatus. This method of locating the source of the interference is known as "triangulating" and is very similar to the systems used for locating the exact positions of ships with direction finders (See Fig. 1).

The actual construction of the set is not very difficult. The tubes are of the dry-cell type such as 199s; the use of these allows the complete unit *including the batteries,* to be enclosed in the metal shield. The latter is made of copper or aluminum and is just large enough to hold all of the parts. The values of the condensers and resistors are shown on the diagram; the transformer should have a ratio of 3 or 4 to 1. The R.F. coil is either home-constructed or may be purchased for the purpose. If it is desired to simplify the receiver, an untuned transformer (such as those employed several years ago) can be used in place of the coil and tuning condenser in the detector grid circuit.

The tuned R.F. coil (if one is used) may be made by winding a primary of about 15 turns of No. 24 D.C.C. wire and a secondary of 75 turns of the same wire on a tube 2 inches in diameter and 3 inches long; about ¼-inch is left between the two windings.

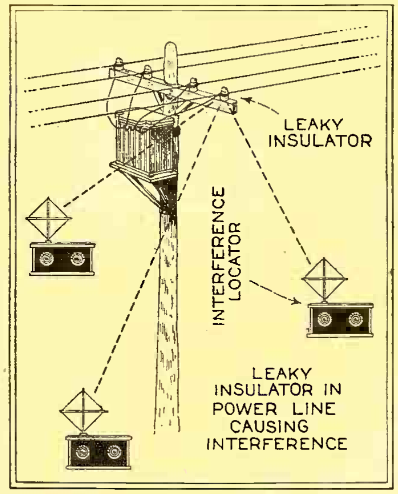


Fig. 1
The loop indicates the direction of noises.

When the interference has been located, it is sometimes difficult to determine just what piece of apparatus or circuit is causing the trouble; and an analysis of the sounds produced by different types of apparatus will help solve this problem. A steady howl is usually caused by a radiating receiver. A rapid and steady clicking noise is often caused by a vibrating-armature battery charger or other electric apparatus with vibrating reeds for opening or closing circuits. (The electric bell is one example of this type of apparatus.) Intermittent rasping and crackling noises may be due to defective insulation or loose connection in power lines, or they may be "static" caused by natural means. A more or less steady crackling noise may also be caused by an arc light or some medical appliances; while a rapid whirring noise or, in some cases, a hum may be caused by a generator or motor in the neighborhood. Crackling noises repeated at regular intervals are often caused by electric-sign flashers. Noises encountered only for certain periods of the day or night

"SERVICE MEN" have problems just like those of every home builder and experimenter, and others which are very different; because every day they are called on to work over receivers and apparatus built by other people, and about which they have not the necessary data. A good service man must be a regular Sherlock Holmes; he has to find clues and solve mysteries by putting two and two together to make five.

While the general information for constructors carried in Radio News is of actual or potential value for the service man, a large part of his work goes outside of this field. He has to deal with sets and apparatus which other people have built; and has often no way of getting information about the circuits except to trace them out. The rapid changes that radio has gone through have left millions of "orphan" pieces of apparatus; their makers are out of business, and diagrams are not to be had. Many requests for such information are received by Radio News, and in many cases we have been unable to supply the complete information; though in some we are able to help out the inquirer. The veteran radio man, who grew up with the trade, will have some facts still in his file or in his head; but the younger repair man has nowhere to turn for it. So, also, the junior radio servicer needs a lot of advice that is not in the books, and can be derived only from older heads. With the co-operation of our readers—who are always willing to do another a friendly turn—Radio News will provide a clearing house for such information.

We can publish here only articles and illustrations which will be of value to a large number of service men; replies to questions of less general interest will have to be handled in the same way as in the "I Want to Know" department. We regret that some well-known manufacturers conceal necessary information concerning receivers and other equipment they have made; and others, while willing that it should be given by letter, forbid its publication. We cannot recommend the use of any specified commercial apparatus as against competing makes, or compare the relative merits of equipment when all is of approved quality. Because many readers need diagrams and data not available here, we will publish (up to a reasonable number) general requests for information on specific obsolete models; so that any fellow radio man who has it may send it to the inquirer direct. We can only print here information on such a discontinued model when it is evident that the demand for it is very large and widespread.

We will be glad to get articles describing layout, construction and equipment of apparatus especially useful in servicing, and the methods of employing it in the shop and on outside calls; systems of trouble-shooting, reconstruction and modernizing of apparatus; special installations; and time-, labor- and money-saving ideas, by practical men who have tried them out. When these are of suitable length, evidently interesting to other service men, and may be suitably illustrated, we will pay for them at regular rates. Very short contributions containing useful hints will be compensated by yearly subscriptions, as with those used in our "Wrinkle" department.

may be attributed to electric refrigerators or blowers in oil-burning furnaces. There are also other noises which are peculiar to certain types of apparatus, but those described above are the most common.

After the interference has been chased to its "lair" the problem arises, what can be done to eliminate it? Some cities and towns have adopted legislation to compel owners of radiating sets or interfering apparatus to overcome the trouble. In this case, it is usually necessary only to inform the owner in order to obtain action. In other cases, however, it is not so easy. Power companies are usually willing to eliminate the sources of trouble if they are informed. In cases where the apparatus is privately owned, a filter of the correct design can usually be installed in the line and several radio manufacturers have placed filters for this purpose on the market.

A booklet published by the Radio Manufacturers Association supplies more information on this subject. The book is priced at $0.25 and may be obtained from the office of this organization at 11 West 42nd Street, New York City.

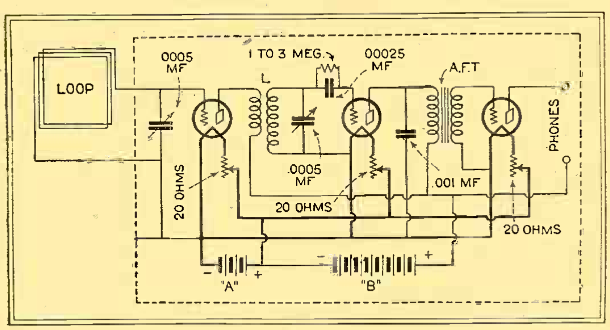


Fig. 2

At the left, circuit for a three-tube receiver of a type which may be used to locate the electrical sources of noises which interfere with radio reception. A dry-cell set will be handiest; as batteries and everything but the loop must be totally shielded.

"Music Master-Ware" Reflex

Editor, Radio News:

I have received an old receiver to be repaired, and I would like to get a copy of the diagram, if one is available. The set is one of the old Music Master-Ware receivers using three tubes of the 199 type. I believe that this receiver was known as the type "T."

If the values of the apparatus are known, I would also like to have you mark them on the diagram. In case these values are not known, the diagram will be sufficient. Can you help me?

Ralph Miller,
Miller's Radio Shop, Schenectady, N. Y.

At the right, the "Music Master-Ware" three-tube reflex circuit, for which we have had many requests. The information printed here gives all the data on this one-time popular set that we have been able to obtain; and may aid in tracing connections.

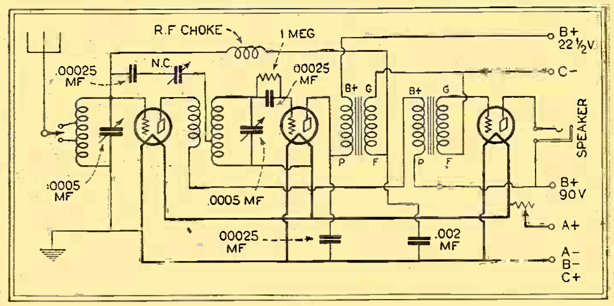


Fig. 3

We are printing the diagram of this receiver as Fig. 3. There are a large number of these sets in use at the present time and many of them require attention from time to time. As you will notice from the diagram, the set is a three-tube reflexed neutrodyne. The first tube acts as both R.F. and A.F. amplifier at the same time. The second tube is the detector, while the third is a straight A.F. (output) stage.

The two tuning condensers have a maximum capacity of about .0005-mf. There are, in the receiver, several by-pass condensers, the capacities of which are marked on the diagram. Much of the trouble encountered with this set is found in the A.F. transformers, and it is usually advisable to test these first in cases where the set fails to operate. The transformers have a ratio of about 3 to 1 and, because of their design, the quality of the receiver can be improved very much by replacing them with new ones of more recent design.

Trouble is often encountered in the tube sockets also; it will often be found that the contacts bend down and lose their spring. In this case, it is best to replace them, since they will undoubtedly be a continual cause of trouble. The final cause of trouble is in the wiring and the battery cable. These should be checked over in the usual way with a battery and pair of phones. Because of the metal panel used in these sets, a short-circuit can very easily occur between the "A—" or ground terminal and the plate circuits, or the "A+"; and extreme care should be exercised when checking the continuity of the wiring.

Increasing Antenna Pick-Up

Editor, Radio News:

I have a Radiola 28 receiver. Is there any way that an outside aerial can be connected to this set, other than an aerial coupler? Is an underground or buried aerial all right to use to reduce static?

T. W. Hilmers,
Chicago, Ill.

A loop set, such as the Radiola 28, can be adapted to operation with an outdoor aerial in several ways. The aerial may be coupled to one side of the loop aerial and the ground wire to the other (Fig. 4A). This will improve the volume but may broaden the tuning too much. The loop continues to operate, and the outside aerial merely increases the pick up.

Another way to couple an aerial and ground to the set is to fasten several turns of wire around the loop, and connect the aerial and ground to the new coil (Fig. 4B). The inductive coupling between the aerial coil and the regular loop will allow an increase of signal strength, while the selectivity is better than with the first method.

The most satisfactory way of increasing the efficiency of the set, however, is to disconnect the loop and insert a coupling coil in its place. The coupling coil is wound with a primary of about 8 to 10 turns of No. 22 D.C.C. wire and a secondary of 50 turns of the same wire. A 3-inch tube is employed and a space of about ¼-inch is left between the two coils. The secondary is connected in place of the loop and the primary is connected to the aerial and ground (Fig. 4C).

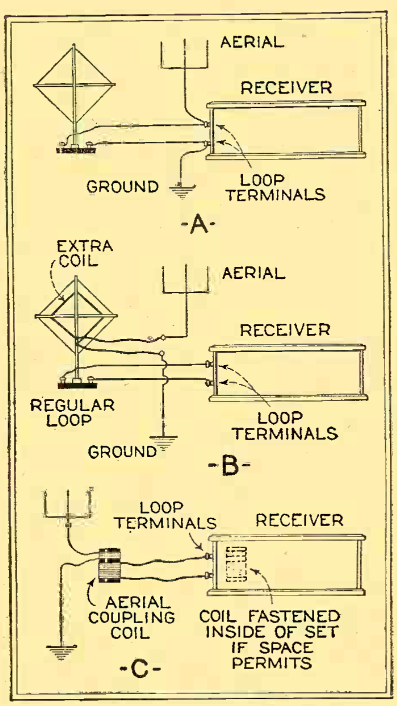


Fig. 4

The combined pick-up of loop and aerial at A makes the set more sensitive but less directive. The directive effect is lost at B, and C corresponds to the ordinary tuned-coupler aerial circuit.

UNDERGROUND PICK-UP SYSTEMS

The buried "aerial" usually operates quite satisfactorily with an ordinary broadcast receiver and, in many cases, the static level is reduced quite noticeably. The operation of this antenna system depends (in the same way as with the usual type of overhead aerial) on the location, the way in which the aerial is installed and the actual design of the aerial.

Such complaints regarding the performance of an underground aerial as are usually received may be traced to the fact that the users expected too much. The underground aerial is shielded; therefore it receives no disturbing impulses from the minute electrified particles which fill the air, and are continually lighting on an exposed wire. It also avoids some other sources of interference; but no device yet suggested which reduces all interference does so without reducing some of the signal pick-up. This undesired result may be overcome by increased amplification; thus taking full advantage of the reduced noise level.

In addition to this, the underground

(*Continued on page 956*)

The Radio Constructor's Own Page

Wherein Custom and Home Set Builders and Experimenters All Over the World Swap Experiences and Suggestions About Hookups and Accessories

"JUNK-BOX" ENTHUSIASM

Editor, RADIO NEWS:

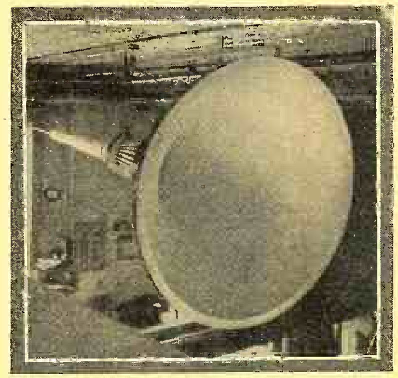
I have constructed the "Junk-Box" and it is a wonderful set. The word "Junk" should be "Joy." I am a set builder, and would not take $25.00 for it. I do not use an aerial, as I find I can get more distance without it. I use a copper panel 5x13 and have no trouble with body capacity. I would be glad to hear from any young constructor who is also interested in this type of set.

JOHN MULLINS, JR.
3921 Asher Ave., Little Rock, Arkansas.

Editor, RADIO NEWS:

Many thanks for the blueprints which you sent me; I have constructed the "Junk-Box" so often that I know it by heart. I am using a 112 tube for a detector and find that if I turn up the rheostat a little way above the point where the tube starts oscillating, the regenerative control works much better. Also, those who have added another stage of audio will find that if the "F—" lead is disconnected from the transformer secondary, it will make it much clearer with some loss in volume. (*This old ham trick substitutes capacitive coupling, with the capacity between the transformer windings carrying on the signal to the last tube. It should be unnecessary with good transformers.*) I use a 7-megohm grid leak; I am sure that if this set is constructed carefully and the coils wound properly, it will outdo any other receiver of its size.

JOHN D. HAYDEN, JR.,
Rowlesburg, West Virginia.



Mr. Morrison's 12-foot exponential horn (see page 969) has a graceful appearance. The bell is linoleum-lined.

A SET BUILDER SATISFIED

Editor, RADIO NEWS:

I have built the J.B. from blueprint 58, and have received very clearly on only 15 feet of aerial and a common ground, 5SW, 2ME, PCJJ, CJRX, 2XAL, 2XAF, KDKA and many C.W. stations. It is a wow for volume, and I only use the two-tube hookup. I have also built the "Extension" two-tube set (blueprints 53 and 55) with two stages of audio, and spent only a few hours logging stations; but after three nights I have received forty, including KNX, Los Angeles, three nights straight.

I can only say you surely put out wonderful circuits; having been a satisfied reader since 1922. I have enjoyed every issue, and the information therein. Just a word of advice to other readers; if they

(*Continued on page 969*)

Fifty Dollars for an Improvement in Short-Wave Sets

IN keeping with the belief which RADIO NEWS has always expressed, that the technical progress which radio has made is in no small measure due to the ingenuity and industry of home experimenters, and that many more good ideas are to come from their workshops, we will pay $50.00 for each accepted and published constructional article from the builder of a *successful short-wave receiver that contains a novel feature of value, electrical or mechanical, which increases its efficiency or makes its operation more satisfactory.* This price will apply only to an article covering *one printed page or more* containing a complete description of the receiver; and the Editor of RADIO NEWS will decide whether any article submitted contains the requisite amount of value and novelty to justify its publication in this form. If a contribution submitted does not measure up to this standard, but contains some matter of interest, the writer will be offered compensation at regular rates for a shorter article, or for a Wrinkle, as the case may be.

No article of this nature will be considered unless the author states that he has built a working model, and is prepared to submit it upon request. We cannot accept under this offer any contribution, no matter how ingenious, dealing with *a theory which has not been reduced to practice.*

Before preparing manuscript at great length, or working drawings, write to RADIO NEWS, stating the elements of your construction, the new feature which it presents, and enclose a clean *schematic* diagram, in ink, of the circuit. You will then be instructed how to proceed further, or whether to send the set to this office for test. *Do not ship any apparatus to us without being first instructed to do so.* As illustrations of a constructional article must be prepared in this office by our staff artists, we reserve the right to construct new apparatus for the purpose, using the same circuit but employing other parts; and to correct the article submitted to conform with our illustrations and customary editorial style.

All communications with respect to this subject and other new ideas, discoveries and inventions in radio should be brief and direct as possible, legibly typewritten or written *in ink* (*not pencil*) and well spaced. If an idea is worth describing, it is worth describing clearly. We will, when so desired, hold in confidence any communications made to us by experimenters, until the latter release them for publication; but we can give no opinion upon the value of their ideas until we are informed of the essential details of their work. All inventors who believe that they have found something new which may be patentable should immediately put on record their evidence of conception, in the manner described in RADIO NEWS for December, 1928 ("How Inventors May Guard Their Rights"); they may then communicate their ideas with the assurance of security. On the other hand, the secretive experimenter runs two risks; he may be working out toilfully something already discovered, which he cannot patent, or he may be failing to show "due diligence" and others on the same track will pass him.

What have you in the way of an improvement in your short-wave set that is new and different? Write to *Short-Wave Editor,* RADIO NEWS, 230 Fifth Avenue, New York City, and begin your letter by saying that you have built a set, and have a story to offer for that Fifty Dollars. Enclose the circuit diagram in *schematic* form, or make a sketch of the layout or new parts.

List of Broadcast Stations in the United States

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
KDB	Santa Barbara, Calif.	200	100
KDKA	East Pittsburgh, Pa.	306	25000
KDLR	Devils Lake, N. D.	248	100
KDYL	Salt Lake City, Utah	232	1000
KEJK	Los Angeles, Calif.	240	500
KELW	Burbank, Calif.	384	500
KEX	Portland, Oregon	254	5000
KFAB	Lincoln, Nebraska	389	5000
KFAD	Phoenix, Arizona	484	500
KFBB	Havre, Montana	220	250
KFBK	Sacramento, Calif.	229	100
KFBL	Everett, Washington	219	50
KFDM	Beaumont, Texas	535	500
KFDY	Brookings, S. D.	545	500
KFEC	Portland, Oregon	219	100
KFEL	Denver, Colorado	319	250
KFEQ	St. Joseph, Mo. (day)	535	2500
KFEY	Kellogg, Idaho	248	10
KFGQ	Boone, Iowa	229	100
KFH	Wichita, Kansas	231	500
KFHA	Gunnison, Colorado	250	50
KFI	Los Angeles, Calif.	468	5000
KFIF	Portland, Oregon	211	100
KFIO	Spokane, Wash. (day)	244	100
KFIU	Juneau, Alaska	229	10
KFIZ	Fond du Lac, Wis.	211	100
KFJB	Marshalltown, Iowa	250	100
KFJF	Oklahoma City, Okla.	204	5000
KFJI	Astoria, Oregon	219	50
KFJM	Grand Forks, N. D.	219	500
KFJR	Portland, Oregon	231	500
KFJY	Fort Dodge, Iowa	229	100
KFJZ	Fort Worth, Texas	219	100
KFKA	Greeley, Colorado	341	500
KFKB	Milford, Kansas (day)	265	5000
KFKU	Lawrence, Kansas	246	1000
KFKX	Chicago, Illinois	294	5000
KFKZ	Kirksville, Missouri	250	50
KFLV	Rockford, Illinois	213	500
KFLX	Galveston, Texas	219	100
KFMX	Northfield, Minn.	240	1000
KFNF	Shenandoah, Iowa	337	500
KFOR	Lincoln, Nebraska	248	100
KFOX	Long Beach, Calif.	240	1000
KFPL	Dublin, Texas	229	15
KFPM	Greenville, Texas	229	15
KFPW	Siloam Springs, Ark. (day)	224	50
KFPY	Spokane, Wash.	216	500
KFQD	Anchorage, Alaska	244	100
KFQU	Holy City, Calif.	211	100
KFQW	Seattle, Wash.	211	100
KFQZ	Hollywood, Cal. (Ltd.)	349	1000
KFRC	San Francisco, Calif.	492	1000
KFRU	Columbia, Missouri	476	500
KFSD	San Diego, Calif.	500	500
KFSG	Los Angeles, Calif.	268	500
KFUL	Galveston, Texas	232	500
KFUM	Colorado Springs, Colo.	236	1000
KFUO	St. Louis, Mo.	545	500
KFUP	Denver, Colorado	229	100
KFUR	Ogden, Utah	219	50
KFVD	Venice, Calif. (Ltd.)	428	250
KFVS	Cape Girardeau, Mo.	248	100
KFWB	Los Angeles, Calif.	316	1000
KFWC	San Bernardino, Calif.	250	100
KFWF	St. Louis, Missouri	250	100
KFWI	San Francisco, Calif.	322	500
KFWM	Oakland, Calif.	322	500
KFXD	Jerome, Idaho	211	50
KFXF	Denver, Colorado	319	250
KFXJ	Edgewater, Colo.	229	50
KFXR	Oklahoma City, Okla.	229	100
KFXY	Flagstaff, Arizona	211	100
KFYO	Abilene, Texas	211	100
KFYR	Bismarck, N. D.	545	500
KGA	Spokane, Wash.	204	5000
KGAR	Tucson, Arizona	219	100
KGB	San Diego, Calif.	220	250
KGBU	Ketchikan, Alaska	333	500
KGBX	St. Joseph, Mo.	219	100
KGBZ	York, Nebraska	322	500
KGCA	Decorah, Iowa (day)	236	50
KGCB	Enid, Okla.	219	50
KGCI	San Antonio, Texas	219	100
KGCN	Concordia, Kansas	211	50
KGCR	Brookings, S. D.	248	100
KGCU	Mandan, N. D.	250	100
KGCX	Vida, Montana	211	10
KGDA	Dell Rapids, S. D.	219	50
KGDE	Fergus Falls, Minn.	250	50
KGDM	Stockton, Calif. (day)	261	50
KGDR	San Antonio, Texas	200	100
KGDY	Oldham, S. D.	250	15
KGEF	Los Angeles, Calif.	231	1000
KGEK	Yuma, Colo.	250	10
KGER	Long Beach, Calif.	219	100
KGEW	Fort Morgan, Colo.	250	100
KGEZ	Kalispell, Montana	229	100
KGFF	Alva, Oklahoma	211	100
KGFG	Oklahoma City, Okla.	219	100
KGFH	Glendale, Calif.	300	250
KGFI	San Angelo, Texas	229	100
KGFJ	Los Angeles, Calif.	211	100
KGFK	Hallock, Minnesota	250	50
KGFL	Raton, New Mexico	219	50
KGFW	Ravenna, Neb.	211	50
KGFX	Pierre, S. D. (day)	517	200
KGGF	Picher, Oklahoma	297	500
KGGM	Albuquerque, N. M.	219	100
KGHB	Honolulu, Hawaii	227	250
KGHD	Missoula, Mont.	211	50
KGHF	Pueblo, Colo.	227	250
KGHG	McGehee, Ark.	229	50
KGHI	Little Rock, Ark.	200	500
KGHL	Billings, Mont.	316	500
KGHX	Richmond, Texas	200	50
KGIO	Idaho Falls, Idaho	227	250
KGIQ	Twin Falls, Idaho	227	250
KGIR	Butte, Montana	220	250
KGIW	Trinidad, Colo.	211	100
KGJF	Little Rock, Ark.	337	250
KGKB	Brownwood, Texas	200	100
KGKL	San Angelo, Texas	219	100
KGKO	Wichita Falls, Texas	526	250
KGKX	Sandpoint, Idaho	211	15
KGO	Oakland, Calif.	380	10000
KGRC	San Antonio, Texas	219	100
KGRS	Amarillo, Texas	213	1000
KGTT	San Francisco, Calif.	211	500
KGU	Honolulu, Hawaii	319	500
KGW	Portland, Oregon	484	1000
KGY	Lacey, Washington	250	10
KHJ	Los Angeles, Calif.	333	1000
KHQ	Spokane, Wash.	508	1000
KICK	Red Oak, Iowa	211	100
KIDO	Boise, Idaho	240	1000
KJBS	San Francisco, Cal (day)	273	100
KJR	Seattle, Wash.	309	5000
KKP	Seattle, Wash.	219	15
KLCN	Blytheville, Ark. (day)	232	50
KLDS	Independence, Mo. (Ltd)	316	500
KLRA	Little Rock, Ark.	216	500
KLS	Oakland, Calif. (day)	208	250
KLX	Oakland, Calif.	341	500
KLZ	Denver, Colo.	535	1000
KMA	Shenandoah, Iowa	322	500
KMBC	See **KLDS**		
KMED	Medford, Oregon	229	50
KMIC	Inglewood, Calif.	268	500
KMJ	Fresno, Calif.	250	100
KMMJ	Clay Center, Neb. (day)	405	1000
KMO	Tacoma, Wash.	224	500
KMOX	St. Louis, Mo.	275	25000
KMTR	Hollywood, Calif.	526	1000
KNX	Los Angeles, Calif.	286	5000
KOA	Denver, Colo.	361	12500
KOAC	Corvallis, Oregon	535	1000
KOB	State College, N. Mex.	254	10000
KOCW	Chickasha, Okla.	211	100
KOH	Reno, Nevada	219	100
KOIL	Council Bluffs, Iowa	238	1000
KOIN	Portland, Oregon	319	1000
KOL	Seattle, Wash.	236	1000
KOMO	Seattle, Wash.	326	1000
KOOS	Marshfield, Oregon	219	50
KORE	Eugene, Oregon	211	100
KOW	Denver, Colo.	216	500
KOY	Phoenix, Ariz.	229	100
KPCB	Seattle, Wash.	248	100
KPFW	Westminster, Cal.	201	25000
KPJM	Prescott, Arizona	200	100
KPLA	Los Angeles, Calif.	526	1000
KPO	San Francisco, Calif.	441	1000
KPOF	Denver, Colo.	341	500
KPPC	Pasadena, Calif.	250	50
KPQ	Seattle, Wash.	248	100
KPRC	Houston, Texas	326	1000
WBAP	Fort Worth, Texas	375	25000
WBAW	Nashville, Tenn.	201	5000
WBAX	Wilkes-Barre, Pa.	248	100
WBBC	Brooklyn, N. Y. City	214	500
WBBL	Richmond, Va.	219	100
WBBM	Chicago, Ill.	389	25000
WBBR	Rossville, N. Y. City	231	1000
WBBW	Norfolk, Va.	250	100
WBBY	Charleston, S. C.	250	75
WBBZ	Ponca City, Okla.	250	100
WBCM	Bay City, Mich.	213	500
WBCN	See **WENR**		
WBIS	Boston, Mass.	244	500
WBMH	Detroit, Mich.	229	100
WBMS	Fort Lee, N. J.	207	250
WBNY	New York City	222	250
WBOQ	See **WABC**		
WBOW	Terre Haute, Ind.	229	100
WBRC	Birmingham, Ala.	322	500
WBRE	Wilkes-Barre, Pa.	229	100
WBRL	Tilton, N. H.	210	500
WBSO	Wellesley Hills, Mass. (Time limited)	384	250
WBT	Charlotte, N. C.	278	10000
WBZ	Springfield, Mass.	303	15000
WBZA	Boston, Mass.	303	500
WCAC	Storrs, Conn.	500	250
WCAD	Canton, N. Y. (day)	246	500
WCAE	Pittsburgh, Pa.	246	500
WCAH	Columbus, Ohio	210	250
WCAJ	Lincoln, Neb.	508	500
WCAL	Northfield, Minn.	240	1000
WCAM	Camden, N. J.	234	500
WCAO	Baltimore, Md.	500	250
WCAP	Asbury Park, N. J.	234	500
WCAT	Rapid City, S. D.	250	100
WCAU	Philadelphia, Pa.	256	5000
WCAX	Burlington, Vt.	250	100
WCAZ	Carthage, Ill. (day)	280	100
WCBA	Allentown, Pa.	208	250
WCBD	Zion, Illinois (day)	278	5000
WCBM	Baltimore, Md.	219	100

THIS list of stations in the United States operating under licenses issued by the Federal Radio Commission is corrected to February 11, 1929. Powers shown are the night strength, or minimum.

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
KPSN	Pasadena, Calif.	316	1000
KQV	Pittsburgh, Pa.	217	500
KQW	San Jose, Calif.	297	500
KRE	Berkeley, Calif.	219	100
KRGV	Harlingen, Texas	238	500
KRLD	Dallas, Texas	288	10000
KRMD	Shreveport, La.	229	50
KRSC	Seattle, Wash. (day)	268	50
KSAC	Manhattan, Kans.	517	500
KSBA	Shreveport, La.	207	1000
KSCJ	Sioux City, Iowa	225	1000
KSD	St. Louis, Mo.	545	500
KSEI	Pocatello, Idaho	333	250
KSL	Salt Lake City, Utah	265	5000
KSMR	Santa Maria, Calif.	250	100
KSO	Clarinda, Iowa	217	1000
KSOO	Sioux Falls, S. D. (day)	270	1000
KSTP	St. Paul, Minn.	205	10000
KTAB	Oakland, Calif.	545	500
KTAP	San Antonio, Texas	211	100
KTAT	Fort Worth, Texas	242	1000
KTBI	Los Angeles, Calif.	231	1000
KTBR	Portland, Oregon	231	500
KTHS	Hot Springs, Ark.	375	10000
KTM	Santa Monica, Calif.	428	500
KTNT	Muscatine, Iowa (day)	256	5000
KTSA	San Antonio, Texas	232	1000
KTSL	Cedar Grove, La.	229	50
KTUE	Houston, Texas	211	5
KTW	Seattle, Wash.	236	1000
KUJ	Seattle, Wash.	200	10
KUOA	Fayetteville, Ark.	216	1000
KUOM	Missoula, Mont.	526	500
KUSD	Vermillion, S. D.	337	500
KUT	Austin, Texas	268	500
KVI	Des Moines, Wash.	224	1000
KVL	Seattle, Wash.	219	100
KVOO	Tulsa, Okla.	263	5000
KVOS	Bellingham, Wash.	250	100
KWBS	Portland, Oregon	200	15
KWCR	Cedar Rapids, Iowa	229	100
KWEA	Shreveport, La.	248	100
KWG	Stockton, Calif.	250	100
KWJJ	Portland, Ore. (Ltd.)	283	500
KWK	St. Louis, Mo.	222	1000
KWKC	Kansas City, Mo.	219	100
KWKH	Shreveport, La.	353	20000
KWLC	Decorah, Iowa (day)	236	100
KWSC	Pullman, Wash.	216	500
KWTC	Santa Ana, Calif	200	100
KWWG	Brownsville, Texas	238	500
KWYO	Laramie, Wyoming	500	500
KXA	Seattle, Wash.	526	500
KXL	Portland, Oregon	240	500
KXO	El Centro, Calif.	250	100
KXRO	Aberdeen, Wash.	211	75
KYA	San Francisco, Calif.	244	1000
KYW and KYWA	See **KFKX**		
KZM	Oakland, Calif.	219	100
NAA	Arlington, Va.	434	1000
WAAD	Cincinnati, Ohio	211	25
WAAF	Chicago, Ill. (day)	326	500
WAAM	Newark, N. J.	240	250
WAAT	Jersey City, N.J. (day)	280	300
WAAW	Omaha, Neb. (day)	454	500
WABC	New York City	349	5000
WABF	Kingston, Pa.	208	250
WABI	Bangor, Maine	250	100
WABO	Rochester, N. Y.	208	500
WABY	Philadelphia, Pa.	229	50
WABZ	New Orleans, La.	250	100
WADC	Akron, Ohio	227	1000
WAFD	Detroit, Mich.	200	100
WAGM	Royal Oak, Mich.	229	50
WAIU	Columbus, Ohio (Ltd.)	468	5000
WALK	Willow Grove, Pa.	200	50
WAPI	Auburn, Ala.	263	5000
WASH	Grand Rapids, Mich.	236	250
WBAA	West Lafayette, Ind.	214	500
WBAK	Harrisburg, Pa. (day)	210	500
WBAL	Baltimore, Md.	283	1000
WCBS	Springfield, Ill.	248	100
WCCO	Minneapolis, Minn.	370	15000
WCDA	New York City	222	250
WCFL	Chicago, Ill. (Ltd.)	309	25000
WCGU	Brooklyn, N. Y. City	214	500
WCLB	Brooklyn, N. Y. City	200	100
WCLO	Kenosha, Wis.	250	100
WCLS	Joliet, Ill.	229	100
WCMA	Culver, Ind.	214	500
WCOA	Pensacola, Fla.	268	500
WCOC	Columbus, Miss.	341	500
WCOH	Greenville, N. Y.	248	100
WCRW	Chicago, Ill.	248	100
WCSH	Portland, Maine	319	500
WCSO	Springfield, Ohio	217	500
WCX	See **WJR**		
WDAE	Tampa, Fla.	484	1000
WDAF	Kansas City, Mo.	492	1000
WDAG	Amarillo, Texas	213	1000
WDAH	El Paso, Texas	229	100
WDAY	Fargo, N. D.	234	1000
WDBJ	Roanoke, Va.	322	250
WDBO	Orlando, Fla.	484	1000
WDEL	Wilmington, Del.	268	250
WDGY	Minneapolis, Minn.	216	500
WDOD	Chattanooga, Tenn.	234	1000
WDRC	New Haven, Conn.	225	500
WDSU	New Orleans, La.	236	1000
WDWF	Cranston, R. I.	248	100
WDZ	Tuscola, Illinois	280	100
WEAF	New York City	454	25000
WEAI	Ithaca, N. Y. (day)	236	1000
WEAN	Providence, R. I. (day)	545	500
WEAO	Columbus, Ohio	545	750
WEAR	See **WTAM**		
WEBC	Superior, Wis.	234	1000
WEBE	Cambridge, Ohio	248	100
WEBQ	Harrisburg, Ill.	248	50
WEBR	Buffalo, N. Y.	229	100
WEBW	Beloit, Wis. (day)	500	250
WEDC	Chicago, Ill.	248	100
WEDH	Erie, Pa.	211	30
WEEI	Boston, Mass.	508	500
WEHS	Evanston, Ill.	229	100
WELK	Philadelphia, Pa.	219	100
WEMC	Berrien Springs, Mich.	508	1000
WENR	Chicago, Ill.	345	25000
WEPS	Gloucester, Mass.	250	100
WEVD	New York City	231	500
WEW	St. Louis, Mo. (day)	395	1000
WFAA	Dallas, Texas	288	25000
WFAN	Philadelphia, Pa.	492	500
WFBC	Knoxville, Tenn.	250	50
WFBE	Cincinnati, Ohio	250	100
WFBG	Altoona, Pa.	229	100
WFBJ	Collegeville, Minn.	219	100
WFBL	Syracuse, N. Y. (temporarily 201 meters, 1000 watts)	333	750
WFBM	Indianapolis, Ind. (Ltd)	244	1000
WFBR	Baltimore, Md. (temp.)	236	250
WFDF	Flint, Michigan	229	100
WFI	Philadelphia, Pa.	535	500
WFIW	Hopkinsville, Ky.	319	1000
WFJC	Akron, Ohio	207	500
WFKD	Philadelphia, Pa.	229	50
WFLA	See **WSUN**		
WGAL	Lancaster, Pa.	229	15
WGBB	Freeport, N. Y.	248	100
WGBC	Memphis, Tenn.	210	500
WGBF	Evansville, Ind.	476	500
WGBI	Scranton, Pa.	341	250
WGBS	New York City (Ltd.)	254	500
WGCM	Gulfport, Miss.	248	100
WGCP	Newark, N. J.	240	250
WGES	Chicago, Ill.	220	500
WGH	Newport News, Va.	229	100
WGHP	Mt. Clemens Mich.	242	750
WGL	Fort Wayne, Ind.	219	100
WGMS	See **WLB**		
WGN	Chicago, Ill.	416	25000
WGR	Buffalo, N. Y.	545	1000
WGST	Atlanta, Ga.	337	250
WGY	Schenectady, N. Y.	380	50000
WHA	Madison, Wis.	526	750
WHAD	Milwaukee, Wis. (day)	268	250
WHAM	Rochester, N. Y.	261	5000
WHAP	New York City	231	1000
WHAS	Louisville, Ky.	366	5000
WHAZ	Troy, N. Y.	231	500
WHB	Kansas City, Mo.	316	500
WHBC	Canton, Ohio	250	10
WHBD	Bellefontaine, Ohio	219	100
WHBF	Rock Island, Ill.	248	100
WHBL	Sheboygan, Wis.	213	500
WHBP	Johnstown, Pa.	229	100
WHBQ	Memphis, Tenn.	219	100
WHBU	Anderson, Indiana	248	100
WHBW	Philadelphia, Pa.	200	100
WHBY	West De Pere, Wis.	250	100
WHDF	Calumet, Mich.	219	100
WHDH	Gloucester, Mass. (day)	361	1000
WHDI	Minneapolis, Minn.	216	500
WHDL	Tupper Lake, N. Y.	211	10
WHEC	See **WABO**		
WHFC	Chicago, Ill.	229	100
WHK	Cleveland, Ohio	216	1000
WHN	New York City	297	250
WHO	Des Moines, Iowa	300	5000
WHPP	New York City	211	10
WHT	Chicago, Ill.	203	5000
WIAS	Ottumwa, Iowa (day)	211	100
WIBA	Madison, Wis.	248	100
WIBG	Elkins Park, Pa. (Sun.)	322	50
WIBM	Jackson, Mich.	219	100
WIBO	Chicago, Ill.	526	5000
WIBR	Steubenville, Ohio	211	50
WIBS	Elizabeth, N. J.	207	250
WIBU	Poynette, Wis.	229	100
WIBW	Topeka, Kans.	231	1000
WIBX	Utica, N. Y.	250	100
WIBZ	Montgomery, Ala.	200	15
WICC	Bridgeport, Conn. (day)	252	500
WIL	St. Louis, Mo.	211	100
WILL	Urbana, Ill.	337	250
WILM	Wilmington, Del.	200	100
WINR	Bay Shore, N. Y.	248	100
WIOD	Miami Beach, Fla.	242	1000
WIP	Philadelphia, Pa.	492	500
WISN	Milwaukee, Wis.	268	250
WJAD	Waco, Texas	242	1000
WJAG	Norfolk, Neb. (day)	283	1000
WJAK	Kokomo, Ind.	229	50
WJAR	Providence, R. I.	337	250
WJAS	Pittsburgh, Pa.	232	1000
WJAX	Jacksonville, Fla.	238	1000
WJAY	Cleveland, Ohio	207	500
WJAZ	Chicago, Ill.	203	5000
WJBC	LaSalle, Ill.	252	100
WJBI	Red Bank, N. J.	248	100
WJBK	Ypsilanti, Mich.	219	50
WJBL	Decatur, Ill.	250	100
WJBO	New Orleans, La.	219	100
WJBT	See **WBBM**		
WJBU	Lewisburg, Pa.	248	100
WJBW	New Orleans, La.	250	30
WJBY	Gadsden, Ala.	248	50
WJJD	Mooseheart, Ill. (Ltd.)	254	20000
WJKS	Gary, Ind.	220	500
WJR	Detroit, Mich.	400	5000
WJSV	Washington, D. C.	205	10000
WJZ	New York City	395	25000
WKAQ	San Juan, Porto Rico	337	500
WKAR	East Lansing, Mich. (day)	288	500
WKAV	Laconia, N. H.	229	100
WKBB	Joliet, Ill.	229	100
WKBC	Birmingham, Ala.	229	10
WKBE	Webster, Mass.	250	100
WKBF	Indianapolis, Ind.	214	500
WKBH	La Crosse, Wis.	217	1000
WKBI	Chicago, Ill.	229	50
WKBN	Youngstown, Ohio	526	500
WKBO	Jersey City, N. J.	207	250
WKBP	Battle Creek, Mich.	211	50
WKBQ	New York City	222	250
WKBS	Galesburg, Ill.	229	100
WKBV	Brookville, Ind.	200	100
WKBW	Buffalo, N. Y.	204	5000
WKBZ	Ludington, Mich.	200	50
WKEN	Buffalo, N.Y. (Ltd.)	288	1000
WKJC	Lancaster, Pa.	250	100
WKRC	Cincinnati, Ohio	545	500
WKY	Oklahoma City, Okla.	333	1000
WLAC	Nashville, Tenn.	201	5000
WLAP	Louisville, Ky.	250	30
WLB	Minneapolis, Minn.	240	1000
WLBC	Muncie, Ind.	229	50
WLBF	Kansas City, Mo.	211	100
WLBG	Petersburg, Va.	250	100
WLBH	Farmingdale, N. Y.	211	30
WLBL	Stevens Point, Wis. (day)	333	2000
WLBO	Galesburg, Ill.	229	100
WLBV	Mansfield, Ohio	248	100
WLBW	Oil City, Pa.	238	500
WLBX	Long Island City N. Y.	200	100
WLBZ	Bangor, Maine	484	250
WLCI	Ithaca, N. Y.	248	50
WLEX	Medford, Mass.	220	500
WLEY	Lexington, Mass.	211	100
WLIB	See **WGN**		
WLIT	Philadelphia, Pa.	535	500
WLDE	Chelsea, Mass.	200	100
WLS	Chicago, Ill.	345	5000
WLSI	See **WDWF**		
WLTH	Brooklyn, N. Y.	214	500
WLW	Cincinnati, Ohio	428	25000
WLWL	New York City	273	5000
WMAC	Cazenovia, N. Y.	526	500
WMAF	So. Dartmouth, Mass.	220	500
WMAK	Buffalo, N. Y.	333	750
WMAL	Washington, D. C.	476	250
WMAN	Columbus, Ohio	248	50
WMAQ	Chicago, Ill.	447	5000
WMAY	St. Louis, Mo.	250	100
WMAZ	Macon, Ga.	250	250
WMBA	Newport, R. I.	200	100
WMBC	Detroit, Mich.	211	100
WMBD	Peoria, Ill.	208	500
WMBF	Miami Beach, Fla.	535	500
WMBG	Richmond, Va.	248	100
WMBH	Joplin, Mo.	211	100

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
WMBI	Chicago, Ill. (day)	278	5000
WMBJ	Wilkinsburg, Penna.	200	100
WMBL	Lakeland, Fla.	229	100
WMBM	Memphis, Tenn.	200	10
WMBO	Auburn, N. Y.	219	100
WMBQ	Brooklyn, N. Y.	200	100
WMBR	Tampa, Fla.	248	100
WMBS	Harrisburg, Pa.	210	500
WMC	Memphis, Tenn.	384	500
WMCA	New York City	526	500
WMES	Boston, Mass.	200	50
WMMN	Fairmont, W. Va.	337	250
WMPC	Lapeer, Mich.	200	30
WMRJ	Jamaica, N. Y. City	211	10
WMSG	New York City	222	250
WMT	Waterloo, Iowa	250	100
WNAC	See **WBIS**		
WNAD	Norman, Okla.	297	500
WNAT	Philadelphia, Pa.	229	100
WNAX	Yankton, S. D.	526	1000
WNBF	Binghamton, N. Y.	200	50
WNBH	New Bedford, Mass.	229	100
WNBJ	Knoxville, Tenn.	229	50
WNBO	Washington, Pa.	250	15
WNBQ	Rochester, N. Y.	200	15
WNBR	Memphis, Tenn.	210	500
WNBW	Carbondale, Pa.	250	5
WNBX	Springfield, Vt.	250	10
WNBZ	Saranac Lake, N. Y. (day)	232	10
WNJ	Newark, N. J.	207	250
WNOX	Knoxville, Tenn.	535	1000
WNRC	Greensboro, N. C.	208	500
WNYC	New York City	526	500
WOAI	San Antonio, Texas	252	5000

Radio Call Letter	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
WOAN	Lawrenceburg, Tenn.	500	500
WOAX	Trenton, N. J.	234	500
WOBT	Union City, Tenn.	229	15
WOBU	Charleston, W. Va.	517	250
WOC	Davenport, Iowa	300	5000
WOCL	Jamestown, N. Y.	248	25
WODA	Paterson, N. J.	240	1000
WOI	Ames, Iowa (day)	535	3500
WOKO	Peekskill, N. Y.	208	500
WOL	Washington, D.C. (day)	229	100
WOMT	Manitowoc, Wis.	248	100
WOO	Philadelphia, Pa.	200	100
WOOD	Grand Rapids, Mich.	236	500
WOQ	Kansas City, Mo.	492	1000
WOR	Newark, N. J.	422	5000
WORD	Chicago, Ill.	203	5000
WOS	Jefferson City, Mo.	476	500
WOV	New York City (day)	265	1000
WOW	Omaha, Neb.	508	1000
WOWO	Fort Wayne, Ind.	258	10000
WPAP	New York City	297	250
WPAW	Pawtucket, R. I.	248	100
WPCC	Chicago, Ill.	526	500
WPCH	New York City (day)	370	500
WPG	Atlantic City, N. J.	273	5000
WPOR	See **WTAR**		
WPRC	Harrisburg, Pa.	250	100
WPSC	State College, Pa. (day)	244	500
WPSW	Philadelphia, Pa.	200	50
WPTF	Raleigh, N. C.	441	10000
WQAM	Miami, Florida	242	750
WQAN	Scranton, Pa.	341	250
WQAO	See **WPAP**		
WQBC	Utica, Miss.	220	300
WQBJ	Clarksburg, W. Va.	250	65

Radio Call Letter	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
WQBZ	Weirton, W. Va.	211	60
WRAF	LaPorte, Ind.	250	100
WRAK	Erie, Pa.	219	50
WRAW	Reading, Pa.	229	100
WRAX	Philadelphia, Pa. (day)	246	250
WRBC	Valparaiso, Ind. (day)	242	500
WRBI	Tifton, Ga.	229	20
WRBJ	Hattiesburg, Miss.	200	10
WRBL	Columbus, Ga.	250	50
WRBQ	Greenville, Miss.	248	100
WRBT	Wilmington, N. C.	219	50
WRBU	Gastonia, N. C.	248	100
WRBW	Columbia, S. C.	229	15
WRC	Washington, D.C.	316	500
WREC	Memphis, Tenn	500	500
WREN	Lawrence, Kansas	246	1000
WRHM	Minneapolis, Minn.	240	1000
WRJN	Racine, Wis.	219	100
WRK	Hamilton, Ohio	229	100
WRNY	New York City	297	250
WRR	Dallas, Texas	234	5000
WRUF	Gainesville, Fla.	204	5000
WRVA	Richmond, Va.	270	5000
WSAI	Cincinnati, Ohio (Ltd.)	375	5000
WSAJ	Grove City, Pa.	229	100
WSAN	Allentown, Pa.	208	250
WSAR	Portsmouth, R. I.	207	250
WSAZ	Huntington, W. Va.	517	250
WSB	Atlanta, Ga.	405	10000
WSBC	Chicago, Ill.	248	100
WSBT	South Bend, Ind.	244	500
WSDA	Brooklyn, N. Y.	214	500
WSEA	Norfolk, Va.	384	500
WSGH	See **WSDA**		

Radio Call Letter	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
WSIS	Sarasota, Fla.	297	250
WSIX	Springfield, Tenn.	248	100
WSM	Nashville, Tenn.	461	5000
WSMB	New Orleans, La.	227	500
WSMD	Salisbury, Md.	229	100
WSMK	Dayton, Ohio	526	200
WSPD	Toledo, Ohio	224	500
WSRO	Middletown, Ohio	211	100
WSSH	Boston, Mass.	211	100
WSUI	Iowa City, Iowa	517	500
WSUN	St. Petersburg, Fla.	333	1000
WSVS	Buffalo, N. Y.	219	50
WSYR	Syracuse, N. Y.	526	250
WTAD	Quincy, Ill.	208	500
WTAG	Worcester, Mass.	517	250
WTAM	Cleveland, Ohio	280	3500
WTAQ	Washington, Wis.	225	1000
WTAR	Norfolk, Va.	384	500
WTAW	College Station, Tex.	268	500
WTAX	Streator, Ill.	248	50
WTAZ	Richmond, Va.	248	15
WTBO	Cumberland, Md.	211	50
WTFI	Toccoa Falls, Ga.	207	500
WTHS	Atlanta, Ga.	229	100
WTIC	Hartford, Conn. Permit 283 meters, 50,000 watts.	500	250
WTMJ	Milwaukee, Wis.	484	1000
WWAE	Chicago, Ill.	250	100
WWJ	Detroit, Mich.	326	1000
WWL	New Orleans, La.	353	5000
WWNC	Asheville, N. C.	526	1000
WWRL	Woodside, N. Y.	200	100
WWVA	Wheeling, W. Va.	258	5000

LIST OF CANADIAN BROADCAST CALLS

CFAC	Calgary, Alta.	434	500
CFBO	St. John, N. B.	337	50
CFCA	Toronto, Ont.	357	500
CFCF	Montreal, Que.	291	1650
CFCH	Iroquois Falls, Ont.	500	250
CFCL	See **CKCL**		
CFCN	Calgary, Alta.	434	1800
CFCO	Chatham, Ont.	248	25
CFCT	Victoria, B. C.	476	500
CFCY	Charlottetown, P. E. I.	312	100
CFJC	Kamloops, B. C.	268	15
CFLC	Prescott, Ontario	297	50
CFNB	Fredericton, N. B.	248	50
CFQC	Saskatoon, Sask.	329	500
CFRB	Toronto, Ont.	312	1000
CFRC	Kingston, Ont.	268	500
CHCA	See **CJCJ**		
CHCK	Charlottetown, P. E. I.	312	30
CHCS	Hamilton, Ont.	341	10
CHCT	See **CKLC**		

CHGS	Summerside, P. E. I.	268	25
CHLS	See **CKCD**		
CHMA	Edmonton, Alta.	517	250
CHML	Mount Hamilton, Ont.	341	50
CHNC	See **CKNC**		
CHNS	Halifax, N. S.	322	500
CHRC	Quebec, Quebec	500	5
CHWC	Regina, Sask.	312	15
CHWK	Chilliwack, B. C.	248	5
CJBC	(Uses several Toronto stations)..517, 357 or 312		
CJBR	See **CKCK**		
CJCA	Edmonton, Alta.	517	500
CJCB	Sydney, Nova Scotia	384	50
CJCJ	Calgary, Alta.	434	250
CJGC	London, Ont.	329	500
CJGX	Yorkton, Sask.	476	500
CJHS	Saskatoon, Sask.	329	250
CJOC	Lethbridge, Alta.	268	50
CJOR	Sea Island, B. C.	291	50

CJRM	Moose Jaw, Sask.	500	500
CJRW	Fleming, Sask.	500	500
CJSC	See **CKCL**		
CKAC	Montreal, Que.	411	1200
CKCD	Vancouver, B. C.	411	50
CKCI	Quebec, Que.	500	23
CKCK	Regina, Sask.	312	500
CKCL	Toronto, Ont.	517	500
CKCO	Ottawa, Ont.	434	100
CKCR	Brantford, Ont.	297	50
CKCV	Quebec, Que.	500	50
CKFC	Vancouver, B. C.	411	50
CKGW	Bowmanville, Ont.	312	5000
CKLC	Red Deer, Alberta	357	1000
CKMC	Cobalt, Ont.	248	15
CKMO	Vancouver, B.C.	411	50
CKNC	Toronto, Ont.	517	500
CKOC	Hamilton, Ont.	341	100
CKOW	See **CFCA**		

CKPC	Preston, Ont.	248	25
CKPR	Midland, Ont.	268	50
CKSH	St. Hyacinthe, Que.	297	50
CKUA	Edmonton, Alta.	517	500
CKWX	Vancouver, B. C.	411	100
CKX	Brandon, Man.	556	500
CKY	Winnipeg, Man.	384	5000
CNRA	Moncton, N. B.	476	500
CNRC	See **CFAC**		
CNRE	See **CJCA**		
CNRM	See **CHYC, CKAC, or CFCF**		
CNRO	Ottawa, Ont.	434	500
CNRQ	See **CKCV**		
CNRR	See **CKCK**		
CNRS	See **CFQC**		
CNRT	See **CFCA**		
CNRV	Vancouver, B. C.	291	500
CNRW	See **CKY**		
VAS	Louisburg, Nova Scotia	434	

LIST OF SHORT-WAVE STATIONS OF THE WORLD

(Some calls may have been altered under new international regulations.)

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
	AFRICA		
AIN	Casablanca, Morocco	51.00	
8KR	Constantine, Tunis	42.80	
JP	Johannesburg, U. S. Africa	25.00	
7LO	Nairobi, Kenya	33.50	2,000
	AUSTRALIA		
2BL	Sydney	32.50	
2FC	Sydney	28.50	
2ME	Sydney	28.50	
3AR	Melbourne	55.00	
3LO	Melbourne	32.00	
6AG	Perth, West Australia	32.90	
6WF	Perth	104.50	
	AUSTRIA		
OHK2	Vienna	70.00	
EATH	Vienna	37.00	
	Vienna	22.20	
	BELGIUM		
EB4A2	Brussels	42.00	300
	CANADA		
CF	Drummondville, Quebec	32.00	
CJRX	Winnipeg, Man.	25.60	2,000
VAS	Louisburg, N. S.	28.00	
	COSTA RICA		
NRH	Heredia	30.30	7½
	DANTZIG		
EK4ZZZ	Dantzig	40.00	
	DENMARK		
D7MK	Copenhagen	32.05	500
D7RL	Copenhagen	42.12 and 84.24	250
	ENGLAND		
5SW	Chelmsford	25.53	16,000
2NM	Caterham	32.50	
GBS	Rugby	24.40	
	FINLAND		
	Helsingfors (Helsinki)	31.50	
	FRANCE		
F8GC	Paris ("Radio LL")	61.00	500
F8AV	Nogent	80.00	500
Radio Vitus	Paris	37.00	1,500
Eiffel Tower	Paris (time signals)	32.50	
YR	Lyons ("Radio Lyon")	40.20	250
	Agen	30.75	
YN	Lyons	58.00	3,000
	Nancy	15.50	500
FW4	Ste. Assise	24.50	
	GERMANY		
AFI	Konigswusterhausen	14.00	
AFL	Hamburg	70.00 and 52.00	
AFT	Konigswusterhausen	14.00	
AFU	Konigswusterhausen	14.00	
AFK	Berlin (Doberitz)	37.56 75.36	
HEA	Nauen	11.00	
AGC	Berlin	17.20	
AGJ	Nauen	56.70	
AGK	Nauen	11.00	
LA	Langenberg	43.90	
POF	Nauen	11.00	
POZ	Nauen	18.10	
	Stuttgart	41.00	

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
	HOLLAND		
PCJ	Eindhoven	31.4	30,000
PCKK	Kootwijk	16.00	
PCLL	Kootwijk	18.00	32,000
PCMM	Ymuiden	46.50	
PCPP	Kootwijk	16.50	
PCRR	Kootwijk	37.00	
PCTT	Kootwijk	21.00	
PCUU	The Hague	37.00	
	ITALY		
1IAX	Rome	20.00, 40.00	300
IAY	Placenza	20.00, 45.00	50

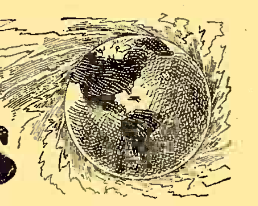
THIS list of the short-wave broadcast stations throughout the world is not complete, although we have endeavored to list every station of whom we have heard reports; since in many cases reliable information about the programs, wavelength and power of the stations cannot even be obtained from the stations themselves.

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
	JAPAN		
JFAB	Taipeh, Formosa	39.50	
JIAG	Ibarakiken (Hirasio)	37.50	2,000
JIPP	Tokio	20.00	
JKZB	Tokio	20.00	
JOAK	Tokio 30.00, 60.00, 35.00,	70.00	500
IAA	Iwatsuki	40.00	
	JAVA		
PLE, PLF	Bandoeng	15.74 and 17.00	
	MEXICO		
XC51	Mexico City	44.00	
	MOROCCO		
AIN	Casablanca	51.00	
	NORWAY		
LCHO	Oslo	33.00	
LGN	Bergen	31.25, 30.00	
	U. S. S. R. (RUSSIA)		
RDRL	Leningrad	28.50	
RDW	Moscow	83.00	
RFM	Khabarovsk (Siberia)	70.20	12,000
RFN	Moscow	50.00	
RA19	Tomsk (Siberia)	37.00	
	SPAIN		
EAM	Madrid	30.70	
EAR55	Barcelona		

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
	SWEDEN		
SAS	Karlsborg	52.50	
SAA	Karlskrona	44.40	
	Motala	99 and 41.45	1,000
SAJ	Karlsborg	47.00	
SMHA	Stockholm	41.00	
	SWITZERLAND		
H9OC	Berne	32.00	
H9XD	Zurich	85.00 and 32.00	
	UNITED STATES		
KDKA (W8XK)	East Pittsburgh, Pa.	62.50	40,000
	(W8XS, W8XP-portable)	42.75	
		25.40	
KEJK (W6XAN)	Los Angeles, Calif.	105.90	250
KEWE	Bolinas, Calif.	14.10	
KFPY (W7XAB)	Spokane, Washington	105.90	100
KFQU (W6XBH)	Holy City, Calif.	31.00	50
KFQZ (W6XAL)	Hollywood, Calif.	108.20	50
KFVD (W6XBX)	Culver City, Calif.	105.00	50
KFWB (W6XBR)	Los Angeles, Calif.	105.00	50
		40.00	
KFWO (W6XAD)	Avalon, Calif.	53.07	100
KGER (W6XBV)	Long Beach, Calif.	48.86	
KGB	San Diego, Calif.	65.18	
KGDE	Barrett, Minn.	40.00	50
KGO (W6XAX, W6XN)	San Francisco, Calif.	10 to 40	10,000
KHJ (W6XAU)	Los Angeles, Calif.	104.10	50
KJBS (W6XAR)	San Francisco, Calif.	61.00	50
KJR (W7XC, W7XO)	Seattle, Washington	105.20	250
KMOX	St. Louis, Mo.	49.00	15
KMTR	Los Angeles, Calif.	108.20	250
KNRC (W6XAF)	Santa Monica, Calif.	108.20	100
KNX (W6XA)	Los Angeles, Calif.	107.10	100
KOIL (W9XU)	Council Bluffs, Iowa	61.06	500
KWE-KEWE	Bolinas, Calif.	14.10	
KWJJ (W7XAO)	Portland, Oregon	53.54	100
WAAM (W2XBA)	Newark, N. J.	65.18	50
WABC (W2XE)	Richmond Hill, N. Y.	58.50	500
WAJ	Rocky Point, N. Y.	22.48	
WBRL (W1XY)	Tilton, N. H.	109.00	250
WBZ	Springfield, Mass.	70.00	
WCFL	Chicago, Ill.	37.24	
WCGU (W2XBH)	Brooklyn, N. Y.	54.00	150
WCSH (W1XAB)	Portland, Maine	63.79	250
WCX	Pontiac, Michigan	32.00	75
WEAJ	Rocky Point, N. Y.	22.48	
WEAO (W8XJ)	Columbus, Ohio	54.02	25
WGY (W2XAF)	Schenectady, N. Y.	31.48	
(W2XAD)	Schenectady, N. Y.	19.56	
		5.00	
WHK (W8XF)	Cleveland, Ohio	66.04	500
WJR-WCX (W8XAO)	Pontiac, Michigan	32.00	
WIZ	New Brunswick, N. J.	43.45	
WJZ (W3XAL)	New York, N. Y.	49.18 to 13.95	30,000
WLW (W8XAL)	Cincinnati, Ohio	52.02	250
WNAL (W9XAB)	Omaha, Neb.	105.00	50
WNBT	Elgin, Ill. (Time Signals)	35.50	500
WND	Ocean Township, N. J.	46.48	
WOR (W2XAQ)	Kearny, N. J.	65.40	50
WOWO	Fort Wayne, Ind.	22.80	1,000
WRNY (W2XAL)	New York, N. Y.	30.91	500
WSM (4XD)	Nashville, Tenn.	31.43	
WTFF	Mt. Vernon, Va.	56.00	

(Several short waves are used for transatlantic telephony. This is private business, not broadcasting.)

On the Short Waves



EDUCATING THE NEIGHBORS

Editor, Radio News:

I have a complaint to offer and, not knowing just how to handle it, decided that you will do as well as any. Lately I purchased a fairly good short-wave receiver to learn a bit more about the code. No sooner was it installed than I found myself host to a number of friends who looked at the receiver and forthwith assumed dancing poses. Not to disappoint them, I turned the dials hoping that I might be able to pick up some short-wave phone outfit which, by some stroke of luck, would be grinding out some dance music. As might be expected, the first sound to come through the speaker chanced to be one of the commercial outfits zipping along about 40 per; a few more frantic turns on the dials only brought forth more Continental—I turned sheepish to my assembly and gave vent to a whopper; I explained the darn thing was designed only for code reception, for which I know I have been forgiven.

I find that most people are unaware of the existence of code stations and, try as I might, I cannot get them to understand what it is all about. What I want to know is, how can the public be educated in regard to this matter?

Ivan Gill,
Fort Lyon, Col.

(We might suggest that Mr. Gill refer his friends to the first article appearing in this issue; also to the rescue of the entire crew of the Florida by the America when the former ship foundered recently, and the accounts of the Vestris disaster.—Editor.)

INVITES RECEPTION REPORTS

Editor, Radio News:

The town of Fleming, Saskatchewan, is located over 200 miles west of Winnipeg, and we broadcast over this station simultaneously with CJRX every afternoon except Sundays, from 4:30 to 7:00 P. M., Central Standard Time. We greatly appreciate reports from listeners on our broadcasts and would like your readers to co-operate in this.

D. R. P. Coates,
Broadcasting Manager, James Richardson and Sons, Ltd., 1018 *Grain Exchange Bldg., Winnipeg, Manitoba.*

(While the 500-meter stations, CJRM and CJRW, are on 500 watts, CJRX on 25.6 meters has two kilowatts, and has been heard very loudly over a large portion of the United States. It operates also from 7:00 to 8:30 P. M. Sundays with church service, 9 to 10 with a concert; from 8:30 to 10:30 on Tuesdays, and from 8 to 9:30 on Thursdays, according to program enclosed.)

CHANGES IN STATIONS

Editor, Radio News:

May I suggest the following changes in your short-wave list. These corrections are based on actual reception, of which I have verifications; which are available if you wish them.

PCJJ, the Philips transmitter, has changed its call to PCJ. GBS, besides being on 24.4 meters, is also on 16.375 every day, and 34 meters also. G5SW changed its wavelength from 24.0 meters beginning December 3, and will in the future continue to work on 25.55 meters. AFK, at Berlin (Doberitz) Germany, beside working on 67.65 is also on, and heard here, on 37.65. There is no JB on short waves, as we have ascertained by writing to that broadcaster in Johannesburg.

A new station which you do not have listed, and which just opened officially on January 16, is PHOHI, a Holland-India radio-telephone transmitter at Huizen, Holland, on 16.88 meters. They have heard here R-7 testing several mornings from 1430-1500 GMT. FW, the transmitter of La Compagnie Generale Telegraphie Sans Fil, at Sts. Assise (Paris), has long since stopped working on 24.5, and now regularly works with Buenos Aires several days a week; Buenos Aires is the station on 15.02-m, and FW is on 15.55-m. The call letters of Buenos Aires are unknown; they are generally R6-7 here in the morning.

A slight error is in PCLL's wavelength—they are on 18.4 instead of 18.1. There is also some error in Java's wavelength. PLE, formerly ANE, is on 15.74 meters, and PLF (was ANH) on 17.00.

All these stations have been received in Pittsburgh. I have confirmations from PCJJ, PCLL, PHOHI, CJRX, 5SW, 2NM, GBS, FW, AFK (first time he was heard in U. S.), 2FC, 2ME, 3LO, ANH, ANE, and Buenos Aires. My receiver is built according to specifications in October, 1927, Radio News, with changes in some cases. Aero coils are used as inductances, tuned by Karas condensers.

The station heard by Arthur J. Green on Nov. 23, at 4 A. M., was 3ME, the short-wave transmitter of 3LO, at Melbourne, Australia. I was listening to them at that time and date. He may have confirmation by writing to The Broadcasting Co. of Australia, Melbourne, Australia.

Trusting the information as to stations will be of aid to some of your listeners and readers, I am,

George Morecroft, Jr.,
212 *Fruit Exchange Bldg., Pittsburgh, Pa.*

Editor, Radio News:

I wish to thank you for the story in the February issue, and at the same time tell you that JHBB (Hirasio, Japan) has changed its call letters to JIAG. I am informed of this in a verification by Mr. E. Takagishi, of the Ministry of Communications. My last verification from ANE shows his present wave is 15.74 and he is on the air from 1240 to 1440 GMT, with 25 kilowatts power. In the same mail is a verification stating that 3LO, Melbourne, is 5 kw. on 32 meters; but he comes in like he was using 40 kw. A2ME is 27.50 meters, 20 kw. Short waves is all the talk on the Pacific Coast; it won't be long now.

Donald Wright,
1123 *South Meyler St., San Pedro, Calif.*

(Radio News wishes to thank all its friends who have good listening posts for data on short-wave changes; as there has been a great deal of reallocation since the first of the year, and official reports of the situation come very slowly.)

NOTHING MORE BEYOND

Editor, Radio News:

I beg to report reception of the following stations for which I have received verifications: 6AG, Perth, Australia on 32 meters rebroadcasting 6WF programs; Godhaven, Greenland on 28 meters at 10:00 A. M. eastern standard time every day; NRH, Costa Rica, around 30 meters, comes in real well here, considering their low power; and ANE, Bandoeng, Java on 33 meters at various hours, received with fair clarity. In my estimation your magazine is always in the lead on short-wave news.

Fred J. Hellmer,
Detroit, Mich.

(Paradoxically, Mr. Hellmer's reception of 6AG places him in an unfortunate position; he has reached the limit of his DX work; for Perth, Australia, is the farthest city in the world from the United States. Incidentally, this is the first report we have had of a fan in the central states hearing Perth.—Editor.)

AN SOS FROM A STRANDED JUNK

Editor, Radio News:

If there is a fan in or near Chicago who has built the "Junk-Box" and had any success with it, I wish he would write to me. I would like to make arrangements to go and hear it work. (You have to show me: I'm from Missouri.) I have had no success after one month of worrying with it.

Donald Howard,
3724 *Parrish Avenue, East Chicago, Ind.*

(Will one of the numerous short-wave fans in the Chicago district help out Mr. Howard by a little practical demonstration?—Editor.)

TUBES FOR SHORT-WAVE RECEPTION

Editor, Radio News:

We are pleased to note that the short-wave field is the subject of your editorial for the February issue. As you know, we are the pioneers in the short-wave adapter field, having advertised constantly in your magazine since July, 1926. During this time, we have been very particular in informing our customers of the true facts of short-wave reception.

We delayed putting on the the market our A.C. model "Submariner" for something like six months, because of the failure of the UY-227 tubes to function properly below 50 meters. In answering all our inquiries in reference to an A.C. short-wave adapter, we always include the following paragraph: "While the 'Submariner' operates as effectively as any short-wave receiver or adapter when using a UY-227 5-prong detector tube in its socket, we invariably recommend the use of an Arcturus No. 127 5-prong detector tube, as the UY-227 tube does not operate satisfactorily under 50 meters."

We might state our experience with 5-prong tubes is this: all 5-prong detector tubes which use

(Continued on page 969)

The Malabar station at Bandoeng, Java, in addition to code work, maintains with Holland the longest regular radio-telephone service in the world; its broadcasts, now under calls PLE and PLF, have been heard by many in the United States. The aerial system, not shown here, is suspended from cables crossing the valley in which the buildings are located.

Conducted by C. W. Palmer

IMPORTANT NOTICE TO CORRESPONDENTS

BECAUSE of the large influx of mail, RADIO NEWS now finds it necessary to discontinue answering free of charge, all inquiries to this department. With several hundred letters received daily by this department, the editors have been taxed so severely in answering the present mail that the magazine has begun to suffer. Hereafter, therefore, only letters accompanied by our standard fee (which, by the way, covers only the actual writing of letters and stenographic help) can be considered. Kindly note these simple rules, now in effect:

(1) Correspondents asking answers by mail must enclose 25c for each separate question. Simple radio problems will be answered, but for this nominal charge we cannot make long calculations or thorough investigations.

(2) We cannot give blueprints or layouts for commercial apparatus, or data which the manufacturers have kept secret.

(3) We cannot advise, *even confidentially*, on the respective merits of trade-marked apparatus or "what make to buy."

(4) We cannot send either replies, blueprints, books or magazines C.O.D.

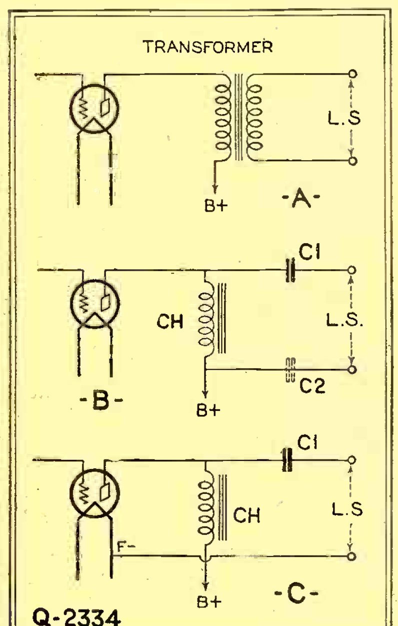
(5) When in doubt, please inquire as to the cost for our services, before remitting.

(6) Be brief. Typewrite or write legibly in ink, on one side of the sheet only. *No attention can be paid to pencilled matter.*

OUTPUT COUPLING DEVICES

(2334) Mr. M. J. Joseph, Chicago, Ill., writes:

(Q.) "Will you please supply as much information as possible as to the use of an output coupling device for a receiver? When is one required, and just what type is necessary for a particular installation? I notice that almost every set now in use uses a filter of some type; although they differ greatly in their construction."



The three standard methods of output coupling which obviate the flow of direct plate current through the speaker: A, transformer; B and C, output choke. The last is somewhat preferable.

(A.) The value of the current which actually operates the loud speaker is continually varying as the signal changes. The plate current, or output, of the last tube may be considered as an *alternating current superimposed on the direct current* in the plate circuit; since the variations in the current follow, exactly, the form of an alternating current. When an output filter is not used, the direct plate current of this tube is continually passing through the windings of the speaker; the amount of this current is dependent on several factors, including the plate voltage, the "C" bias and the resistance of the plate.

This direct current does no useful work in actuating the speaker, but is necessarily produced by the normal operation of the tube. If some method is used to separate the alternating-current *component* from the continuous or direct-current, the speaker operates just as efficiently, and actually gives better quality, since it is not loaded with unnecessary current. Also, the windings of the speaker are not endangered, since the actual signal variation is comparatively small when compared to the plate potential.

The output filter supplies a means of separating the two currents; it has also another use, that of providing a means of *matching the impedances* of the tube and the speaker. In order to obtain the greatest efficiency from a speaker, its impedance should be close to that between the filament and the plate of the last tube in the set. A transformer with properly designed windings will supply these requirements.

Fig. Q-2334 shows three common methods of coupling. The first (A) is that of using an output transformer; as mentioned above, this serves the double purpose of keeping the plate voltage away from the speaker and matching the impedance. The second method (B) employs a choke coil CH and a condenser C1; the condenser prevents the direct current from passing through the windings of the speaker, while the choke coil prevents the alternating component from being by-passed around the speaker through the "B" battery. The choke coil has, usually, an inductance of about 30 henries and the condenser a capacity between 2 and 4 mf. There is one fault in this system, and that is the possibility of getting a shock when the speaker and the ground are touched at the same time, as the speaker is at the highest "B+" voltage. This may be overcome by connecting an additional condenser (C2) at the point shown by the dotted lines; the speaker is thus entirely insulated from the plate supply.

The same results may also be obtained, without using the additional condenser, by connecting the loud speaker between the condenser and the negative filament lead. In this case, as shown at C, the alternating component still passes through the speaker, but the direct current is entirely separate.

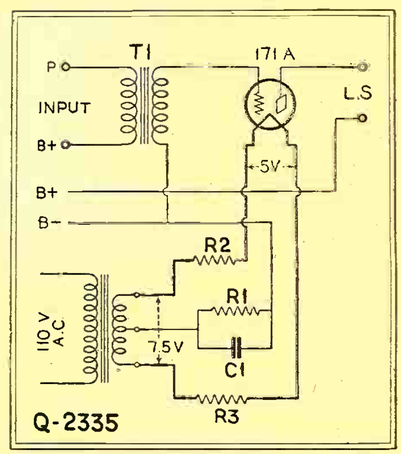
REDUCING A.C. FILAMENT SUPPLY

(2335) Mr. M. R. Smith, Flushing, N. Y., writes:

(Q.) I have a filament transformer designed for 7½-volt tubes, such as the 210 and the 250. I am using a 171 tube in the last stage in my set and I would like to use this transformer. I have tried to place a resistor in series with one side of the line to the filaments, but this produces an excessive amount of hum. Can you help me?"

(A.) In order to keep the filament current of the tube in a balanced condition (which is necessary to keep the hum at a minimum) the potential on each side of the center tap of the transformer must be the same. If resistance is added on one side, the voltage on that side of the filament is reduced and the filament is unbalanced.

If the center tap of the transformer is not used, and a variable voltage-divider or potentiometer is employed for the center tap of the filament circuit, the adjustable arm of the resistor may be used to counteract the unbalancing. A series resistor might also be connected directly to the filament terminal on the tube socket. In this way, the center arm of the tapped resistor would not need to be moved

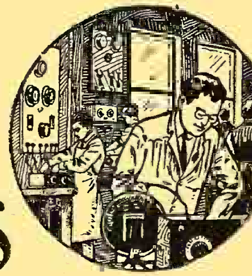


When a 171A tube is used with a 210-type transformer, hum must be filtered out as shown. The two resistors R2-R3 balance the voltage drop.

from the mechanical center, and a fixed tapped resistor could be employed.

When using a center-tapped transformer, however, this method of reducing the voltage is not practical; since it causes an unbalancing of the filament circuit. The obvious way of overcoming the difficulty is, of course, to place two resistors (R2, R3, in Fig. Q-2335) in the circuit, one in each side of the filament supply. In this way, the voltage on each side of the center tap is kept the same and the hum is naturally reduced to a minimum. The actual value of the resistors depends on the filament current and the amount of voltage reduction required. Ohm's law is used for this calculation—that the resistance is equal to the voltage drop divided by the current in amperes. In this case, the voltage drop is equal to 7½ minus 5 volts or 2½ volts; the 171A tube draws ¼-ampere, so the resistance should have a value of 10 ohms. Each side would then need 5 ohms, in order to produce the required voltage-drop. The center tap of the filament transformer is connected to the negative "B" lead and grid return through the resistor R1 in order to supply the required "C" bias for the power tube. R1 is 2,000 ohms and C1 at least 0.5-mf.

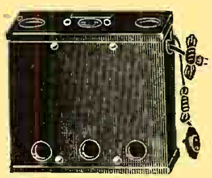
Radio News Laboratories



RADIO manufacturers are invited to send to RADIO NEWS LABORATORIES *samples of their products for test. It does not matter whether or not they advertise in* RADIO NEWS, *the* RADIO NEWS LABORATORIES *being an independent organization, with the improvement of radio apparatus as its aim. If, after being tested, the instruments submitted prove to be built according to modern radio engineering practice, they will each be awarded a certificate of merit; and that apparatus which embodies novel, as well as meritorious features in design and operation, will be described in this department, or in the "What's New in Radio" department, as its news value and general interest for our readers shall deserve. If the apparatus does not pass the Laboratory tests, it will be returned to the manufacturer with suggestions for improvements. No "write-ups" sent by manufacturers are published in these pages, and only apparatus which has been tested in the Laboratories and found of good mechanical and electrical construction is given a certificate. As the service of the* RADIO NEWS LABORATORIES *is free to all manufacturers, whether they are advertisers or not, it is necessary that all goods to be tested be forwarded prepaid, otherwise they cannot be accepted. Apparatus ready for, or already on, the market will be tested for manufacturers free of charge. Apparatus in process of development will be tested at a charge of $2.00 per hour required to do the work. Address all communications and all parcels to* RADIO NEWS LABORATORIES, 230 *Fifth Avenue, New York City.* **Readers will be informed on request if any article has been issued a Certificate of Merit.**

VOLTAGE REGULATOR

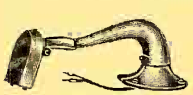
The "Type VR-1" A.C. voltage regulator shown, submitted by the Acme Apparatus Corporation, Cambridge, Mass., has been designed to maintain a constant output of 110 volts when operated from a supply, in which there are variations from 90 to 135 volts. The automatic regulation is accomplished by introducing a combination of capacity and inductance which governs the effective voltage by setting up a phase-difference between two portions of the primary circuit. It is designed to handle a continuous load of 60 watts; and was tested under full load at four input values, 100, 105, 115 and 120, from all of which was obtained a 110-volt output. The device is 7¼ inches wide, 6¾ inches high and 3½ inches long, and is provided with a six-foot two-wire cable and plug for the light-socket supply and a two-wire cable and "on-off" switch. An output receptacle at the top of the housing connects to the device to be operated. The metal housing is of black crystalline finish, with ventilating holes.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2546.

PHONOGRAPH PICK-UP AND TONE ARM

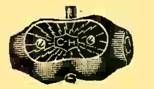
The phonograph pick-up submitted by the Buckingham Radio Corp., 440 West Superior St., Chicago, Ill., is of the electro-magnetic type and when used in connection with the amplifying system of a radio receiver, will give excellent reproduction of music and speech from phonograph records. The balanced armature is factory-adjusted for maximum sensitivity and volume. The pick-up unit is housed in a closed case of horse-shoe shape, 2⅛ inches wide, 2⅝ inches long and ¾-inch thick. A special bracket, fastened to the back of the housing by screws, forms part of a hinged joint, the other side of which is integral with the tone arm; the length of the latter is 9½ inches and its height 3¼ inches. It is pivoted and swings over a restricted arc on its base support, which has three holes for fastening to the motor-board by wood screws. Both pick-up and tone arm are of a polished bronze finish. A special adapter is provided for connection to a radio receiver.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2550.

POWER SWITCH

The "Type 70-50 Feed-Through" switch submitted by the Cutler-Hammer Manufacturing Company, P. O. Box 1564, Milwaukee, Wis., has been designed for insertion in a power circuit to control current not exceeding 6 amperes at 125 volts. The switch mechanism is of the toggle two-button type, and housed in molded brown bakelite; connections are made or broken by snapping in or out the buttons which, by a molded bakelite lever, operate a spring connected to the movable contact arm.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2551.

LOOP ANTENNA

The collapsible loop antenna submitted for test by Paul Rinkel, Charlottenburg 4, Sybelstra. 69, Germany, when tuned by a .0005-mf. condenser will cover the broadcast waveband from 200 to 550 meters. The trapezoidal loop is of box type, having 14 strands of flexible wire separated ½-inch, and is supported at the base of the walnut frame by a special wooden support which pivots on a special wooden tripod. The width of the frame is 5 inches, and it is held apart at each of the four corners by threaded bakelite rods; the alternate threads of the rods are used for spacing the turns. The over-all height when extended is 26 inches, 24 inches long and 6½ inches wide; when collapsed the loop can be stored in a space 24 inches long, 2½ inches deep and 7 inches wide.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2552.

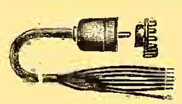
POWER-ANTENNA SOCKET

The "Beldentenna" shown here, submitted by the Belden Manufacturing Co., 2300 S. Western Ave., Chicago, Ill., has been designed for use where both an extension for the 110-volt house lighting supply and a light-socket antenna are desired for a radio receiver; it consists of a 10-foot double twisted cable, provided at one end with a receptacle plug and at the other with a molded receptacle in which is placed a condenser for connection to the "Aerial" post of the receiver. The capacity is .00015-mf. A five-foot single lead, provided with spade terminals, is used to connect the condenser terminal on the molded receptacle to the "aerial" post.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2553.

CABLE PLUG AND SOCKET

The "No. 780" cable assembly submitted by Herbert H. Frost, Inc., Elkhart, Indiana, has a black molded-bakelite socket of substantial construction. Further to increase its strength, the pin sockets have been spun into the molded socket base and prevent possibility of cracking, which might occur if they were molded together. The terminal prongs are of ample size, and present a large contact surface; they are so constructed and fastened within the plug that they cannot be loosened by ordinary usage. The color code of the wires is molded into the bakelite to prevent possibility of confusion; their special arrangement prevents the contacts being made in any but the proper positions. The cable leads are encased in a braided and woven sheath; the length over all is five feet.



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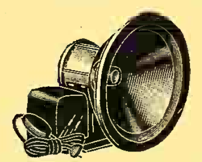
DYNAMIC SPEAKER CHASSIS

The reproducer shown here, submitted by the Leslie F. Muter Company, 76th and Greenwood Ave., Chicago, Ill., is of the A.C.-operated electro-dynamic type. The moving coil, of low resistance, is connected to the output of the radio receiver through a specially-designed speaker input transformer. The field winding is of the 100-volt type with high resistance; power is supplied from a step-up power transformer, whose output is converted to direct current by a full-wave (280-type) rectifier tube, and filtered by a specially-designed unit. The cone, 8 inches in diameter, is anchored to the speaker frame by thin kidskin strips 1 inch wide, which are cemented around the edge of the cone. The chassis base is 11 inches long and 5 inches wide; the depth of the speaker is 8 inches, its height 10½ inches and its width 11 inches. The speaker handles tremendous power, with good reproduction of music and speech.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2557.

AUDIO TRANSFORMER

The "No. 391" audio transformer submitted by the Pilot Electric Mfg. Co., 323 Berry Street, Brooklyn, N. Y., has a winding ratio of 3½-1, and is of excellent mechanical and electrical design. Upon measurement it was found to have a very good frequency-characteristic. The transformer is mounted in a molded bakelite case where it is held in position and sealed against moisture by the impregnation of a black waterproof sealing compound. The whole height of the transformer is 3½ inches; it is 3 inches long and 2½ inches wide. Terminal designations are etched on a metal plate, which is riveted to the top of the transformer case.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2558.

SHIELDED R.F. COIL

The "Type A.C. 226" R.F. transformer shown here, submitted by the Twin Coupler Co., Poughkeepsie, New York, has been designed for use as an interstage radio-frequency transformer when used in connection with the 226-type A.C. tube. This coil may be used also in battery-operated sets, in which the 201A-type is employed, with very satisfactory results. Its measured secondary inductance is 240 microhenries; and when tuned with a .00035-mf. condenser, it covers the waveband from 200 to 550 meters. The coil is of the small-field type; being wound on a 1¼-inch tube, 2½ inches long, and mounted on a disc (provided with either four prongs for an interstage coupler, or five prongs for use on an antenna coupler) which is in turn placed in the bottom of an aluminum can 2½ inches in diameter and 3⅜ inches high. The arrangement of the prongs on the base is adapted for plugging into the standard UX or UY tube sockets.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2559.

(*Continued on page 971*)

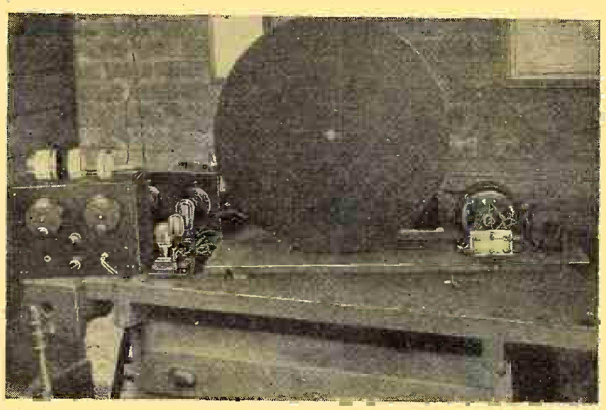
Successful Home Television

(*Continued from page 923*)

readily. Decrease the friction, and the image will rise if the speed is too great, or descend if it is not sufficient; in either case, it will be quickly brought to adjustment.

Mr. Demikis, whose station is at 3128 Warren Avenue, Chicago, gives the following figures for the constants of his apparatus, diagrammed herewith (Fig. 1): Coils for short-wave set, primary 8 turns No. 18, S.C.C.; secondary 40 meters, 6 turns No. 18, 80 meters 13 turns, broadcast range 70 turns No. 24 S.C.C.; tickler 6 to 10 turns No. 24 S.C.C.; grid leak, 3-megohm; grid condenser .00025-mf.; variables, C 170-mmf., C1 300-mmf.; choke coil RFC, 150 turns No. 28 D.C.C. on a one-inch tube; C2, .001-mf.; C3, .01-mf.; R, 0.1-meg.; R1, 1-meg.; R2, 0.5-meg.; R3, 0.25-meg. In sketch, I is an idle motor used as a bearing, D the driving motor of the disc, and R the reversing switch.

The reactance coil used, whose dimensions are given, is wound with No. 13 S.C.C. wire.



A glimpse at Mr. Demikis' televisor assembled for operation. The constructional data are given in the text.

TELEVISION SCHEDULES

Radio News will be glad to hear from other experimenters who have had good results with picking up television signals, and who have found changes or adjustments in the apparatus effective. While there has been some delay in the progress of television broadcasting on the longer waves, because of the restrictions placed on this work by the rulings of the Radio Commission, it is still continuing on short waves. Some of the more or less regular schedules reported are:

W1XAY, Lexington, Mass., 62 meters (just below KDKA); "standard" scanning—48 lines, 15 frames a second—3 to 4 p. m. and 7:30 to 8 p. m., E.S.T. Power 300 watts.

W8XAV (KDKA) 62.5 meters, 60-line, 20 frame; largely motion-picture work. 5:10 to 6 p. m., E.S.T., Mondays, Wednesdays and Fridays. Power, 2 kilowatts.

W3XK, Washington, D. C., 187 meters and 47 meters, standard; 8 to 9 p. m., E.S.T., Monday, Wednesday and Friday. Radio movies only. Power, 250 watts, with a 5-kilowatt transmitter authorized.

W2XAD (WGY), Schenectady, N. Y., has been conducting tests on a special 19.56-meter wavelength, considerably shorter than its former wave, on Tuesdays, Wednesdays and Fridays from 1:30 to 2 p. m., E.S.T. and from 11:45 to 12:15 p. m. on Sundays. W2XAF, on 31.48 meters, operates on Tuesdays from 12 to 12:30 p. m. These are 24-line, 20-frame pictures.

Other stations are under construction, or awaiting a final assignment of frequency and hours, like WRNY-W2XAL and WCFL-W9XAA. In these cases the short-wave transmissions had been made simultaneously with those on the broadcast band. By the time that this issue reaches the reader, it is probable that greater activity will be under way in television broadcasting.

The Radio Corporation of America has been authorized to operate at New York a 5-kilowatt transmitter on 20 meters, under the call W2XBW. The short-wave transmitter W4XA of station WREC, Memphis, is on 122.5 meters; that of W6XC, Los Angeles, on 66 meters. (As television channels for short-wave work run up to 100 kilocycles, they are much wider than speech transmission in their tuning.)

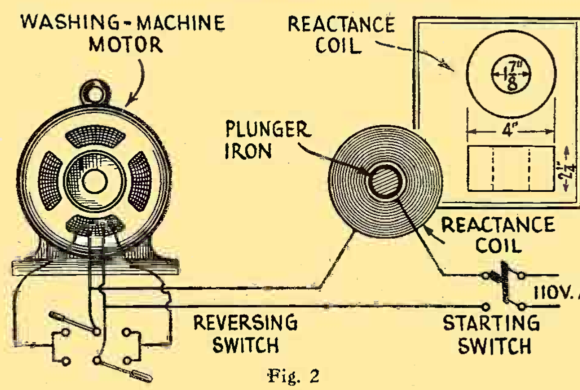


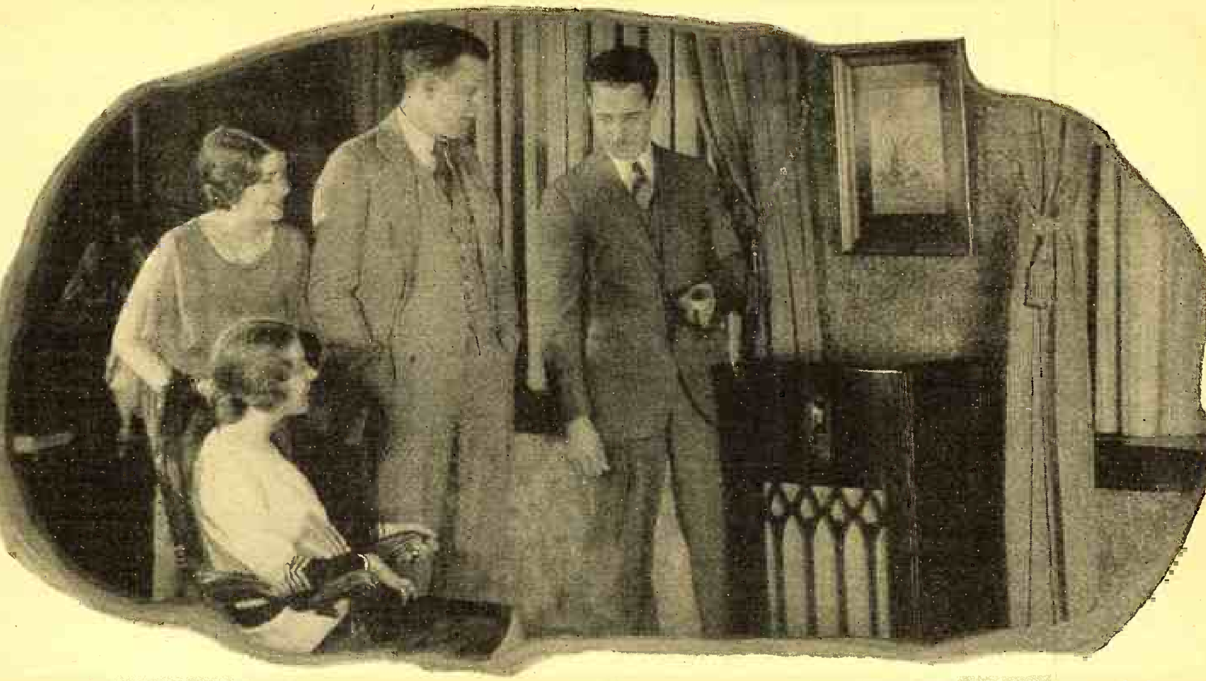
Fig. 2

The connections of the regulating mechanism. A plunger iron, by increasing the reactance of the coil, slows the motor accordingly.

Experimental visual broadcast channels between 130.36 and 149.76, and between 101.63 and 109.03 meters have also been indicated by the Commission; and for the amateurs, the lower part of the uppermost band (150–175 meters) and the 5.00-5.35-meter range. The latter, however, is highly experimental for even the most advanced amateurs.

TELEVISION ON A RURAL ROUTE

Another experimenter who has been receiving the "radio-movie" transmissions over



They Could Hardly Believe Their Own Ears — when I Switched to *Ground Wave Reception*!

"IT'S no use trying to listen in to-night," said Bill as I took his hat. "Jane and I tried to get reception during dinner but all we got was static. It's usually this way—just the night they broadcast Paul Whitman's band or some other good program it's spoiled by howls and fading. Why own a radio at all?" he ended up disgustedly.

"Perhaps my set will do a little better," I suggested. I had a surprise in store for him!

"He looked doubtful as I turned on the set switch. I had left my old aerial antenna attached on purpose and soon the room was filled with an ear-splitting excuse for music. Manipulation of the dials only served to make it worse or to choke down reception until it was hardly audible. Occasionally it faded out altogether and I could picture the roof aerial swaying helplessly in the strong wind. Then the jumble and howls would start up again until my wife finally shouted above the din, "Turn that thing off—it's terrible!"

"Satisfied, I laughed and disconnecting the old aerial and ground wires, I then attached the lead-in wires of my new underground antenna, which I had installed just before dinner. "Now listen!" I commanded.

The Thrilling Test

"As though by magic, the sweet high notes of violins, the stirring sobbing of saxophones, the clear pure notes of a clarinet brought Bill to his feet! Jane looked dumbfounded. Even my wife, who had not paid much attention to my preliminary tests, was amazed. "What did you do to it?" she demanded. "I think he bewitched it," Jane accused. The music went on, clear and strong, with only a long moan or slight jumble now and then to remind us of the storm raging outside. The static was so greatly reduced that we hardly noticed it. The important thing was—we were getting one of the year's best programs with scarcely any trouble on a wild, stormy night.

"You see," I explained later to Bill, "I buried my new underground aerial about two feet below the ground, where wind and storms can't affect it so easily. It has certainly been proved tonight that radio waves are just as strong in the ground as they are in the air. They call this thing "Subwave-Aerial" and it's insulated some way to keep out interference and noise. It's combined with a scientific ground so I'm sure now that I have the correct ground connection. And all this isn't costing me any more than my old aerial antenna that I've nearly broken my neck repairing after wind storms like this. And last but not least," I finished triumphantly. "I'll never need to touch it again. It's guaranteed for 25 years."

"Hardly necessary to say that Bill went home with the name and address of the Subwave-Aerial manufacturers in his pocket."

SUBWAVE-AERIAL GETS DX INSTALLED 50 FEET FROM 60,000 VOLT POWER LINE

Underground Aerial Products,
Suite 618, St. Clair Bldg.,
St. Clair and Erie Sts., Chicago, Ill.

Gentlemen: Regarding a test with your underground aerial, "Subwave-Aerial." On January 27, 1929, Mr. Frank Smith and I drove out near the Sanitary District power plant in a Ford Sedan. We stopped about 50 feet distant from the plant's 60,000 volt transmission line and dug a small hole, into which we dropped the Subwave-Aerial. We left the two sets we brought with us in the sedan, attaching the lead-in wires of the Subwave-Aerial first to one, then the other. One set was a 5-tube Freshman—the other a single dial Atwater-Kent, Model 35. We used the Ford battery.

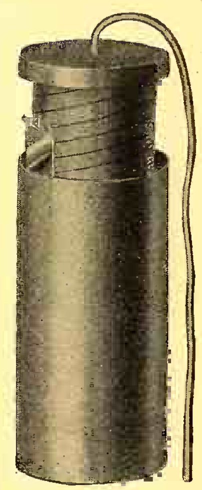
At 15 minutes to six we got WCCO, St. Paul, Minnesota. It came in loud and clear at 27 on the dial. There was not the slightest interference from the 60,000 volt power transmission line only 50 feet away. At 20 minutes after six, we got Toronto, first on one set and then the other. We plainly heard the program, which was being sponsored by a Spartan Radio dealer.

It was impossible to get reception at all with an overhead aerial under the same conditions.

Yours truly,
F. Bennett Smith,
Harry R. Jackson.

Test It Yourself—Free!

The above story illustrates the results for which the designers of the Subwave Aerial struggled for months. At last, enthusiastic reports such as this from Radio Experts reproduced here, proved that they had succeeded. Now you have a chance to prove the merits of this great new radio development for yourself. Try, if possible, to pick a night when static is bad and make the thrilling test. It's fun! And if you are not more than pleased with Subwave-Aerial, the test won't cost you a cent. We feel safe in saying, however, that once you've heard the amazing difference in reception and realize the wonderful convenience of this modern combined antenna and ground, you'll wonder how you ever put up with the old-fashioned, dangerous, inefficient methods. Be sure to send at once for all the interesting details on the development of Subwave-Aerial. It's the newest, most thrilling thing in the romantic world of radio! Use the coupon below. Fill it in and mail it NOW!



UNDERGROUND AERIAL PRODUCTS
Suite 618, St. Clair Bldg.
Dept. 827-E.W.,
St. Clair & Erie Sts.
Chicago, Ill.

UNDERGROUND AERIAL PRODUCTS,
Suite 618, St. Clair Bldg.,
Dept. 827-E.W.,
St. Clair & Erie Sts.,
Chicago, Ill.

Rush illustrated literature on the new Subwave-Aerial and details of your Free Test Offer.

Name...

Address...

City.................................... State....................

a considerable distance is Bernard Bierhals, of Fond du Lac, Wisconsin, which is nearly 700 miles airline from Washington. He writes: "I have been receiving these for the past several weeks, and have received some good images, though I have been bothered a lot with fading. On January 11

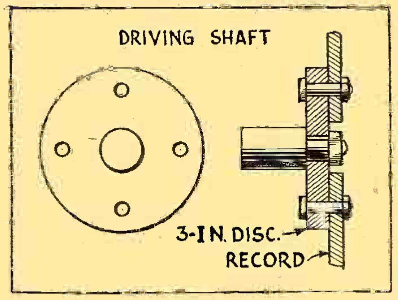


Fig. 3
The taking up of screws on one side or the other corrects warping of a record disc.

I was able to see the movements of the little girl with the ball very plainly for about ten minutes.

"I am using a detector and five stages of resistance coupling; the scanning disc is a 12-inch phonograph record drilled with 48 apertures, 1/32-inch. Several images appear at the same time, but I am able to maintain better synchronization. I use a 6-volt auto-horn motor, which drives the disc nicely, because I have no electric light.

"As all discs wobble, I mount my disc by the following method, which may be of interest to other experimenters; a 3-inch disc is cut from a piece of hard rubber. A hole is drilled in the center and four around the edge; the record is then drilled to match. Four 6/32 screws are run through disc and

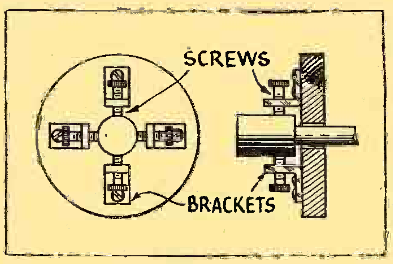


Fig. 4
The screw method indicated is to center the phonograph record used as the scanning disc.

record, and by adjusting them the record may be made to run very smoothly. In case there is a slight eccentricity, brackets may be mounted as shown (Fig. 2) and by adjusting these it may be removed." (NOTE: *The high speed of revolution of a television disc renders it highly desirable to* KNOW *that its fastenings are strong enough to withstand any strain which may be put upon them, even though the disc be of light material.*—EDITOR.)

Movie Radio Messages

(*Continued from page 908*)

Storage batteries are used throughout for all receivers, the former being cared for by means of a "charge-discharge" cabinet in which all batteries are contained; suitable charge-discharge switches are mounted on the doors of the cabinet.

A remarkable feature of the traffic now being carried on with the Byrd expedition is found in the "duplex" transmission and reception being accomplished by both sides. In order to meet the extremely heavy traffic of transmitting press dispatches, which often total 3,000 and 4,000 words during the course of an evening, Byrd's operators have found it more convenient to employ two transmitters, operating simultaneously and each handling its share of the traffic.

To co-operate with this emergency measure the *Times'* radio staff has installed a "remote-control" receiver, located in Mr. Meinholtz' home, about twenty-five miles from Times Square. In this manner, the latter receiver and the set in the station are engaged in copying simultaneous transmissions from the Antarctic; thus cutting the time required in half.

What's New in Radio

(*Continued from page 913*)

The characteristics of the new tubes, which may be preserved for reference with previous tables, are:

	A.S. Screen-Grid Tube	Intermediate	Power Tube
Filament volts (A.C.)	2.25—2.5	2.5	2.5
Control-grid volts	1.5	....	....
Screen-grid volts	75	....	....
Plate volts	180	180	250
Bias volts	....	33	50
Amplification	420	3.5	3.5
Plate resistance, ohms	400,000	6,000	6,000
Mutual conductance	1,050	1,800	1,850
Plate current, milliamps	4	26	32
Output impedance, ohms	....	1,950	1,900
Max. undisturbed output, milliwatts	....	750	1,600

Manufacturer: *Radio Corporation of America, New York City.*

An EXTRA $12.50 a week as a starter!

Rockville, Conn.

Chemical Institute of New York, Inc.,
66 West Broadway,
New York, N. Y.

Gentlemen:

You will probably be pleased to learn one of the lessons gave me an idea to turn my chemical knowledge to profitable account. I am now making a varnish and paint which undersells the other type products by $2.60 a gallon, in some cases more. Have been receiving gallon orders from painters during past week which has netted me a profit of $13.50 for my "spare-time chemical industry. Many thanks for your training thus far.

Youre very truly,

James J. Kelly

Chemistry Student turns Knowledge into big Sparetime Profits!

Because he knew how to prepare his product from a knowledge of chemistry, J. J. Kelly produced a highly profitable article far below the price of organized competition. Sales came easy—because competition was overcome. Chemistry solved his problem.

Boundless Sparetime profit opportunities from Chemical Formulas—for those who grasp them

Chemical Formulas are the basis of, not one, but *thousands* of big profit sparetime businesses, such as selling soaps, cleaning and polishing compounds, paints, acids, inks, cements, extracts, glues, gold, silver, and bronze lacquerings, oils, perfumery, rust removers, etc.

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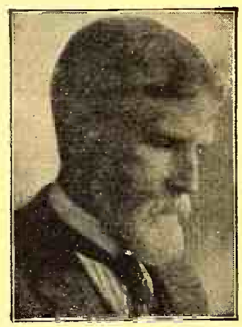
To qualify for this remarkable calling requires careful specialized training. Formerly it was necessary to attend a university for several years to acquire that training, but thanks to our highly perfected and thorough system of instruction, you can now stay at home, and let us educate you in Chemistry during your spare time. Even with only common schooling you can take our course and equip yourself for immediate practical work. Dr. Sloane gives every one of his students the same careful, personal supervision that made him celebrated throughout his long career as a college professor. Your instruction from the very beginning is made interesting and practical, and we supply you with apparatus and chemicals for performing the fascinating analyses and experimental work that plays such a large part in our method of teaching, and you are awarded the Institute's diploma after you have satisfactorily completed the course.



T. O'CONOR SLOANE
A.B., A.M., LL.D., Ph.D.

Noted Instructor, Lecturer, and Author. Formerly Treasurer American Chemical Society and a practical chemist with many well-known achievements to his credit. Not only has Dr. Sloane taught chemistry for years, but he was for many years engaged in commercial chemistry work.

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We give to every student without additional charge his chemical equipment, including fifty-two pieces of laboratory apparatus and supplies, and fifty-two different chemicals and reagents. These comprise the apparatus and chemicals used for the experimental work of the course. The fitted heavy wooden box serves not only as a case for the outfit but also as a useful laboratory accessory for performing countless experiments.

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Clip the coupon below and mail it at once. Your name and address on the coupon will bring you by return mail our interesting free book, "OPPORTUNITIES FOR CHEMISTS," and full particulars about the course and what it will do for you.

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Please send me at once, without any obligation on my part, your free Book, *Opportunities for Chemists*, and full particulars about the Experimental Equipment given to every student. Also please tell me about your plan of payment.

Name..

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The "Space-Charge Autodyne"

(*Continued from page* 932)

After the proper precautions have been observed, the shield is taken apart and the proper components are mounted on the bottom section; the matter of exactness in drilling hardly need be mentioned, after the illustrations have been seen. So close are the components mounted in relation to one another, that it is obvious the design of the set shown here will not tolerate an error in mounting any instrument.

While it is true that the possibility of grounding the terminals of the various components is constantly before the constructor during the course of assembly, there are actually only two cases where special care must be taken; these in mounting the amperites, R5 and R6. One of the mounting details is shown in Fig. 4 and illustrates a simple but efficient method of avoiding short-circuits to the shield; simply elevate the mountings on three or four metal or fiber washers. Still another method is to place a strip of cardboard under the mounting.

In the same compartment with the amperites are the audio-frequency transformer T1, which is a rather small component having a 6:1 ratio, and the resistance coupling

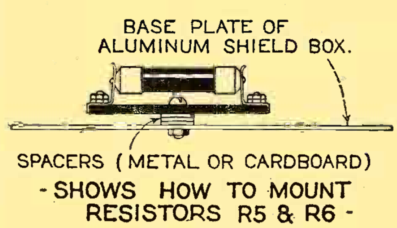

Fig. 4
The metal end pieces must be kept from contact with the shield, to avoid a short-circuit of the "A" battery.

unit comprising the .01-mf. fixed condenser C7 and two resistors, R3 with value anywhere between 50,000 to 250,000 ohms, and R4 with a value up to one megohm. The latter two constants are to be found by experimentation and the best resistance, when determined, is adopted. The radio-frequency choke coil RFC is a manufactured product with inductance of 1½ millihenries, and is convenient for this particular type of layout because its bakelite casing prevents any danger of shorts to the shield. The sockets, of course, require no special mounting instructions, nor do the phone-tip jacks, J-J; in the former the solid bakelite form offers no difficulty, while in the latter fiber washers are supplied by the manufacturer for mounting these components on conductive surfaces.

ANTENNA REGULATION

The antenna coupling condenser C1 may be constructed by the builder in any form he desires; such a capacity-introducing device has been described so often that it has become something of a pastime to devise new methods of assembling these gadgets. Some builders employ coins, such as pennies, dimes or nickels, separated by the space of a fraction of an inch, which is adjustable; others construct more pretentious affairs weighed down with adjusting screws and what not, offering very fine adjustment.

All in all, the antenna coupling capacity is obtained by nothing more than two small pieces of metal forming a condenser; such a component is shown in Fig. 5. A hard-rubber or wooden block, about ¾-inch square, will serve for the base. The mounting block used in this receiver measures ¾x½-inch and is cylindrical in form; however, this does not mean that the constructor need run about looking for an object resembling in every detail the one used.

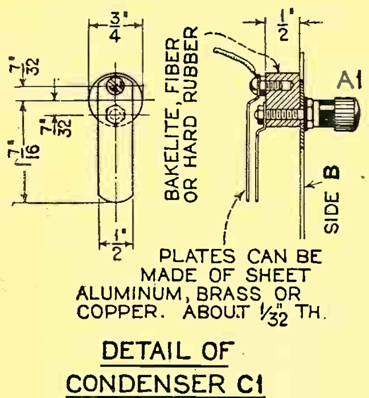

Fig. 5

Any means of varying the distance between two small, flat, insulated pieces of metal will do for this purpose.

The illustration requires no further explanatory note as its simplicity is obvious. The aerial post A1 must not make contact with the shield, and for this reason a fiber or pasteboard washer is placed between the shield and the post; the second aerial post A2 also is mounted with similar precautions. In the case of the ground post, however, matters are quite reversed; here care should be taken to see that this post *makes* proper contact with the shield.

The arrangements in the other two compartments, housing the radio-frequency and detector units, are sufficiently simple to require no detailed instructions regarding their assembly.

COIL DATA

The wavelength range of this receiver is 17-203 meters; this is covered by the use of two sets of four coils each. Each coil has three windings—primary, secondary and tickler—and is wound on a special bakelite form somewhat larger than a UY-type vacuum-tube base, although fitted with the prongs of the latter. As one wire from the primary winding is connected to one end of the secondary, only five prongs are required; even though the coil has three windings which at first glance may appear to require six terminals. To standardize construction when employing these forms, the prongs have been so arranged that they fit all UY sockets.

While these coils and forms may be made by the constructor, the forms, or even the completed coils, may be obtained so cheaply that it does not pay to go to the trouble. However, for those who must exercise their ingenuity, data for these coils are offered in Fig. 3. The manufactured coil form is ribbed to reduce the area of contact between the wire and the dielectric; but this is not an essential construction, although it does increase slightly the efficiency of the coil.

In winding the coils, No. 24 D.S.C. wire is used throughout; the primary is located near the base of each form, the secondary is wound at the top and the tickler in the center. All are wound in the same direction and a distance of ¼- to ½-inch

is left between each pair of windings. After the coils have been completed, some distinguishing mark may be placed on each so that they may easily be identified. Painting each, or some part of each, a different color is a rather efficient way of solving the problem; the manufactured coils are red for the shortest waves, then orange, yellow and green. Fig. 3 gives the number of turns required on each winding, and also the wave-length range of each coil.

ACCESSORIES AND OPERATION

After the receiver has been completed, it is suggested, all circuits should be gone over with a meter; in order that short-circuits may be caught before such treasures as screen-grid tubes could be sacrificed on the altar of high-voltage. First of all no "A" or "B" power units of any type should be used with a short-wave receiver; this narrows us down to batteries. Following this course, the constructor must decide what type of tube he desires to employ; if he chooses the dry-cell type, he must obtain three cells of the familiar bell-ringing type commonly referred to as No. 3s; these are wired in series—that is, center post of one to outer post of the next, and so forth. The "B" batteries must meet the same requirements, regardless of the type of tubes used; three 45-volt blocks are required for efficient operation of this receiver. The matter of "C" batteries depends upon the type of tube employed; when using the 199- and 120-types as specified in this article, a 22½-volt block having a 4½-volt tap is required. However, if the constructor uses storage-battery tubes he will require two 4½-volt "C" blocks; as the 201A-type requires just 9 volts for "C" biasing with 135 on the plate, while 4½ volts "C" is sufficient for the first audio stage.

When changing to the 201A-type tube in the audio stages, it will also be necessary to change the value of the amperites to conform with the tubes and voltage of the supply used.

AERIAL AND GROUND

Another important consideration in the use of this receiver as in all others, is the choice of aerial and ground systems. The circuit employed allows the use either of the regular broadcast antenna or, if the constructor desires to erect it, of a special antenna for short-wave reception. When the former is utilized, the lead-in is connected to the aerial post A1; in which case grid coupling results through the antenna coupling condenser C1; a short aerial, not over 40 or 50 feet in length over-all, would be connected to the aerial post A2. At any rate, it is suggested that the experimenter try a number of antennas to find which one is best suited for his particular locality. (See also page 918.)

The ground system is purely a matter of convenience; try everything available.

AT THE EXHIBITION

RADIO PEST: "Gosh, what kind of a little set is that?"

RADIO HAM: "This is a short-wave set that will tune in Australia. It works from 15 to 75 meters."

RADIO PEST: "Where are all them meters? I can't see but one."—*Rudolph W. Nothnick.*

Some Methods of Detection

(Continued from page 917)

DIFFERENCE IN RESULTS

The distortion mentioned at the beginning of the article should now be understood more thoroughly and we can see that, although some distortion is always present, it does not have much effect on the quality of the signals. The advantages of the plate-current method of detecting are in the amount of current which may be handled without overloading the detector. By increasing the plate voltage and readjusting the grid bias, the tube may be arranged to handle much more current than usual and, in some cases, plate voltages of 100 to 200 are used with correct "C" biases in order to handle the very large grid-voltage variations produced by the incoming signals. The disadvantages of the system are the lessened sensitivity and the necessity of using a separate battery for the detector's grid bias.

In describing the action of the vacuum tube as a detector when using the grid-current method, it is advisable to refer to the action of the electrons sent out by the hot filament. When a positive bias is placed on the grid, the grid *attracts* the electrons sent out by the filament. But when a negative bias is used, the grid *repels* the electrons.

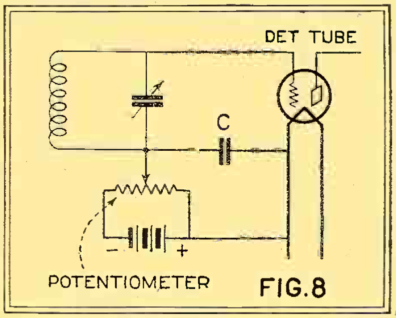

FIG. 8

When a detector has many tubes ahead of it, the arrangement shown is preferable to that of Fig. 7, as it permits a larger signal-voltage "swing."

Rectification in the grid circuit (as in the plate-current method) is also dependent on an unequal variation of current, as the signal changes from positive to negative during each cycle. In this case, it is the varying of the grid *current* that produces rectification. In Fig. 9, we have another graph similar to Fig. 5, but with the *grid current* plotted in place of the *plate current*. It will be noticed that in this curve, there is a comparatively sharp "bend" at the lower end.

If the grid leak is of the proper resistance, it will bias the grid circuit to the point indicated. Since the "+" half of the radio-frequency current has a greater effect on the grid current (as shown in the shape of the resulting curve due to the sharp bend) the grid current gradually increases. This increase in the grid current causes an increase in the current flowing through the grid leak. This increase in the current flowing through the grid leak causes an increase in the voltage drop, in accordance with Ohm's law (voltage drop equals the product of the current and the resistance) and

(Continued on page 953, opposite)

(*Continued from previous page*)

causes a reduction in the positive grid potential. Since a reduction in the grid voltage causes a reduction in the plate current, there is a gradual increase and decrease in the plate current following the signal changes; and this produces the required rectification.

With rectification occurring in the grid circuit, the *amplification factor* of the tube is utilized, and causes this system to be more sensitive than the plate-current rectification method. The use of a "high-mu" tube as a detector will increase the sensitivity, although the detector is apt to be more critical. The advantage of the grid-current method of obtaining rectification is apparent from the above description. The disadvantage is in the fact that the bend in the curve (Fig. 9) occurs at a point very near to zero potential and, for this reason, the detector is liable to be overloaded very easily. It will be noted that the signal curve is distorted in this method as well as the other.

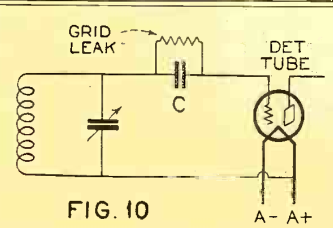

FIG. 10

The most common method of detection is that shown; it is best for small sets.

The method of connecting the gridleak in the circuit is shown in Figs. 10 and 11; the grid leak may be across the grid condenser as in the former, or lead directly to the filament, as in the latter. In order to find the most efficient point for the detector, the grid leak may be connected to the center arm of a potentiometer in the filament circuit (Fig. 12). The arm is then moved until it is found that the detector is operating at its best.

REMOVING TUBE DISTORTION

In this analysis of the effect of the tube's characteristic on the waveform of the de-

(*Continued on page 955*)

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Spring 1929 Issue

JOHN F. RIDER, engineer and author of several radio text books, who has been connected with the art of Radio since 1911, is now MANAGING EDITOR of our magazine.

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Methods of Detection

(Continued from page 953)

tected signal, we have illustrated the R.F. component. But it is evident that this distortion must apply also to the waveform of the A.F. signal, even though to a smaller extent. As a matter of fact, this effect is

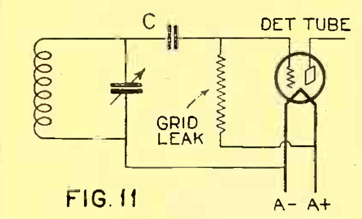


FIG. 11

The leak serves the same purpose as in Fig. 10 but is not in series with the tuned circuit or across the condenser. A more convenient connection when using a gang condenser.

difficult to recognize in a properly-made receiver, unless the detector is overloaded, but is nevertheless present and to be accounted for. Several systems have been advocated for the reduction of this, but most of them do not improve the results to a worth-while degree. One which has been suggested is the use of an audio-frquency choke coil in place of the usual grid leak in the grid-current detection method; this is satisfactory except for one thing. The impedance of most A.F. choke coils is not even over the audible frequency-range, and this will introduce distortion of its own; so that the results are not improved but might rather be made worse.

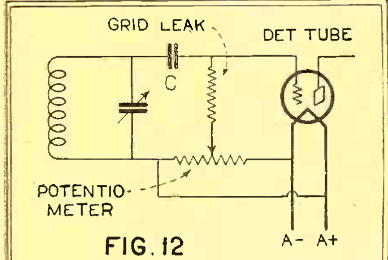


FIG. 12

Even with the grid leak, the potentiometer will be convenient for adjusting the grid bias and finding the point of greatest sensitivity.

For the average set, using one or two stages of tuned-radio-frequency amplification, the grid-leak method is probably the most satisfactory, because of its greater sensitivity. For superheterodynes, or sets using a greater number of radio-frequency stages, the "C" bias method is more satisfactory, because of its higher current-carrying capacity.

CROSS YOUR FINGERS—NOT YOUR WIRES

Of all sad words of radio boobs—

The saddest are, "I've blown the tubes!"

—Ted Hagedorn.

The Service Man

(Continued from page 934)

aerial, like the overhead aerial, must be extended at full length to give maximum pick-up. This involves digging a trench (or, in some soil, a hole might be "jetted" as in laying small water pipes) and is not possible for many set owners whose grounds are limited; but if it can be done, it is worth the effort.

On the other hand, an underground aerial may be coiled into small space, but, as with a loop, the lessened area of the electric field which it cuts results in less flow of current in the aerial. With a set of very high amplification in the R.F. stages, this matters little; because there is ample reserve of power for any but the weakest signals. The owner of a small set, however, will observe a decrease in the signal; and perhaps blame the aerial. Even in this case, the use of a suitable variable tuning condenser in series with the aerial—just as if it were overhead—may enable him to take advantage of the greatly-increased sensitivity of a tuned antenna system. The discussion of antenna characteristics in the article on "Short-Wave Aerials and Grounds," elsewhere in this issue, will be helpful; as the principles there laid down apply equally to reception on a somewhat higher waveband.

The Radio Beginner---Pick-Ups

(Continued from page 915)

The original phonograph was developed soon after the telephone; the first commercial record was a wax cylinder upon which the mechanical vibrations engraved grooves by means of a sharp needle. (The needle was connected to a metallic diaphragm, similar to the telephone's, and the selection was played directly in front of the diaphragm.) In reproducing the music from the wax cylinder, a needle was again connected to a diaphragm and the cylinder was revolved by a suitable spring mechanism. The needle passing over the surface of the cylinder, in the grooves, was forced from side to side and this made the diaphragm vibrate, thus reproducing the sound. Later, the cylinder was replaced by a more compact disc, and the diaphragm was placed in the small end of a conical horn, in order to direct the sound more effectively.

MODERN DESIGN

The design of the electric pick-up required much research in order to overcome the usual difficulties from distortion. The amplifiers, with their new power tubes, could be made sufficiently perfect for the purpose; but there were several difficulties inherent in the design of the pick-up device, which caused trouble at first. The vibrating reed, or armature, was found to have a "resonant point," and distortion was caused through this. By careful design, it was found, a suitable magnetic reed could be made with its resonant point above the audible band and this source of distortion was eliminated. The magnet, case and support of the pick-up also had to be considered from the standpoint of resonant frequencies, but these problems were comparatively simple.

The rigidly-mounted vibrating reed was too stiff in motion at first and caused an excessive amount of wear on the record; so, in order to prevent this wear, the reed was supported in bearings and allowed to vibrate freely. By using small pads of rubber or other suitable material, the reed was prevented from vibrating too far.

The weight of the complete unit and the way in which it was mounted also had a great deal to do with the wear on the records and, with most of the units, it was found necessary to use a balanced type of mounting in order to prevent the records from being scratched too much.

The actual difficulties encountered in the design of a pick-up are comparatively small, and most of them can be overcome by carefully balancing the parts and the weight.

VOLUME CONTROL AND "NEEDLE SCRATCH"

Another point which had to be considered was the method of controlling the volume of the reproduced currents. A large amount of distortion could be introduced in this way, if the volume were incorrectly controlled. The use of either a resistor connected fully across the pick-up (Fig. 3) or a potentiometer connected as shown in Fig. 4, is the most common method; although other systems are also suitable. A resistor connected in the audio amplifier, across the secondary of one of the A.F. transformers, or across the speaker may be used. Many of the commercial pickups are already equipped with volume-control systems; usually of the simple resistor or potentiometer type. These resistors are placed either in the pick-up mounting base or in a separate case, connected in the leads to the amplifier.

Music from the old type of phonograph reproducer was accompanied, in most cases, by an annoying scratchy noise known as the "surface noise" or "friction noise." In reproduction of the old type, it was not possible to eliminate this; but, fortunately, the new electric reproducer allows a great reduction of these noises, and in many cases the scratch is almost inaudible. The reduction of these noises involves the use of a filter which is tuned to a frequency near to that of the undesirable tone. These noises are rather high-pitched and the absence of harmonics of the music, which are cut off at the same time, do not affect the quality sufficiently to cause any trouble. In fact most listeners could not discern most of them anyway; since the average person can hear only up to 9,000 or 10,000 cycles. Broadcast stations carry signals only up to 5,000 cycles, because of the interference problem; and the loss of the higher frequencies is hardly noticeable even by musically-trained hearers, when the transmission and reception are otherwise perfect.

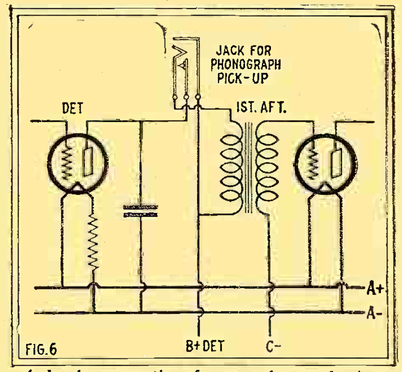
The filter used for reducing these noises is very simple in construction; it consists of a choke coil of suitable design and a fixed condenser in series. The complete filter is connected directly across the terminals of the pick-up. Most commercial pick-ups are already equipped with a suitable filter and, in case one is not incorporated in the device, it can be improvised very easily by using a radio-frequency choke coil of approximately 200 millihenries and a fixed condenser of .006-mf. The connections of such a filter are shown in Figs. 3 and 4.

CONNECTING THE PICK-UP

Almost all commercial units are equipped with plug-in devices, so that the experimenter can use the regular audio amplifier in his radio set for phonograph reproduction. Ambitious fans can build separate amplifiers for the purpose by using power tubes and suitable power supplies. A number of amplifiers of this type have been described in back issues of RADIO NEWS; that in the February, 1929, issue is designed for high quality and great volume, and a special phonograph amplifier was published in the January, 1928, issue.

The pick-up may be coupled to the set in several ways; to either the primary of the first audio-frequency transformer, the grid circuit of the detector tube, or the grid circuit of the first audio-frequency tube. These methods are shown in Figs. 6, 5, and 7, respectively. The method of Fig. 5 will probably supply the greatest volume, since it converts the detector into an amplifier tube; although this is a matter for experimentation. It is necessary to connect a "C" battery in the circuit in order to obtain the best quality. The battery would need only a small potential: probably several flashlight batteries connected *in series* will be the easiest way of obtaining this bias.

The second method (shown in Fig. 6) uses the pick-up in the plate circuit of the detector tube, across the *primary* of the first audio-frequency transformer, thus using the amplification of this instrument. The final method connects the pick-up across the *secondary* of the audio transformer. Although this system supplies the least volume of the three methods, it is quite satisfactory in cases where the required volume is low or where a very powerful amplifier is employed. Either jacks or switches may be employed for changing from radio to phonograph, or an "adapter" may be used.

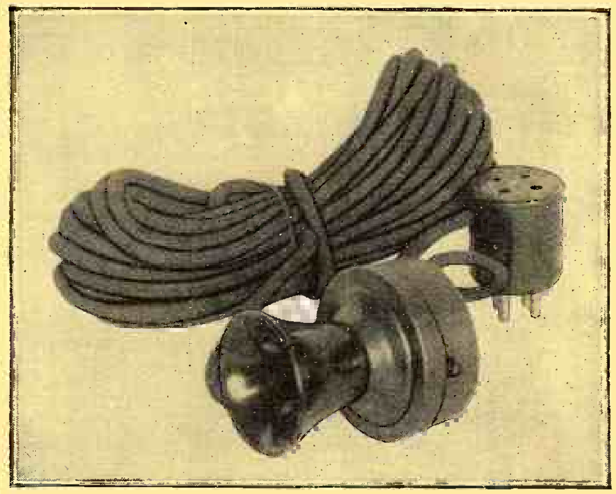


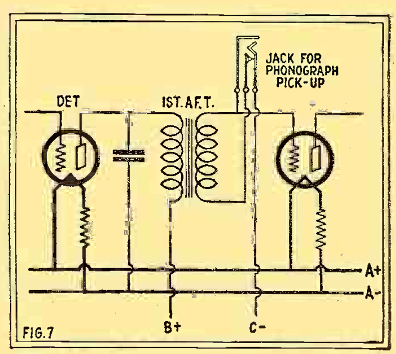
A handy connection for record reproduction.

The "adapter" supplied with a pick-up is plugged into the detector socket and connects the unit to the plate circuit of this tube; the connection thus made being equivalent to that in Fig. 6. In some cases, adapters are obtainable for both the four- and five-prong sockets; so that the unit will be equally adaptable to battery sets and A.C. sets using the 227-type detector. The connections for power-operated sets are the same as for the ordinary battery sets using the common (201A-type) detector tube. The only change necessary is in the method shown at Fig. 5. In this case, the "C" battery is connected to the *cathode* terminal instead of to the filament wiring; this is done in order to keep the hum at a minimum.

In order to make operation of the phonograph entirely electric, an electric motor may be used in place of the usual spring mechanism. A number of constant-speed motors, some of which are equipped with turntables, speed controls, etc., have appeared on the market; one of these motors is illustrated in this article. The motor is of the "induction" type and is equipped with a friction-type governor to keep the speed constant. The switch may be so arranged that the motor is automatically turned off when the record is finished, or that it will continue until it is turned off by hand.

For those who have neither a phonograph nor the inclination to purchase an electric motor and turntable, there is one very good way of making a cheap but good unit. The small portable phonographs which were made several years ago (and in fact are still being made) have a very satisfactory operating spring mechanism and, with an electric pick-up, one may be made into a high-quality phonograph. These portable phonographs will take full-size records. If desired, the mechanism may be removed from the case and mounted in another cabinet; in fact, this is a very good way of making a good combination phonograph-radio console. A switch placed on the panel


With a small microphone connected to the detector socket by a plug, speech is clearly reproduced through the A.F. amplifier of a receiver.



This connection gives somewhat less volume than others, but is often satisfactory.

of the radio connects the pick-up to the amplifier when desired.

"HOME BROADCASTING"

While on the subject of uses for the audio amplifier of a radio set, it may be well to mention the pick-up devices now made for home "broadcasting." Such an outfit (one of which is pictured herewith) consists of a microphone, a long lead and an adapter to be plugged into the detector socket of the set. By connecting the microphone in this way, a great deal of amusement can be realized from "broadcasting" programs and announcements at home. Such devices also have another use, besides experimental amusement; in cases where it is desired to make any public announcement and more volume is desired than the unaided voice can supply, the microphone with an audio amplifier and a speaker will serve the purpose.

MANUFACTURE OF RECORDS

The distortion in the old type of phonograph was not due entirely to the reproducer and horn used; the records themselves were made under conditions which cut off the low notes and distorted some of the higher ones The apparatus for cutting the records consisted, fundamentally, of a large horn, a rotating ("screw-feed") mechanism and cylindrical record blanks of wax of the original type, mentioned before. The artist or artists (and there were often too many for the available space) were placed directly in front of, and very close to, the large horn. The wax record was then rotated and the needle, which was connected to a diaphragm at the small end of the horn, cut a wavy line in the wax. The wax master record was then used to make the great numbers of records which were sold.

The defects of the system were that the horn was incorrectly shaped, the diaphragm had resonant points, the artists were too closely crowded before the horn to play correctly, and the volume of the music was too weak to allow the diaphragm to be vibrated over a sufficiently wide range. The result was that the low notes were cut off because of the horn and the diaphragm, the higher notes were distorted because of the resonant frequencies of the apparatus, and the result was generally far from perfect.

RADIO METHODS ADOPTED

Even if an electric reproducer were used with these records, the sounds would not be natural and, for this reason, the method of making records was changed most radically some years ago. The modern phonograph studio resembles the radio broadcast studio very closely. Standard broadcast microphones are used, as many of them as necessary to give the best results. They are very carefully placed, and the sounds picked up are "mixed," or proportioned so that the instruments of even a large symphony orchestra are brought out properly. The musicians do not have to play softer, or shift around, in order to prevent some of the instruments from being drowned out. All this is regulated at the control board. The sounds are picked up through the "mikes" and the audio-frequency currents passed into power amplifiers. They are then converted into the required mechanical motion for cutting the records, by using light rays with a photoelectric cell and other suitable equipment. The advantage of this is apparent; the light rays have no "time-lag" or "inertia," and they carry all the impulses equally well, regardless of their speed or frequency. For this reason the low notes of a large orchestra or organ are heard with normal volume, while the high notes are left natural. Special cutting machinery has been developed with practically no resonant points on the audible band and this takes care of another point at which distortion might be introduced.

The fan who wants the best quality should use the new records, and should be sure of getting that type when new records are purchased.

OTHER ELECTRICAL REPRODUCERS

Up to this point, the only unit which we have mentioned has been of the magnetic type. Besides this type, there are at least three others; the crystal, condenser, and carbon types; of these only the magnetic type is at present commercially important. One large corporation has experimented with a crystal pick-up, but this device is still in the experimental stage, and no information is available at this time as to the method of construction, or the quality obtained.

A pick-up of the condenser type was described in Radio News some time ago, but this unit is no longer on the market, notwithstanding its theoretical merits. A condenser reproducer has also been developed by one company which is interested in the use of the device for other purposes, but this unit is not at present available for public use. The condenser pick-up differs in operation from the magnetic type in the fact that it is connected to the *radio-frequency* section of the set. A vibrating element is used as one side of a condenser and when it vibrates, the capacity changes. A small oscillator-tube circuit is employed and the variations in the capacity of the pick-up modulate the output of this oscillator. The resultant "signal" sent through the set is very similar to a broadcast signal picked up over the air. It is amplified and detected by the radio-frequency and detector tubes, and then amplified again by the audio amplifier. A description of the device and its operation will be found in the April, May, and June, 1927, issues of this magazine; but, as we have said, it is not being manufactured now.

Pick-ups of the carbon type have been known for a number of years, but only a few which will supply a high quality of reception have been developed. Such a pick-up depends for its operation on the changes of resistance in a mass of carbon granules when they are alternately compressed and released. This is the same principle as that used in the ordinary hand microphone or telephone transmitter (See Radio News for May, 1928, page 1206). When the needle vibrates, it compresses or releases the carbon grains in a small box attached to the unit. This type of pick-up is somewhat different from the magnetic type and is designed to operate a speaker without the use of an amplifier.

As explained above, however, the only type which is as yet of commercial importance is the magnetic, which is both cheap in production and good in quality. The difficulties of design are comparatively small and are easily overcome by the use of good material and careful consideration of the parts which might cause distortion or noise.

Light-Sensitive Cells

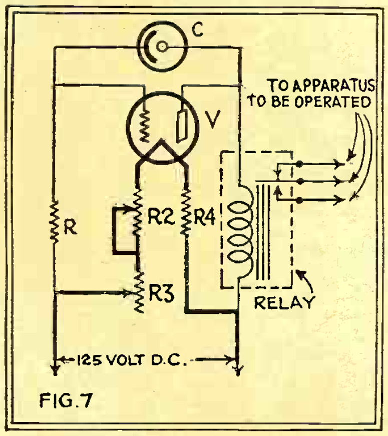
(*Continued from page 911*)

this manner, the action of an automatic lighthouse is duplicated with startling realism.

Toy-trains may be controlled, using the same circuit; a flashlight being employed as a source of illumination for this experiment as well as any others which suggest themselves to the experimenter.

A LIGHT-CONTROLLED PET

As an example of what may be accomplished by the ingenious constructor, the reader is referred to the July, 1923 issue of RADIO NEWS; an article in this number describes a development by John Hays Hammond Jr., comprising two light-sensitive cells in combination with suitable components, mounted on wheels, which could be made to perform many complex maneuvers.



How a photoelectric cell operates a relay to open a door or throw a switch, etc.

By throwing a flashlight on the cells Mr. Hammond was able to make the "Electric Dog," as he termed it, follow him about, turn in circles or (by reversing the current to the motor it contained) back away from him or, more properly, from the source of light he controlled (Fig. 6).

Among some of the practical applications suggested is a highly-desirable arrangement for closing the windows with the coming of daylight. This same circuit may include, also, an arrangement for firing the boiler, lighting the stove, heating the morning coffee, and, for our modest readers, pulling down the shades. In these cases, of course, suitable motors or other electrical accessories will be needed.

AN AUTOMATIC DOORKEEPER

For those interested in these experiments, the opening of a garage door with a beam of light from the car's headlight or from the usual flashlight, is something at once practical and thrilling. In accomplishing this stunt, a light-sensitive cell employing the *photoelectric* effect was utilized; the circuit diagram is given in Fig. 7, wherein R is a 20-megohm resistor, R2 a 200-ohm resistor, R3 a 50-ohm variable resistor, and R4 a 420-ohm fixed resistor. The high-voltage current may be taken direct from a D.C. lighting main, or can be supplied from a "B" power unit or a set of "B" batteries.

Several different tubes have been tried

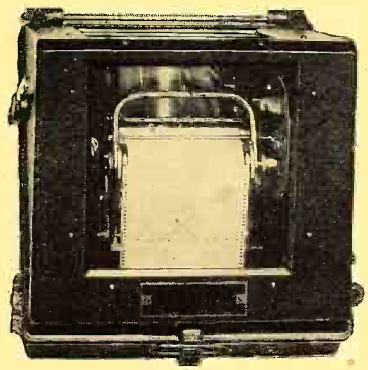


Fig. E
The apparatus shown above is a typical commercial design of a recorder which makes a graph in ink showing the amount of light which has fallen on it each minute during the day.

in this circuit; but the 112A-type has proved most satisfactory. When the cell is in darkness, about 0.25-milliampere flows in the plate circuit of the vacuum tube; but when a flashlight is placed close to the cell, a current of about 6.25 milliamperes flows.

The relay should have a resistance of 8,000 ohms or thereabouts. It is easily operated by a flashlight at a distance of ten feet from the cell. The relay actuates at about 2.5 to 3 milliamperes, and will "hold down" at about 1.0 to 1.5 milliamperes. The garage door may be slid or swung by a suitable motor drive; or an even simpler method is to arrange a self-actuating system whereby the relay, when operated, releases a trip holding the door; a sufficiently powerful spring or counterweight, depending upon the operation of the door, does the rest.

Obviously, the light-sensitive arrangement in the above application must be equipped with some form of cover; so that it can be turned off during the day and actuated at night. With this arrangement, it is necessary only to drive up in front of the garage door, as is the usual custom, and turn on the bright lights of the car; this will supply more than enough illumination for the purpose.

The light-sensitive cell used in this experiment was spherical and gas-filled, mounted upon a standard tube base so that it may be inserted into a UX socket, and is known as a 3GS; its ionization voltage is about 150.

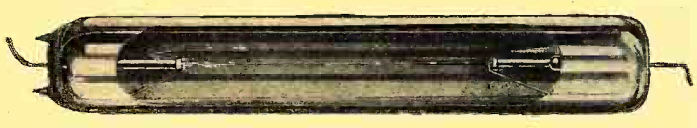


Fig. F
Above we have illustration of another type of photoelectric cell. This is over a foot long and presents a very large "window" to a light-source. It is a gas-filled tube.

Aerials and Grounds for Short-Wave Reception

(*Continued from page 919*)

librium or balance of the electrical forces of the world. It is a "wave," because a definite time is required for the impulse to be felt over a given distance; and consequently many alternations, or changes in the electrical arrangement at one place, may take place before the first of them is felt at the receiver. We have read how new stars light up, and are extinguished again, hundreds of years before we see the conflagration. So, on a smaller scale, half a million radio alternations may be sent into space at New York before the wave set in motion by the first arrives at Melbourne, Australia.

In Fig. 2 we look down on the aerial and its surrounding waves; unfortunately, we can see here but one cross-section, horizontally, through the field. The impulses are spreading out in every direction from the vertical aerial; electric lines of force (perpendicular to the paper) in an electrostatic field and magnetic lines of force in an inductive field revolving round and round in directions changing with the flow of current. These two types of lines of force are simply two directions in which a very complicated form of energy is exerting itself; and one does not exist without the other.

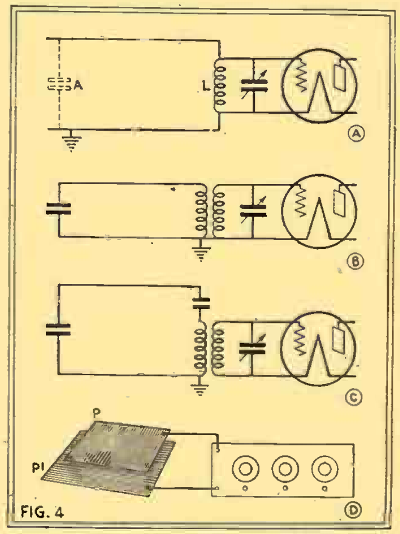
In Fig. 3 we have a classic example of an illustration of the wave: the electric field is a membrane—like a sheet of rubber, with a rod attached to its center, so that it can be moved up and down. A very slight motion up and down causes waves to roll outwards from the center, their height increasing as they spread. (A fixed-edge cone speaker illustrates formation of waves of this kind in its diaphragm.) However, as we have said, this represents only one cross-section of the wave, which is moving in three dimensions. Let us consider how it is to be met at the other end.

THE WAVE RECEIVED

In Fig. 4A we have schematically represented an aerial of the ordinary outdoor type, directly coupled to the grid of a vacuum tube. If it is encountered by an advancing electromagnetic wave, the latter exerts a pressure on all the free electrons in the system, tending to rearrange them. The result is a flow of current, resulting from the rearrangement. As a matter of fact, in any antenna system, hundreds and thousands of waves are crossing and recrossing; and the actual current flow in the system is the composite of them. If a nearby transmitter sends waves to which the antenna is resonant, or nearly so, the influence which it will exert is so great that ordinary tuning methods will not eliminate its effects. However, if the signals being received are nearly of a strength, we may tune the aerial to one particular wavelength, and the flow of current in it will conform to this frequency.

We can use this current in a receiver, however, in only one way—that is, if we have the usual vacuum-tube amplifier and detector. We must convert it into a *voltage* or potential difference between the *grid* and the *filament* of a tube; that means, we must find some way to obstruct the flow of that current. At the same time, that current, in the case of a distant short-wave station, is so minute that we cannot afford to waste it.

The inductance of a coil L, placed across the filament (which is grounded) and the grid (which is connected directly to the aerial, as at A), affords opposition, or *reactance*, to the flow of the alternating signal current. The current is driven into the tuning condenser between the coil and the tube, and builds up a voltage until the current has ceased to flow. This voltage is impressed on the tube grid; it begins to fall as the stored energy of the condenser is driven back through the coil; and its alternations are recorded in the output of



The ordinary type of aerial, showing schematically the effect of condensers in tuning it. At D, a condenser-type aerial actually tried.

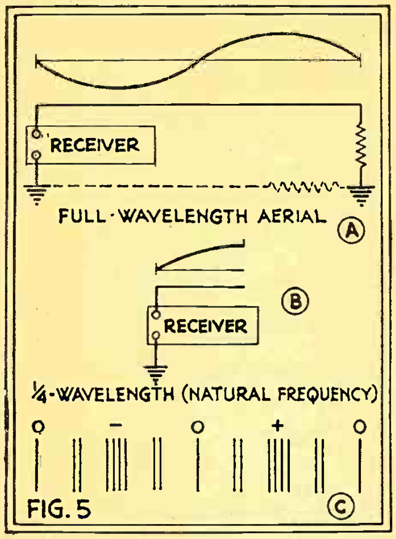
the tube, the last determined by the nature of the circuit used.

AERIAL TUNING

It will be noted that the aerial forms a *capacity* with the ground—the two represent the plates of a condenser of very large size, but of small capacity—and that this is in parallel with the tuning condenser. For this reason, in addition to the self-capacity of the tuning coils, wires, etc., it is impossible to tune a circuit to as short a wavelength as the minimum capacity of a condenser would suggest. A condenser with a maximum of, say, .00015-mf. has a minimum capacity of .000005-mf. This would suggest that it should tune over a range from, say, 33 meters down to 6 meters (the wavelength increases or decreases with the *square root* of the capacity); while, as a matter of fact, if it will cover a third of that range of frequencies, the circuit is low-loss.

If we arrange the circuit as at B, the tuning condenser is no longer across the aerial; and the tune of the antenna is determined by its natural inductance and capacity. This inductance is coupled magnetically to the tuned secondary circuit which, therefore, does not respond to its own inductance alone; but is affected also by the "mutual inductance," or effect upon it of the aerial coupler. This is one reason why single-control tuning becomes increasingly difficult on the very short wavelengths.

The commonest method used is shown at C; a small condenser is placed *in series* be-



If an aerial were the full length of the wave received, there would be no voltage difference between its two ends. The natural wavelength of an aerial is four times its actual length.

tween the aerial and the primary coil. The result is that the aerial is "shortened," because its total capacity value is reduced below that of the aerial condenser. The latter, if its value is properly regulated, will tune the aerial to an incoming signal, and enormously enhance the response. It is therefore one of the most important adjuncts to short-wave reception.

If the aerial is only one plate of a condenser, why can we not hook our aerial and ground posts to a condenser and receive? As a matter of fact, some years ago the Bureau of Standards made tests on an antenna of this type. Two metal plates (copper screening was used satisfactorily) were separated about 32 inches and connected to a receiver and signals were measured. The lower plate was larger than the upper, to shield it from the ground, but was only 16x18 inches. The wavelength of the antenna was estimated at 16 meters. (Fig. 4D.)

However, for a longer wave, it would be desirable to increase the size of the antenna system; because, after all, and notwithstanding the fact that partisans of "kilocycles" say that "wavelengths" are obsolete—a wavelength is a physical fact.

THE NATURAL FREQUENCY

It is commonly stated, as most readers know, that an aerial has a "fundamental frequency" equal to that of a wavelength four times its own length. In other words, an aerial 10 meters (32 feet 9.7 inches) in length—including lead-in—has a fundamental or natural frequency of 40 meters. The reason is that, as shown in Fig. 5 at B, the quarter-wavelength represents the greatest uniform tendency, toward creating a voltage, set up by a wave of a certain strength. At half a wavelength, the difference may be between "+ Max." and "— Max." or it may be between 0 and 0. At a full wavelength, the two ends of the wire will be always at the same potential, as shown at A. An aerial over a wavelength long may have one end grounded, if there be sufficient resistance in the exterior circuit, without "shorting" it, as would be the case with the quarter-wave type; the latter is more selective, and more critical. The longer wire allows the flow of more current, and gives a better pick-up; but if there is interference, it picks that up also, and signals as well on longer waves. The rule, therefore, arrived at by amateurs, is that it is better to use an aerial shorter than the quarter-wavelength of the signal which is desired. On the other hand, in transmitting, a longer aerial is used.

It must be borne in mind, also, that there are some limitations which should be observed. An amateur is forbidden to couple the oscillating circuit of his transmitter directly to the aerial. The reason is that the range of a short-wave transmitter is so tremendous that it is necessary to minimize radiation. A receiving set with an oscillating tube coupled directly to the aerial, as in Fig. 4A, would be a transmitter of the type prohibited; and even a 201A tube, with its small output, is capable of sending a radiated signal a long ways. For that reason, this direct coupling should not be used. The addition of a screen-grid amplifying tube ahead of the oscillating detector in a short-wave set is becoming necessary as a precaution; just as a stage of amplification ahead of a regenerative detector is required in broadcast receivers. Previous to the development of the screen-grid tube, R.F. amplification at very high frequencies was not practicable; but it is now quite successful. It will be preferable to bring up signals by tuning the antenna, rather than try to "lower its resistance" by oscillating into it from the detector plate circuit.

We have commented on the skip distance; Fig. 6 may help to make it clearer. Suppose radiation escaping from an aerial at the top of the figure; it cannot enter the earth and, consequently, if the wave pursues a straight path, it cannot be received at a point below the horizon from the aerial, and consequently out of sight. This is true of very short waves, while longer ones cling to the surface of the earth and bend round it. The short waves above the horizon continue out until they encounter the "Heaviside layer," from which they are turned back toward earth; not sharply, as from a mirror, but gradually. After they come down to earth again, outside the first "skip-distance" ring, they are again detectable for a distance, depending on the angle of their refraction. Then there is another "skip-distance" and perhaps another zone of reception, and so on. Much experiment is now being made to determine skip-distances most accurately; as upon this knowledge depends the future success of international short-wave broadcasting. The effect of daylight upon transmission of this kind is disconcerting to the effect to maintain a long program, though very good results at long range are obtainable when conditions are at the best.

AN ALL-AROUND AERIAL

Unfortunately, many of the things that should make for high receiving efficiency are of no use to the broadcast listener who is desirous of bringing in *everything*. If he could specify, like the transatlantic telephone service, that he wanted to receive from a certain transmitter three thousand miles away, and from no other source, the engineers could give him a blueprint of a system that would work wonders. As a matter of fact, a good many broadcast listeners get the transatlantic telephone, though not quite as satisfactorily, perhaps, as the gentleman who is paying $5 a minute for his call. But, in order to receive also Australia and Java at their strongest, one will require a receiving system pointed in a different direction. (What, may be another question; the shortest line from New York to Java runs through the North Polar regions, but radio waves at long distances do not follow exactly the shortest path, because of their reflection and refractions.

It is well known that a loop gives a much stronger response when it is set edgewise toward the direction of a signal; the same is true of a horizontal aerial pointed *away from* the station received (See Fig. 7). A vertical aerial, on the other hand, should receive with equal strength from any direction; and the practical combination at which we arrive is an aerial with both a horizontal member, and a nearly vertical lead-in, which alters its characteristics. This is not as sensitive in the direction of its length as if it were brought directly in to the set, without bending it; but it has more strength of signal in response to a wave advancing from one side, to which the straight horizontal wire aerial would be almost unresponsive, if not entirely so.

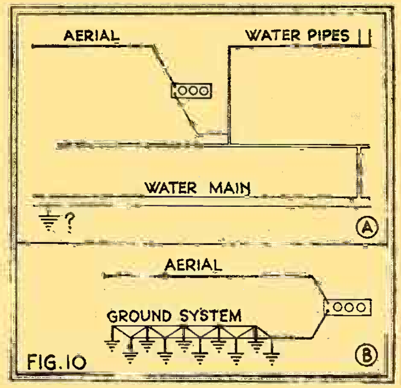
We have therefore only the following advice for the broadcast listeners who are fortunate enough to be able to follow their fancy in aerials: every collecting system is stronger in one direction than it is in others. Two aerial systems, one at right angles to the other, with switches permitting a choice, will give the option of greater signal strength in two directions. It would be well to have one of them pointing, approximately, away from the station which it is desired to make a standby for distance reception. Such a line should follow the great circle course—say to England and Holland, which are close enough together for the purpose of regarding them as one, from America; they are about east-northeast from New York. Another at right angles to this would afford a greater opportunity of reception from the southern hemisphere.

Since an aerial for broadcast reception on the longer waves is intended to receive 200- to 550-meter signals, it might be 164 feet long and keep below the quarter-wavelength of the shortest wave. But, with a 50-meter wave, 41 feet would be a long aerial; and at 15 meters, 12 feet over all would be suggested. However, unless such a short collector of energy were tuned, it would be advisable to use the longer aerial with a very small series condenser, and loose coupling (variable) to the secondary. A very small degree of coupling at such enormously high frequencies is sufficient.

For this same reason—the penetration of the high frequencies into the dielectric—it is necessary to keep a short-wave aerial away from other objects more carefully than other collecting systems. A mast, a tree, the eaves of a house, all offer slight losses (Fig. 8). For that reason, some use a single straight wire, brought in through the center of a window pane, or through a glass bowl, as aerial and lead-in. It is, however, more directional than the bent aerial.

HOW WAVES WIGGLE

We have considered the vertical aerial; it is non-directional, and it is used for transmitting quite frequently. Though there are certain difficulties connected with its erection, why should it not be the ideal for the broadcast listener?



The set is connected to a "ground" which is often much larger than the aerial. What is the ground connected to? At B we have a system often used by amateurs and DXers.

Undoubtedly it would be an excellent addition to our proposed optional horizontal aerials—one pointing west and the other south. It would pick up some signals to which neither of them would respond. But it would not be a panacea. Some years ago the vertical aerial was considered the thing for short-wave reception. Then Dr. Pickard, a leading radio engineer, investigated; he built an ideal aerial for reception: it was of the Hertzian type, with long, opposite rods, as in Fig. 1A. It could be turned to any angle with the horizon, from horizontal to vertical; it could be turned to any point of the compass. Its length could be adjusted—within reason—to any of the short wavelengths on which it was to receive. The only trouble was that a tower as illustrated (Fig. 9) was needed for the mounting of the aerial; as the receiver had to be in the middle of it. The short-wave fan who wishes the perfect aerial may try this stunt. It can be adapted to anything; except that for the sixty-meter band a tower (built of wood) about sixty feet high will be needed and, also, a good highly-insulated swivel mounting of considerable strength.

What this experiment showed was that, though waves are emitted vertically from a short-wave transmitter, they have turned on their side after going a few miles; and, from say sixty to three hundred miles away, the horizontal aerial wire receives them more strongly. After a few hundred miles more, the advantage in favor of horizontal reception dies away. Another curious thing is that the waves emitted horizontally do not turn over—but apparently a short wave has the same objection to standing upright that a cat has to landing on its back. These conditions, of course, do not prevail with the much longer waves of even the highest amateur band.

WHAT IS THE GROUND SYSTEM?

We have now a short, selected aerial, of heavy wire (theoretically copper tubing of a fair size might be better, for high-frequency current flows on the surface) protected against corrosion by enamel and heavily insulated. It is spaced very carefully away from all nearby conductive objects until it is connected to its condenser in the set. Then we attach our ground—to what?

A glance at Fig. 10 shows us that the ground system is often composed of a mass of metal several times the length of the aerial, and exposed to radio waves. Consequently, we may take the aerial completely off and find that signals come in without change in strength. We will probably find that local "harmonics," at least, do not show the loss of the aerial by the slightest falling off. For that reason, for short-wave work, we may find the ground a source of trouble. It will be well to experiment.

In the country, or even the suburbs, where the short-wave fan may control the ground beneath his aerial, an excellent ground is secured by driving several metal pipes to moist earth and connecting them by wire to the ground lead of the set, as shown at Fig. 10B. This reduces the "antenna resistance," which is important when we are putting power into it; and should be considered when we are trying to get the most out of what little power it can pick up out of the air for itself. The ground is part of the antenna; and should be of very low resistance, as well as the aerial. The only place where it is desirable to check the flow of signal current—except on very strong signals—is in the reactance of the tuned circuit across the first tube grid, where it will create a voltage that counts in results.

In conclusion, a few suggestions may be repeated as to making connections to set and antenna, if the conventional type of the latter is to be used:

Try every accessible ground; quite often it will be found that a combination of two or three grounds gives better results than one. First try each singly; then try them in combinations. The one, or the combination, giving the greatest signal strength on a station which has been tuned in to test the different arrangements should be used. If water pipes or radiator pipes are used, scrape the section of the pipe where the ground-clamp is to be secured until the bare metal glistens; fasten the ground-clamp securely and then solder the ground-lead to the clamp. If it is convenient to do so, solder the ground-lead to the pipe without recourse to a clamp; however, where this proves inconvenient, a clamp may be used with good results if due care is exercised in securing it to the pipe.

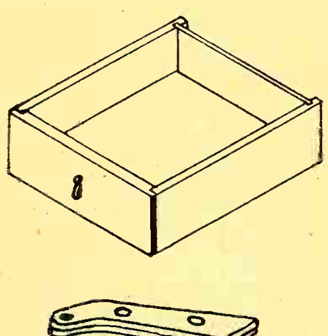
Soldering the lead-in to the aerial has always been considered quite a task; because of the almost general belief that this operation must take place after the aerial has been erected. It is far simpler to perform this operation in the house while aerial and lead-in wires are still rolled up; merely scrape an end of each roll, solder, tape; and both may then be taken to the roof and unrolled for their respective duties.

When using paste to solder that new job, go over each joint immediately after it has cooled, and with a clean piece of muslin wipe it clean of any paste which may have remained. Failure to do this will eventually cause corrosion at the joint, with resultant loss in efficiency, and noisy reception. For this reason it is best to use as little paste as possible—preferably, none at all.

Popular Handiwork---How to Build a Handsome Radio Console

(Continued from page 922)

One brace, $\frac{3}{4}$ x 2 x $30\frac{1}{4}$ inches (Q);
Two sides, $\frac{3}{4}$ x $13\frac{1}{8}$ x $23\frac{3}{4}$ inches; front edges to be faced with moulding H (R);
One sub-base, $\frac{1}{2}$ x $12\frac{3}{4}$ x 29 inches, to hold top section together; fastened to N with screws (S);
One rail, $\frac{3}{4}$ x $1\frac{1}{8}$ x 30 inches, mortise into posts (T);
Four drawer slides, $\frac{1}{2}$ x $1\frac{1}{2}$ x $11\frac{3}{4}$ inches, to be attached with screws and nails (U);
One back rail, $\frac{3}{4}$ x 5 x 30 inches; mortise into legs (V);
One top cabinet rail, 1 x $1\frac{1}{4}$ x $30\frac{1}{4}$ inches; mortise into sides (W);
Two stretchers, $\frac{3}{4}$ x 11 x $30\frac{1}{4}$ inches; mortise into end rails (X);
Two end rails, $\frac{3}{4}$ x 1 x $11\frac{3}{4}$ inches; mortise into posts (Y);
One drawer front, $\frac{1}{2}$ x 3 x $17\frac{1}{4}$ inches (Z);
Two drawer fronts, $\frac{1}{2}$ x 3 x $5\frac{1}{4}$ inches (A1).
Drawer materials: Corner glue blocks; drop pulls; friction catches for doors; rosettes; transfer designs; nails and screws; and invisible hinges, as shown, to be used at top and bottom of doors.



Detail of drawer and "invisible" hinge.

The "Home-Builder's Seven" Superheterodyne

(Continued from page 929)

shortened or a weaker station selected. Oscillations of the R.F. stage are controlled by the panel knob of R8 which serves also as a volume control.

At this time the oscillator tube V3 should be removed from its socket; upon which the signal should immediately disappear. If it does not, the coupling between the primary and the secondary of L4 is too great. The normal separation of the coils should be about one inch, where medium selectivity is desired. Great selectivity may be obtained by greater separation, or by placing the coils in right-angle relation. It should be remembered that, as selectivity increases, signal strength decreases. A compromise must be struck for the peculiarities of the location and the aerial which is used.

In rare cases, it may be difficult to cause V3 to oscillate. A simple test is to place a pair of phones in series with the plate return of this tube and its lead "B+Osc," with battery connected. With the tube in its socket, upon touching the grid and plate socket terminals with a wet finger tip loud and distinct "plops" should be heard. In some cases the turns of the plate coil of L3 must be increased, to obtain oscillation. A defective condenser at C5 will also prevent oscillation.

As the builder becomes acquainted with the operation of the receiver, excellent distant reception will be obtained. The DX possibilities of this receiver, as with any other sensitive set, will depend on the locality, the efficiency of the aerial and grounds, "atmospherics," and the ability of the operator.

BIASING A.C. TUBES

If the constructor wishes to build this set for A.C. operation, it is recommended that he use only tubes of the heated-cathode (227, AC-22, and similar) types except in the power stage. Here a 171A, or other power tube of any desired type, may be used with raw A.C. on the filament and the proper plate voltage, in the conventional way.

be one and a half milliamperes, or .0015-ampere; and to give 1.5 volts "C" bias a resistance of 1,000 ohms will be required.

For the detector tube V5 it is recommended that the resistor be variable from 0 to 2,000 ohms; the proper resistance value is then conveniently found when the set is placed in operation. The value for the resistor in the cathode return of the power tube V7 should be 2,000 ohms, when 180 volts is used as the plate supply.

As the "C" biasing voltage is taken from the plate potential of the particular tube supplied, it follows that, to obtain the correct bias at the recommended "B" voltages, that the voltage output of the power unit must be increased at each "B+" tap by the amount of the "C" voltage. Thus, for the power tube, 40 volts plus 180 volts would require 220 volts at "B+180" for normal operation; as the cathode of the

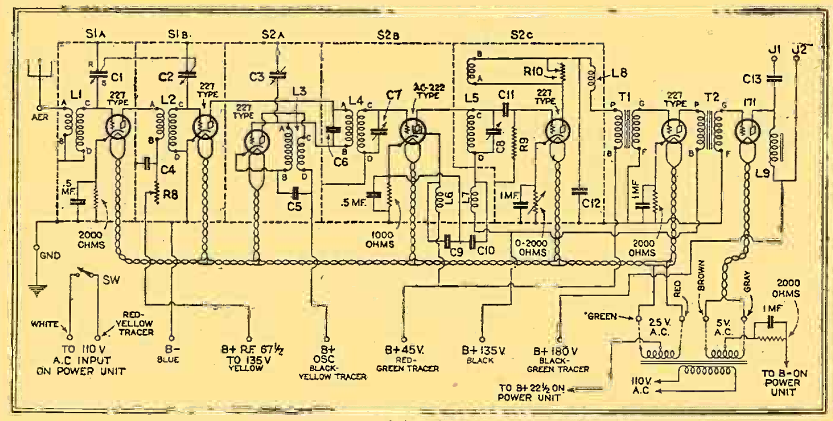


Fig. A

The "Home-Builder's Seven," constructed to use A.C. tubes, follows the same layout as in the constructional drawings; the resistors and condensers shown replace the filament ballasts.

If we compare the circuit for battery operation (Fig. 1) with that given here for A.C. tubes (Fig. 1A), it will be seen that the latter eliminates the amperites R1-R2-R3-R5-R6-R7 and the tapped resistor R4. All grid returns (including that of the detector) are made to ground and "B—" on the shielding, instead of to filament; and the cathodes of the tubes are maintained above ground potential by resistors, the voltage drop through which provides the necessary bias. This is the usual method employed in A.C. tube operation; the values of the necessary resistors may be calculated by dividing the bias (in *millivolts*) required for a given tube by its plate current (in milliamperes); for instance, if a tube requires a 6-volt bias, this is six thousand millivolts; the plate current of a 227-type tube is normally three milliamperes. Division of six thousand by three gives two thousand; and, accordingly, a 2,000-ohm resistor is what we need between cathode and ground to give a six-volt drop.

Therefore, resistors of this value are required by the cathode returns of V1 and V6, in series with their ground leads. On the other hand, V2 and V3 do not require a grid bias; the former has no "B+" potential on its plate (because of the peculiarity of the Ultradyne modulation system) and the latter is an oscillator, and should a bias be put upon its grid, greater plate potential would be required to cause oscillations. The A.C. screen-grid tube V4 requires a "C" bias between 1 and 1.5 volts. With 45 volts on the screen-grid, and 135 on the plate, the normal plate current will

tube is 40 volts positive above ground potential.

BY-PASS CONDENSERS

To prevent the blocking of either the R.F, I.F., or the A.F. frequencies by the biasing resistors, the latter must be by-passed with suitable condensers; these, in the cathode circuits of the audio tubes, have a value of 1 mf. Where either I.F. or R.F. frequencies are by-passed, a 0.5-mf. condenser will be sufficient.

To prevent excess of hum, the proper value of "B+" potential should be applied to the center tap of the 2½-volt winding supplying the heaters of the 227-type tubes. Usually, this should be 45 volts.

For placing the A.C. set in operation, the same procedure is followed as with the battery-model receiver, as described above.

IT HAPPENED (?)

Radio Fan (*who finds the usual atmospheric conditions accompanying a demonstration of his new hook-up before company*): "Gee, what a rotten night! I can't seem to hold any stations at all!"

Visitor: "Oh, the weather is nice out Maybe the radio stations are not sending out enough ether!"—*C. Walker.*

RADIO MATHEMATICS

Instructor: "In measurements, *"micro-"* means "one-millionth"; a microampere is one millionth of an ampere, and a microfarad is one-millionth of a farad. Now, can anyone give me further examples?"

Star Pupil: "Yes, sir: a micrometer is one-millionth of a meter and a microphone is one-millionth of a phone."—*Bernard Ring.*

The Constructor's Own Page

(Continued from page 935)

build these sets strictly in accordance with the diagrams, proper plate voltage and low-loss parts, they will not be disappointed with results. I will be only too glad to help anyone wishing my advice on either of the above sets. I started in the radio field seven years ago and (being a N.R.I. student) I can appreciate a good circuit when I see it.

CHESTER L. PRICE,
One River St., Cohoes, N. Y.

WANTED, A GOLD FINDER

Editor, RADIO NEWS:

I have noticed that the "Hams" are always ready and willing to lend their knowledge and aid to a fellow-worker in the experimental field. Thanks to their generosity.

Now I have a problem in which I would like very much to enlist their aid. My father buried twenty thousand dollars on our farm and we have never been able to find it. It was all gold dust and nuggets. He died suddenly of apoplexy and left no information as to where the exact spot was.

I have experimented for years trying to get an oscillating circuit that I could detect it with. But so far, I have been able to detect any non-magnetic metal only about eighteen inches. I would gladly give a prize to the one who offered the best known circuit that would detect it, say six feet away. Please tell me how to get their aid in this matter.

A. R. ENYEART,
48½ North Orange St., Medford, Oregon.

(Those having a hook-up of the required sensitivity are invited to communicate directly with Mr. Enyeart.—EDITOR.)

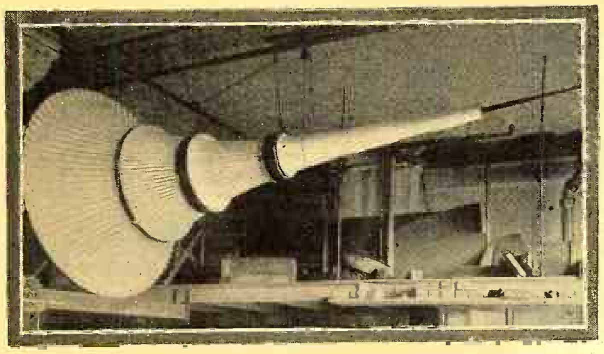
FB (FINE BUSINESS) OM!

Editor, RADIO NEWS:

Your Audio Amplifier for the "Extension" receiver, the "Bloopless' receiver and the "'Lamp-Socket Five" are all wows; I sold the latter for a net profit of $32.54! It was constructed of dime-store parts and worked better than a well-known commercial model. I would like to correspond with boys about my own age—which is thirteen.

JACK B. KAMMER,

(Some of the readers of RADIO NEWS *who express a desire to communicate with other fans are: Jack B. Kammer, 1531 Andrew Street, Fort Wayne, Ind.; Louis C. Skipper, Jr., 3295 Carnes Avenue, Buntyn, Tenn.; S. Kwictniak, 527 Graham Avenue, Brooklyn, N. Y.; S. N. Kalra, c/o The Wireless House, Lahore, India; Raymond Lokken, Box 308, Heron Lake, Minn.; M. P. Nemitz, Box 286, Hampton, Iowa.*



Al Morrison, of 81 South Sherman St., Denver, Colo., has just built the third and largest of the exponential horns he designed from data in RADIO NEWS. *This is 12 feet long and 64 inches across the bell, which is lined with battleship linoleum. The rest is built of heavy seasoned lumber. The resultant volume is tremendous and the tone quality remarkable*

RADIO IN THE ARMORY

Editor, RADIO NEWS:

It is the desire of this unit to express thanks for the recent blueprint of the televisor. We are assembling this at the present time and are planning on using it with a Pilot Short-Wave set as described in RADIO NEWS for December. Enclosed is a coupon for blueprints 69 and 70, for which we thank you in advance. This unit owns and operates station W8AJM.

MILTON K. BROWNE,
First Sgt., 2nd Battalion Hq. Co., 10th Inf., N. Y. Natl. Guard, Binghamton, N. Y.

On the Short Waves

(Continued from page 938)

a *screen mesh for a plate* have an abnormal characteristic when tuning below 50 meters. All other tubes using a metal plate we have found satisfactory.

Another thing that might be of interest is the fact that when using a 171 power tube, the output when attached to a short-wave adapter is much less than if a 112-tube is used. Good speaker volume is usually available with the 112-tube on very weak signals, whereas it takes tremendous signal strength to deliver speaker volume with a 171-tube.

J. M. PETERSON,
The J-M-P Manufacturing Co., 3407 Fond du Lac Avenue, Milwaukee, Wisconsin.

*(The information contained in this letter will be of interest to many A.C. set owners. Such complaints as we have received from a few readers, as to difficulty in accommodating adapters (of whatever make) to their sets, have arisen from the use of an A.C. detector. While we do not think that, considering the number of A.C. sets thus in use, the percentage of dissatisfied users of adapters can be high, the suggestions given by Mr. Peterson from his long experience should be of great value to many who are not getting maximum results.—*EDITOR.)

SHORT-WAVE R.F.

Editor, RADIO NEWS:

It is reasonable to suppose that there are not many —no, not even amongst the "dyed-in-the-wool" hams—who have a short-wave receiver with two stages of screen-grid R.F. Amplification. Now, I should be the last to say that this is easily possible to have; but, on the other hand, I shall not be such a pessimist as to think it is impossible. By the time these lines are in print I hope to have one such receiver working upon the lines set out. I am not altogether sure at present as to whether it would not be better to omit the aerial inductance in the first stage and insert a 10,000-ohm resistor in its stead. I shall probably try both.

Will my American friends who want to make an electro-dynamic speaker sit up and take notice, when the output from such a receiver is administered to the input of said speaker from such a station as G5SW, please endeavor to construct according to these lines? Should they care to correspond with me upon their success or otherwise, I shall use my endeavors to see that their letters are answered if they will be so good as to enclose international postage order.

On the 28-Megacycle amateur band it is surprising to hear "W" stations come in at from 1,300 to 1,530 on Sundays at QSA4 and, if a few clouds roll up it is interesting to note the signal strength die down. What is still more amazing is to hear "G" stations about 200 miles away come in at QSA2—thus rather damping the skip-distance theory on ultra-high frequencies.

Here is another field to experiment in with two stages of R.F. as outlined, and here let me sound a word of warning to the uninitiated—be particularly careful in your shielding arrangements when using two UX-222's on such high frequencies and do not omit chokes in their plate leads.

I want to congratulate you upon your very fine write-up and diagrams of your screen-grid short-wave receiver. I have made mine work perfectly smoothly up to 28 megacycles and shall very shortly be experimenting upon using two screen-grid tubes; Marconi S.610's (like the 222); for R.F. amplification at signal frequency. This has, of course, been done by Capt. Round; but not to my knowledge by ordinary individuals such as myself!

A power tube just brought into use over here has the same impedance as the 171A, but twice the amplification factor—it is the Marconi P.625 and is really magnificent. It intrigues me to be consuming only 0.55 amps on my S.G.S.W. receiver!

It appears to me that *there are* channels available for good people like yourselves, WLW, and the General Electric on the short waves; as, over here at any rate, I never hear anyone between 17.4 and the amateur 20-meter band. Another gap is between 8XK and 2FC, Sydney, on 28.5-meters; W2XAF and W8XK are full loud-speaker volume almost nightly now.

PLE and PLF (late ANE and ANH) are now on the air on Sundays instead of Wednesdays on 15.74 and 17.00-meters respectively.

The B.C.L. Band is in a shocking mess since Jan. 13, when the new "'Plan de Bruxelles" came into force allowing only 9-kilocycle separation—I certainly don't possess such a receiver!! The heterodynes caused by the powerful ones—G5GB, Toulouse, Langenberg, etc.—are awful!

We are having a very cold winter and I long for Africa with its warmth and sunshine!! I haven't heard your short-wave transmitter for sometime: the "stars" at present being those who transmit below 20 meters. Kindest regards from,

E. T. SOMERSET, G-BRS 125,
Inholmes Park, Burgess Hill, Sussex, England.

"SWINGING" IS NATURAL

Editor, RADIO NEWS:

I can understand why it is hard to pull in the really DX stations, but I'm getting through with patience; but they are very faint. But why don't I get the U. S. stations apart from WGY and KDKA? I had 2XAL on Nov. 29; faint, but intelligible. But there must be at least 25 more with fair power and they don't come in. One more question—is the swaying of the signals caused at the transmitting end, or is it in part due to receiver faults? My aerial is a 50-foot vertical wire, held really taut. And, once again, congratulations on your magazine. You have no idea what it means to me, away here in the bush, and the nearest radio fan who is interested in the technical side over fifty miles away.

J. E. WILKS,
Forest Gate, Saskatchewan, Canada.

(Perhaps his "location" is against Mr. Wilks, and perhaps he will find the stations easier to get later; they are easy to pass over. Some experiments with the ground, and with the aerial condenser, may bring better results. The swinging of the signal is an effect caused by the electrical condition of the atmosphere between transmitter and receiver, and cannot be remedied.)

A DOUBLE GROUND

Editor, RADIO NEWS:

My receiver is somewhat similar to the Pilot short-wave, except that my coils are of the basket-weave variety, and my aerial is indoors—about 42 feet of wire around the moulding in the living room. I have reduced body capacity to a minimum by using a double-ground system. I have the tuning condenser encased in a shield, to which are connected the "A—" and the rotor of the condenser, and one of the grounds. The other ground is connected to the primary, which consists of ten turns. Hoping that this may be of interest to brothers in the radio game.

RUFINO RAMIREZ,
No. 1 Jose M. Fernandez St., Santurce, Porto Rico.

A CORRECTION

Editor, RADIO NEWS:

I have received quite a few letters asking for details on my set (shown on page 655 of the January issue) which I have answered to the best of my knowledge. Will you allow me to compliment the artist for the fine piece of work which he did in drawing the circuit from the meager details I furnished him? However, a slight oversight may be corrected: namely, the grid return of second detector in Peridyne part of the circuit is also connected to "A+" lead. The piece of wire you take out here may be used to bridge the "B—135," so this correction does not necessitate any extra outlay.

J. H. VAN KOOLBERGEN,
Montreal, Canada.

A JUNK-BOX ADAPTER

Editor, RADIO NEWS:

Here are some hints concerning the "Junk-Box," which I made into an adapter for my broadcast receiver, besides shielding it. I bought a small pan, approximately 6 inches long, 3¼ wide and 2¼ high, with tapering sides, and mounted the two sockets for tube and plug-in coils on the top of the upturned pan. The condensers are all mounted on one side, and the "A+" leads grounded to the pan. The grid condenser and the leak (5-meg.) and the choke are also mounted on the inside of the pan. No rheostat or switch is necessary, as these are in the regular set. The aerial coupling condenser is mounted on the base of an old upright crystal detector on one end of the pan. Leads from the choke coil and the filaments are taken direct to a plug which may be inserted in the socket of the broadcast set.

The set is very neat and complete and the pan provides a shield which reduces body capacity to almost nothing. Fans who cannot get distant stations might try Mr. Peadro's suggestion of using another aerial connected to the plate coil of the set. I find that this greatly increases the volume, particularly on coil No. 1; though it greatly increases body capacity.

JOSEPH ROWE.
R. F. D. 3, Smithburg, Md.

(As stated elsewhere in this issue, direct coupling of the oscillator of a transmitter to the aerial is prohibited. While listeners are not under license restrictions, the increasing vogue of short-wave work is almost certain to bring about official action for the prevention of radiation. It appears that this is already being done around the Canal Zone. For that reason, short-wave listeners should begin looking forward to the necessity of screen-grid tube coupling ahead of their detectors; just as broadcast listeners are now—that is, all should be—using a nonregenerative first stage.—EDITOR.)

ELABORATE EXPERIMENTS

Editor, RADIO NEWS:

When I first completed my Junk-Box I could hardly hear 5SW and they were very hard to tune in. Now I have not missed hearing at least a part of their program every day they have been on the air for six weeks. I have had PCJJ six times on the loud speaker.

The first thing I did on my set was to substitute two 5-plate condensers for the midgets and add two vernier dials; it now takes three complete turns of the knob to go from KDKA on 24.5 meters to 5SW, who are supposed to be on 25.53 (but I get them on 25.20). I next put cardboard extensions on my tube bases, made the coils 1¼ inches in diameter, and wound them with No. 18 and No. 22 wire; the secondaries being space-wound. The improvement was surprising. It required the same number of coils to cover the 20-80 meter band. I next wound a primary coil of 6 turns of No. 18 wire, space-wound, and made it variable above the secondary. I find that on my set inductive coupling is the best. However, I can change from one to the other by merely changing from one aerial post to the other. I advise all Junk-Box owners to try this. Next, I put a CX300A special detector tube in; and I advise everyone to do the same. I then added another audio stage; this can easily be done, provided both transformers are kept away from all detector elements.

I then cut my aerial in half and took two lead-in wires, one from each side of the insulator, placed one on the "P" post of my first audio transformer, and used the other as a regular aerial. Try this! *(This evidently increases the plate to grid feedback; but the same effect may be more easily accomplished.)*

My best experiment was with choke coils. I have a $1.50 special choke, but I can beat it with some paper and about fifteen feet of No. 30 wire. At first I made coils as spools, some slot-wound and others space-wound, etc.; but finally I took a piece of linen paper, wrapped it around a lead pencil, and wound it full of No. 30 wire. I can go down to 13 meters and not leave any holes. (I got this idea from RADIO NEWS, so I do not take credit for the invention.) I have experimented with an R.F. stage and with putting my short-wave detector ahead of the R.F. on my large set, but without much success. In conclusion, I may state that the entire six weeks of my experimenting have been stormy and foggy. I would like to hear from anyone trying any of these experiments.

I should like to identify a station on 28 meters heard on Nov. 3 using Spanish; no English was spoken. On Nov. 23 a station on the same wave stopped the program to give three sharp code signals at exactly 1 p. m., Greenwich time. On Dec. 11 a station between 16 and 17 meters was calling San Francisco in Spanish and four persons were laughing and talking at once.

I would like to know, also, how to send stamps or money to stations in foreign countries in order to get verifications of reception.

ARTHUR J. GREEN,
700 Alpha St., Klondyke, Ohio.

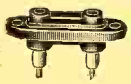
(International postage coupons may be had at large postoffices, and may be obtained by all postmasters. They are exchangeable in any country in the Postal Union for stamps of that country's issue.)

Radio News Laboratories

(Continued from page 940)

MOLDED TIP JACKS

The molded tip jack shown, submitted by The H. H. Eby Manufacturing Company, 4710 Stenton Avenue, Philadelphia, Pa., is designed for output terminals on radio sets of chassis construction, and consist of a molded brown bakelite plate in which have been placed two tip jacks spaced one-inch apart. It is 2 inches long, and 11/16-inch wide; the thickness is 11/16-inch and the over-all depth to ends of jacks 1¼-inches. Holes are provided at each end to fasten the device to the chassis by 6/32 machine screws. These tip jacks are available with "Speaker" or "Phonograph" markings.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2560.

MICROPHONE TRANSMITTER

The microphone transmitter shown, submitted by the Amplion Corporation of America, 280 Madison Ave., New York City, is of a new type in which the metal diaphragm and carbon buttons have been eliminated. Its internal construction comprises a thin rubber membrane stretched across a channelway 1½-inch wide, 3/16 of an inch deep and 3 inches long. The cavity of the latter is closed by the membrane, which also holds in place specially prepared carbon granules. Sixty milliamperes of current has been passed through this arrangement without the usual hiss or packing; while satisfactory sensitivity has been obtained with as low as 5 milliamperes of current. Its measured internal impedance at 1,000 cycles is 500 ohms. For proper operation, it is recommended that a 4,000-ohm variable wire-wound resistor, capable of carrying 60 milliamperes, be inserted in series with the microphone and a 45-volt storage battery. The manufacturers also recommend impedance coupling of the microphone to its transformer in order to prevent core saturation of the latter; this system is identical with the choke or impedance output system used in the plate circuit of a radio receiver's power stage.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2561.

Editor, RADIO NEWS,
230 Fifth Avenue, New York, N. Y.

I have read the article on page 920, entitled "A New Departure." My opinion of your new department, entitled "Popular Handiwork," is:

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I would like to have you publish *Handiwork* Blueprints on the following articles:

....

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Name ....

Address ....

City.................................... State...............

AUDIO COUPLING UNITS

The "Type 225" interstage audio coupling device shown, submitted by Silver-Marshall, Inc., 846 W. Jackson Blvd., Chicago, Ill., has been designed to couple a detector tube to the first audio-frequency tube. When used in the plate circuit of a 227-type A.C. tube, and in connection with the second stage unit described below, almost straight-line response is obtained from 30 to 5,000 cycles. This device consists of a resistor in the plate circuit of the tube, connected on the plate side through a .01-mf. condenser to the center tap of an auto-transformer. The units described above are contained in a black baked enamel container 4 inches high, 3¼ inches long and 2½ inches wide. All terminals are located on one side, and insulated from each other and from the metal container by a strip of bakelite. Designations of the terminals are stamped on the name-plate, which is riveted to the top of the container.

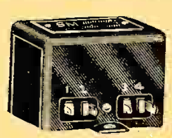
AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2562.

The "Type 226" audio coupling unit which was submitted by the same manufacturer is designed as a second-stage audio coupling unit, when used in an audio amplifier, in which the "Type 225" unit described above is used. When used in this way, it has a frequency response of nearly straight-line characteristics from 30 to 5,000 cycles. The dimensions are identical with those of the 225.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2563.

OUTPUT IMPEDANCE

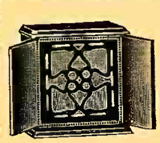
The "Type 251" output impedance shown here, submitted by the same manufacturer, is designed for use between the plate circuit of a power amplifier and the loud speaker. It consists of a choke coil, of approximately 30 henries inductance, providing a direct-current path for the plate supply. A 0.1-mf. condenser, one side of which is connected to the plate terminal of the choke and the other side to the loud speaker, affords a low-resistance path for the A.F. currents to pass through the speaker and return to a terminal connected to the "B+" terminal of the choke. This unit may be used in the plate circuit of any last audio stage where the plate current is not greater than 30 milliamperes. The choke and condenser are encased in a black enamelled container, 2¾ inches long, 2¼ inches wide and 2 inches high.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2564.

CONE SPEAKER

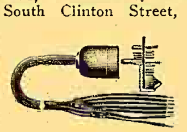
The cone speaker shown here, submitted by the Ottawa Furniture Company, Holland, Mich., is of the balanced-armature type; the cone is 8 inches in diameter. A die-stamped conical frame, serving as a support for both the unit and the cone, is 9½ inches in diameter and 4 inches deep; it has oblong perforations around its sides to prevent resonant frequencies and to allow the passage of sound waves. The inside of the frame is lined with thick felt, which also serves to prevent resonant tones. The frame, cone and unit are fastened within a walnut-finished cabinet 12 inches high, 11 inches wide and 8 inches thick, whose front and back are grilled for the passage of the sound waves. It is provided with doors which open outward, and which may be closed when the speaker is not in use.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2565.

CABLE AND CONNECTOR PLUG

The "No. 612" cable and connector plug shown here, submitted by the Yaxley Mfg. Company, 9 South Clinton Street, Chicago, Ill., consists of twelve wires, 5 feet long, enclosed in a woven and braided sheath and terminating in a molded bakelite head. The 12 split sockettes are molded into the head, and to their exposed ends are soldered the ends of the cable leads. The junctions of the sockettes and cable leads are protected by a metal cap, which fits over the cable, and screws to the head. The terminal unit consists of a bakelite body to which are riveted twelve plug prongs in such positions as to fit into the respective sockettes of the head. A large central prong serves as a guide, and another prong as a guide and lock for the proper position of the terminal head. The bakelite frame is 2½ inches long, 2 inches high and fitted with two metal brackets for mounting; each of the upper corners provides holes for the insertion of tip jacks.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2567.

FILTER CONDENSER

The filter condenser shown, submitted by the Gerd Electric Co., Kendall Square Building, Cambridge, Mass., and designed to operate continuously on 400 volts D.C., is of the paper-and-tinfoil type, wound and vacuum-impregnated with a special insulating compound. It is enclosed in a metallic housing of black crystalline finish 4¾ inches long, 5 inches high and 1 inch thick. The tip-jack terminals are located at each end of the housing near the top. The capacity of the condenser tested was found very close to its rating of 1-mf.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2570.

POWER RESISTOR

The resistor shown here, submitted by C. W. Love & Company, 3567 Cottage Grove Ave., Chicago, Ill., is of the compressed-carbon type. Four samples, of various values, were submitted for test, and found within 5% of their rated values for the low-resistance, and 10% for the high-resistance types. The resistance element is 1½ inches long, 5/16 of an inch in diameter and is provided with wire terminals; which are molded into it, thereby providing electrical contact at all times. These resistors were found to dissipate 5 watts of energy without appreciable change in resistance, or heating to any great extent.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2571.

BINDING POST

The binding post shown, submitted by the X-L Laboratories, 1224 Belmont Avenue, Chicago, Illinois, is of the push type, and consists of three parts; the cap, the body and a 6/32 mounting screw. The cap consists of an aluminum sleeve 7/16-inch in diameter and ½-inch long, molded into the bakelite top on which the designations are marked. The sleeve is pierced through its side with a ⅛-inch hole, which becomes aligned with another in the aluminum body when the spring contained in the cap is compressed by the finger. The cap is held to the body by an oval slot engaging a pin on the side of the latter. The post is furnished engraved with any standard radio terminal lettering.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2572.

Book Review

By H. M. BAYER

THE RADIO INDUSTRY, THE STORY OF ITS DEVELOPMENT, a compilation of lectures. Published by A. W. Shaw Company, New York City. 9¼x6¼ inches; 330 pages. Fine drawings and half-tones. Price $5.00.

The book contains a series of lectures which were delivered at the Harvard School of Business Administration by gentlemen who need no introduction to those connected with the radio or kindred industries: General J. G. Harbord, president, Radio Corporation of America; David Sarnoff, vice-president and general manager, Radio Corporation of America; E. E. Bucher, assistant vice-president, Radio Corporation of America; Dr. F. B. Jewett, vice-president, American Telephone and Telegraph Company; E. P. Edwards, manager, radio department, General Electric Company; Judge Stephen B. Davis, New York City; H. P. Davis, vice-president, Westinghouse Electric and Manufacturing Company; Merlin H. Aylesworth, president, National Broadcasting Company; J. L. Ray, general sales manager, Radio Corporation of America; Pierre Boucheron, advertising manager, Radio Corporation of America; and H. C. Weber, Massachusetts Institute of Technology.

There is no doubt that it would be difficult to find a body of men better fitted than those listed above for such an undertaking; but we cannot help wondering whether the lectured did not find themselves snoozing now and then during the course of these dissertations. However, it must be said that those who managed to remain awake were treated to a carefully-balanced course in the commercial development of radio, its commercial application and other phases of interest to the business executive.

Opening with an introduction by Mr. Sarnoff and a foreword by Dr. Anton De Haas, the lectures unfold themselves in what was no doubt their given order: a resumé of early radio development; radio in the world war and the organization of an American-owned transoceanic radio service; the development of the radio art and radio industry since 1920; the development and use of radio telephony as a means of communication; research and manufacture in the radio art; the law of the air; the early history of broadcasting in the United States; the "National Magazine" of the air; the distribution and merchandising of radio equipment; advertising radio to the American public; and a final lecture on applications of radio principles and devices in industry, offered by Mr. Weber who, also, has appended to the volume a brief chapter on the basic principles of radio transmission and reception.

Some interesting facts contained in these lectures, although published time and time again in the past, are worthy of notation. "From a nominal volume, (*of radio sales*), in 1920 to a half-billion dollar industry in 1928! Such is the amazing growth of radio program broadcasting (*no doubt the writer meant radio sales.*—REVIEWER) in the United States. In less than eight years, seven and a half million people had become users of radio sets—a potential audience of thirty million listeners! A public that spent nearly two billion dollars for radio sets and equipment in six years—and is still spending half a billion dollars a year for the output of twelve hundred factories, employing three hundred and twenty thousand workers!"

The sales and advertising policy of the Radio Corporation of America is outlined and illustrated.

Its size and a rather imposing binding, make this volume an attractive addition to the library.

LOUD SPEAKERS, by Joseph Morgan, Published by International Resistor Company, Philadelphia, Pa. Leaflet, 13 pages; line drawings, curves. Free distribution.

Mr. Morgan (who, it is said, fills a chair of one of our larger universities in its electrical engineering departments) has spoken more words of wisdom; this time anent speakers and their relative merits. It is gratifying to note that, throughout the doctor's little treatise, the laboratory graph stands head and shoulders above personal prejudice and commercial interests. The pamphlet's contents make an excellent course for the radio beginner, and enlightening reading for the advanced student who may possess a bias or two regarding speakers. Some of the author's conclusions are worthy of publication:

"A good exponential horn should have a small

RADIO NEWS BLUEPRINTS Nos. 78, 79 and 1A

RADIO NEWS BLUE PRINT ★

TO encourage the construction of radio apparatus illustrated in this magazine, and make it easier for our readers, RADIO NEWS makes up each month large blueprints of the diagrams which accompany the principal constructional articles; these sets include full-sized drilling templates, coil data, etc., where required, and in each case a list of the apparatus originally used, with full specifications. Several thousand of these have been distributed each month.

If you desire a set of blueprints for any or all of the apparatus described in this month's Blueprint articles, fill out the attached coupon as directed and send it in with 25 cents for each set requested. The blueprints requested will be mailed to you postpaid. We cannot send blueprints with magazines.

Back-number RADIO NEWS blueprints can be obtained at the same rate while the stock lasts. We cannot furnish blueprints of commercially-manufactured radio apparatus.

Blueprint Department, RADIO NEWS: (E)
230 Fifth Avenue, New York, N. Y. (U. S. A.)

I enclose 25 cents for each item checked; for which please send me a set of large RADIO NEWS blueprints.

- ☐ No. 78. The "Home-Builder's Seven" Superheterodyne.
- ☐ No. 79. The "Space-Charge Autodyne" S-W Set.
- ☐ No. 1A. A Handsome Radio Console.
- ☐ No. ....

Name ....

Street Number ....

Postoffice ....

State (Province, etc.) ....

(Please typewrite your name and address or print it with a pen—not a pencil—as many signatures cannot be read. This will avoid errors in addressing the mail.)

OPPORTUNITY AD-LETS

Follow these advertisements every month. Reliable advertisers from all over the country offer their most attractive specials in these columns.

Classified advertising rate twenty-six cents a word for each insertion. Names and addresses must be included in the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency. No advertisements for less than 10 words accepted.

Objectionable or misleading advertisements not accepted. Advertisements for the June issue must reach us not later than April 2nd.

CIRCULATION LARGER THAN THAT OF ANY OTHER RADIO PUBLICATION

EXPERIMENTER PUBLISHING CO., INC., 230 Fifth Avenue, New York, N. Y.

Agents Wanted

Guaranteed Genuine Gold Leaf Letters anyone can put on store windows. Large profits, enormous demand. Free samples. Metallic Letter Co., 422 N. Clark, Chicago.

Make $10 every day introducing New Automatic Window Washer. Amazing Invention. Send for Free Sample offer. National Industries, 67 E. Lake, Dept. 854, Chicago.

$50.00 Weekly. Men wanted to demonstrate and take ten orders daily direct from motorists. Amazing Magnetic Trouble Light. Sticks anywhere! More orders, bigger pay. Write for demonstrator and particulars. Magno Co., 6 Beacon St., Dept. 794, Boston, Mass.

Business Opportunities

Amateur Cartoonists: Sell Your Cartoons New Plan. Smith's Service EX1194, Wenatchee, Wash.

Free Book. Start little Mail Order business. Hadwil, 5A-74 Cortlandt Street, N. Y.

Inventions Commercialized. Patented or Unpatented. Write Adam Fisher Mfg. Co., 278 Enright, St. Louis, Mo.

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Learn Chemistry at Home. Dr. T. O'Conor Sloane, noted educator and scientific authority, will teach you. Our home study correspondence course fits you to take a position as chemist. See our full page ad on page 947 of this issue. Chemical Institute of New York, 16 E. 30th Street, New York City.

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initial throat area, a slow rate of taper and a large final opening."

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"A speaker possessing all the desirable qualities demanded by science, such as that it should not produce any frequencies not present in the original sound—it should be capable of delivering its output with sufficient volume without the introduction of distortion due to overload—its ratio of sound output-power to the electrical input-power should approach as nearly as possible to unity—its performance should be independent of atmospheric changes, etc.—cannot be found this side of paradise."

The author describes the respective advantages and disadvantages of the common horn speaker, the balanced-armature, or cone speaker, the exponential horn, and the moving-coil or dynamic speaker. The information offered is simply and clearly told, and makes highly interesting and informative reading. It deals, of course, solely with the theory of loud speakers.

A TREATISE ON TESTING UNITS FOR SERVICE MEN, by John F. Rider, published by Radio Treatise Company, New York City. 9 x 6 inches, 43 pages; circuit diagrams, curves. Price $1.00.

Doubtless, times have changed. It was only a few years ago that Johnny, the neighbor's son, and a bright lad at that, was considered the radio genius of the town. His duties, much like those of the country physician, were to bring your receiver into the world, and thereafter tend to its ills and ails. His curative methods were interesting if not startling; at any rate some excerpts from his "'Materia Medica" may be recalled by those who had occasion to use his services.

If we remember correctly, dry-cells (the WD12 tube was popular then) were tested by the simple method of placing the tongue across the terminals. Exactly what this test indicated is somewhat of a mystery; but, as it was accompanied generally by a scholarly wrinkling of the brow, this act of engineering was passed by along with the famed "B" battery test. Regarding the latter, the innocent spectator knew little except that he had once heard it referred to as "a lulu"; whatever that meant. The test itself required nothing more than a piece of bare copper wire, one end of which was connected to one terminal of the battery; the other end of the wire was then rapidly flicked across the other battery post. The result was a miniature display of pyrotechnics which, incidentally, cost the battery three-fourths of its life; but, somehow or other, the young engineer found in the result of his test an indication of the battery's condition.

The one remaining item on the test schedule offered no difficulty; if the filament of the tube refused to light after the filament prongs had been placed across a cell, the tube was considered out of the running and another was sent for. On the other hand, if the filament lighted, all was well. (All this was some time ago.)

Today "Johnny" deals with cathode-ray oscillographs, beat-note audio oscillators, reactivating voltages, electronic-emission tables and resonance indicators. And, if we take it from Mr. Rider, all this must be known by the modern service man, and a good deal more.

What he is supposed to know, what the instruments he is supposed to use, and how he is to use them, are comprehensively told in Mr. Rider's "Treatise for the Service Man." A servicing or trouble-shooting instrument is listed for every conceivable affliction which might befall a present-day receiver; and, from the number and types of instruments described, their afflictions must be legion.

Complete constructional data are given, so that the service man may build his own equipment. Among the apparatus described, including those mentioned above, are: a tube reactivator, a calibrated vacuum-tube bridge, a tube tester, a "B" unit tester, output indicating systems, a tube voltmeter, an improvised high-resistance voltmeter, and a description of a complete service station's test bench and its panel equipment.

To the real service man, a book of this type should prove invaluable.

TO SAY NOTHING OF LANGUAGE!

Hint to constructors from the *Radio World*: "You can push back the insulation of the solid, single-strand wire with your ANGER after having cut the wire to the desired point." Yes, and after an unexpected collision with the warm end of the iron, our anger had risen to such a degree of solidity that you could punch a hole through the panel with it.—*R. A. Bell.*

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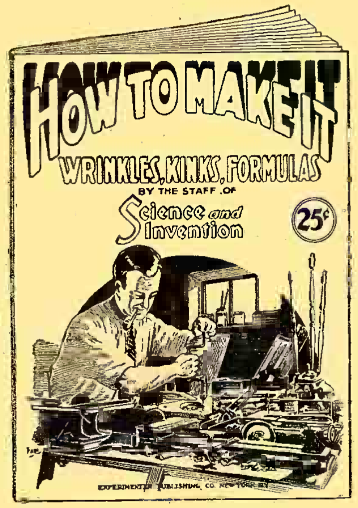

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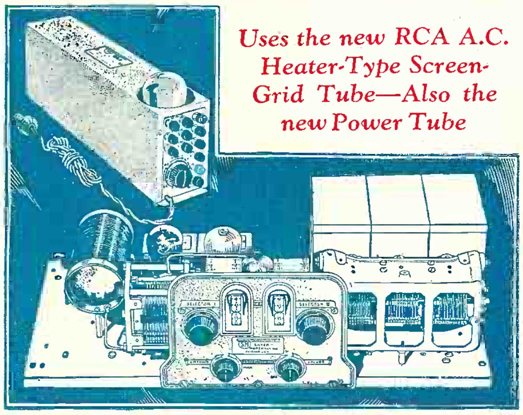

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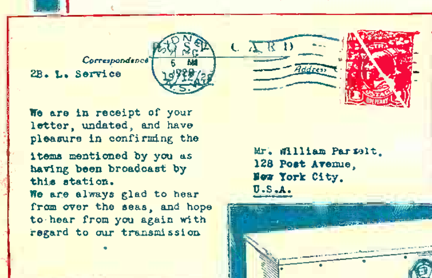

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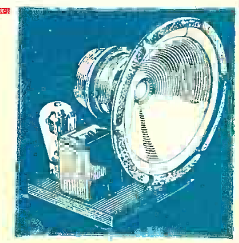

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