1001 RADIO QUESTIONS AND ANSWERS

COMPILED BY THE STAFF OF

1928 Edition

RADIO NEWS

EXPERIMENTER PUBLISHING CO.
NEW YORK CITY

1001 RADIO QUESTIONS *and* ANSWERS

CONTENTS

1001 Radio Questions and Answers

Compiled by the Staff of

RADIO NEWS

Edited by

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Technical Editor Radio News

A Classified, Complete Collection of Radio Questions and Answers, of Incalculable and Inestimable Value to Everyone Interested in Radio, Covering Practically Every Phase of the Art

Vol. No. II

Published by
EXPERIMENTER PUBLISHING COMPANY, Inc.
230 Fifth Avenue
New York

Introduction

It is the consensus of opinion among the general public that radio is different from all other sciences. For the average layman there is a romance and mystery attached to it which appeals to the thought and imagination in a manner different from that of similar specialized studies.

Annually there are hundreds of thousands of persons in the schools and colleges of this country who study mathematics, physics, chemistry and other advanced subjects. Upon the completion of their course of instruction they have a very thorough appreciation of underlying principles combined with a large number of practical facts. After a few years in the business world a large majority of these students have forgotten all but the most rudimental information.

In contrast with this, there are few places where classes in radio are conducted, and only a very small percentage of people of the United States have received scholastic instruction in this subject. However, there are probably more than a million radio fans who have a valuable working knowledge of this highly technical art. In the majority of cases they have become proficient through actual experience in the construction of radio receiving sets and by information acquired through reading various monthly periodicals, newspaper radio sections and books.

It is not difficult to understand why the study of radio has become such a popular national pastime. Boys and young men have always been fascinated with new forms of communication, including coded letters, flag signalling, telegraphy, etc. It was most natural, therefore, to find that young men were the pioneer investigators of radio communication. They built and perfected many types of transmitters and receivers for personal satisfaction, and incidentally were largely instrumental in giving impetus to the rapid development of the industry.

Broadcasting was started entirely as an experiment, and when the first stations were erected less than seven years ago the promoters were not in a position to prophesy the probable outcome. However, in an incrediably short period of time it eclipsed all other forms of home entertainment.

When the enthusiasm for radio entertainment swept the country the supply of manufactured sets was very limited, and this is probably responsible for the fact that a majority of those who wished to listen-in built their first receiver. Of the ever-increasing army of radio experimenters it may be said that many acquired their initial interest at this time.

In connection with this science there are many problems which puzzle the more advanced experimenters as well as the beginners, and therefore, it is the purpose of this book to answer as many of the questions of both classes as possible. Also it has been the aim of the publishers to classify these questions and corresponding answers in such a way that they are available for ready reference. They include the actual queries of hundreds of radio fans from all parts of the world and provide information on practically every phase of radio development, including elementary facts and advanced theories. For this reason this volume may be considered a practical handbook on radio.

EDITOR.

October, 1927.

Printed in the United States of America

EXPERIMENTER PUBLISHING CO., 230 FIFTH AVE., N. Y.

Miscellaneous Circuits

TROPADYNE

(1) Mr. Clarence L. Alger, Rochester, N. Y., asks:

Q. 1. So far I have been unable to hear any sounds from my Tropadyne, using New York Coil Company intermediate frequency transformers.

A. 1. For best results, the equipment designed for this receiver and now available on the market should be used. Properly constructed, this set will prove to be sensitive, selective, clear and loud.

A 23-plate variable condenser is required across the secondary of each one of the transformers. The size condenser required for the primary of the input transformer would probably be in the neighborhood of .001 mf.

Test all tubes in an oscillating receiver, to determine whether they are uniform in their characteristics. Test your potentiometer for open circuit. It is also possible that you have connected it across the tube filaments instead of across the "A" battery direct. Some of the wires may be making poor contact. The condenser across your radio frequency transformer may be shorted. If you are using a phone condenser in the detector plate circuit, that also may be short circuited.

Test your transformers for open circuit. This may be done by connecting a single dry cell in series with a pair of receivers. When one side of the receivers is touched to the free binding post of the battery, a loud click should be heard. This click should also be heard if the free end of the battery and the free end of the headphones are touched to the primary or secondary terminals of the transformers. It will be noticed, when testing audio frequency transformers, that the click is much less pronounced at the secondary side as compared to the primary side. This is due to the greater resistance of the secondary and is not to be considered a fault.

Examine the tube sockets carefully; it is possible that the tubes are making poor connection to the socket springs.

Test all batteries to be sure they are at the rated voltage. This should be the first operation whenever testing defective sets.

Check the wiring very carefully to be sure that a primary is not connected where a secondary should be, or vice versa; also to be sure that battery polarities are correct.

Q. 2. Is the arc transmitter more likely to produce harmonics than other types of transmitters?

A. 2. The arc is a prolific producer of harmonics. It has been stated that the Eiffel Tower station has been heard on 13 different harmonics between 650 and 162 meters. The great objection to the arc system is apparent. Fortunately there have been new developments enabling a nearly entire control of the harmonics ordinarily produced and radiated by arc transmitters.

Q. 3. What is the object of the piece of string at the end of headphone cords?

A. 3. This is a "tie-cord." It is fastened to the receiver in some convenient manner and serves to take the strain which would otherwise develop at the point where the phone cord is soldered to the phone tip. There is usually a knob or a loop made on the receiver for this purpose.

NOISY SET

(2) Mr. Chas. W. Hyde, Richmond, Indiana, asks:

Q. 1. Please explain why a WD-11 tube will not work in a set that operates when a UV-200 tube is used.

A. 1. We should say that the WD-11 tube is defective. Or, a higher "B" battery may be required for it. While the UV-200 tube may operate with only 16 or 18 volts on the plate, you may require as high as 45 volts on the plate of the WD-11 tube. It is also possible that your "A" battery was not sufficiently strong; try putting the entire output of a single dry cell on the filament of the tube. Some rheostats do not cut out quite enough wire at the minimum resistance position, resulting in a greatly reduced current supply to the filament (insufficient for operation of the tube). If an adapter is used, contacts may not be perfect. The information you furnished was only fragmentary.

Q. 2. What can you suggest for reducing the rushing sounds heard when no signals are coming through my five-tube set (two stages of tuned radio frequency amplification)?

A. 2. You may have a noisy "B" battery or tube. Socket connections may not be good. You may have leaky fixed condensers. The grid leak may be noisy. The "A" battery may be in need of charging, or it may be erratic in action for other reasons. The rheostat or battery switch may not be making good connection. The phone cord may be partly broken and the test for this is to shake the phone cord without moving the phone plug. If loud crackling sounds are heard when the phone cord is moved, it is evident that the cord should be changed. Occasionally phone plugs do not make good connection in the jack. The variable condensers may be making poor contact. If turning the plates produces loud crackling sounds, this may usually be considered the trouble.

Poor connections are easily located by moving the panel and by moving the wires. Often, wires that appear to be firmly fastened may not be making good contact at all. Try a 0.05 mf. condenser from the last audio tube plate, to "A" minus.

Q. 3. What are microphonic noises?

A. 3. The "imperfect contact" microphone consists, in addition to the battery supply, of metals imperfectly touching. This combination is susceptible to slight motions. If such a condition arises in a receiving set, the result is a "microphonic" effect and the constantly varying current causes the audible sounds usual from imperfect contact microphones.

FUNDAMENTALS

(3) George Davis, West New York, N. J., asks:

Q. 1. Kindly show and explain the various wave forms and transformations in a simple regenerative circuit?

A. 1. In the antenna circuit of Fig. 3, the incoming oscillations are absorbed to a maximum degree if the circuit is in resonance with the wave. From the primary inductance, the energy is transfered to the secondary circuit, in which it assumes the wave form as shown in the accompanying sketch. This is due to the rectifying action of the detector. As the current in the plate circuit is always direct and varies at radio frequency, its wave form is shown depicted in below. Due to the responsive action of the diaphragm in the phones, what is known as the actual value of the current fluctuations in the plate circuit are reproduced, assuming variations as shown.

THE "Z" CIRCUIT

(4) Mr. Chas. Schumachey, Detroit, Mich., asks:

Q. 1. Kindly advise if Federal radio frequency transformers can be used in the "Z" circuit?

A. 1. These transformers, or any other good make of radio frequency transformer, may be used with the "Z" circuit. However, tuned radio frequency transformers of the type used in the Neutrodyne re-

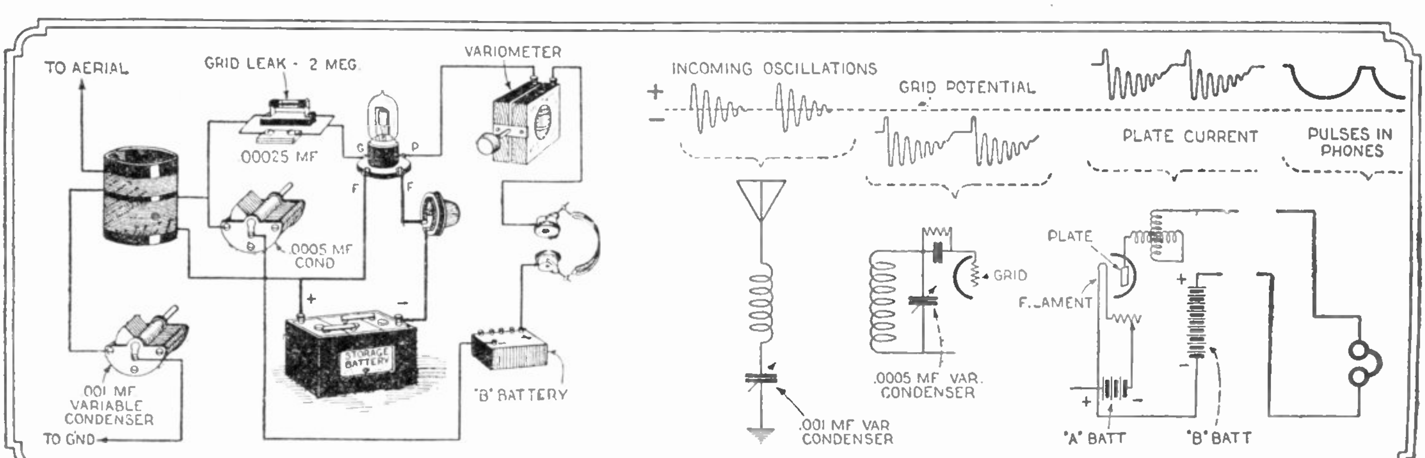


Fig. 3. Just what happens in the different parts of a simple regenerative circuit is depicted here. Memorize the diagrams. They will help you in solving and understanding more complicated hook-ups.

ceiver will be considerably better; tuning will be sharper and signal strength will be greater.

Q. 2. What tubes are best suited to this circuit?

A. 2. The circuit is more in the nature of an exposition of a principle, rather than a particular system of connections. This principle should be adaptable to any good tubes. A particularly convenient combination would be to use UV-201A tubes for the three amplifying tubes. WD-11 or WD-12 tubes may well serve as the coupling tubes.

Q. 3. I have tried many circuits and have found that in some I can entirely eliminate the grid leak without undue loss in volume of an incoming signal. Can you explain this?

A. 3. While it is true that many circuits will work satisfactorily without a grid leak, yet there are many more that will work to better advantage with one. During the process of reception, negative charges of electricity pile up upon the grid due to the action of the grid condenser. If a means for returning these superfluous and excessive negative charges to the filament is used, through the employment of a suitable grid leak, signals will be reproduced with fidelity. However, if a grid leak has too high a resistance these charges escape too slowly and naturally the incoming signal becomes distorted. If the grid-leak resistance is too low, the incoming signal is short circuited and a large amount of the energy is wasted. For the ordinary detector tube, 1 to 3 megohms should be experimented with, in order to find a suitable value for the tube. As a detector tube is generally a soft tube or in other words has a gaseous content, it sometimes is not necessary to employ a grid leak. This is because the negative charges are carried away by the ionized hot gases within the tube. Again in the employment of a hard tube for detection, the gas content being relatively much lower, the negative charges, if no grid leak is employed, actually become sufficient to paralyze the rectifying action of a tube and no signals will be heard. In this connection especially when a high voltage "B" battery is used, it is best to use a grid leak.

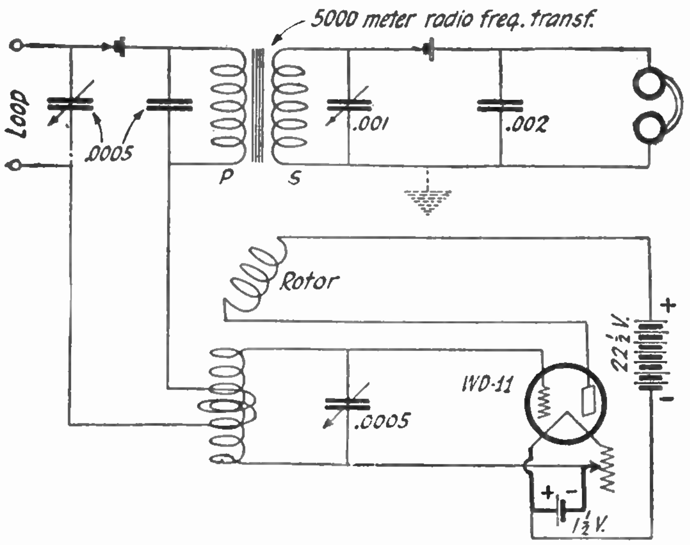


Fig. 5A. Diagram showing method of reducing the number of tubes in super-heterodyne construction. Two detectors of the usual crystal type are required.

ONE TUBE SUPER-HETERODYNE

(5) Mr. Lorne Machean, Bellevue, Chateuquay Co., Quebec, Canada, asks:

Q. 1. Is it possible to construct a Super-Heterodyne in such a manner as to eliminate vacuum tubes?

A. 1. Diagram 5A shows the most practical method of doing this. The two detectors are of the usual crystal variety and may be of the fixed adjustment type.

The oscillating unit required to produce the beat note of 5,000 meters may be an oscillating crystal of the quartz, Rochelle salts, or zincite-steel type. Since these systems are either experimental or unavailable to the average experimenter, we have shown the more practical vacuum tube oscillator. A WD-11 tube will be quite satisfactory. Of course, any other tube can be used as well.

The radio frequency transformer used may be of the iron core variety, as shown, or of the air core type. The values of the primary and secondary condensers will be determined by the transformer construction. The transformer constants given are for the Tropaformer. If air core Ultraformers are used, the primary condenser would be of about .001 mf. capacity (a 43-plate variable condenser would do for test) and a .00025 mf. condenser will be used across the secondary (an 11-plate condenser could be used here).

Q. 2. Is it possible to combine the Tropadyne principle, with a Super-Heterodyne employing crystal detectors?

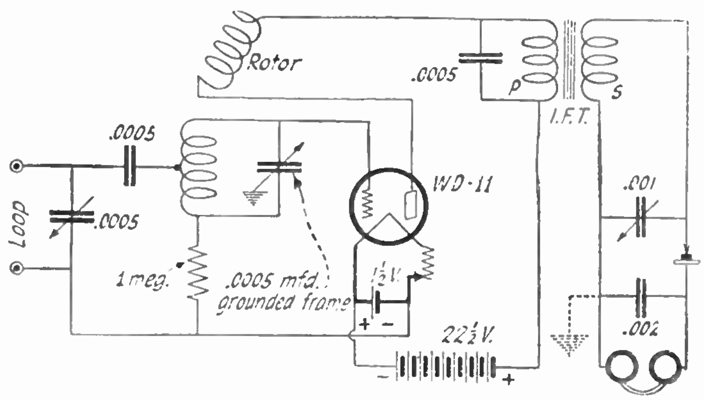


Fig. 5B. This circuit illustrates the method of combining the super-heterodyne with the tropadyne principle. This system is satisfactory only for local reception when using a loop.

A. 2. Circuit 5B illustrates the method. It may be advisable to connect one side of the headphones to "A" minus, or to the ground, as shown.

This system would be satisfactory only for local reception, using a loop aerial.

Since the lower potential side of the oscillator condenser is at a higher potential than "A" minus, it is necessary to use a grounded frame condenser. This will entirely eliminate the hand-capacity otherwise present.

A standard variocoupler may be used for the two tuning inductances shown. If a three coil coupler is used, the untuned primary is left unconnected.

Q. 3. What would be the circuit for reflexing the oscillator tube for one stage of audio frequency amplification?

A. 3. Circuit 5C is the theoretical circuit. The choke coil consists of about 300 turns of No. 30 D.C.C. wire wound on a 3-inch tube, in a single layer. The standard untuned primary, three circuit coupler is used for the radio frequency tuner, or oscillator coil. The untuned primary adapts itself very well as the pick-up coil. This coupler arrangement is the same as that used in circuit "A"

The ratio of the audio frequency transformer may vary between 3:1 and 10:1.

It may be necessary to experiment with this circuit before it tunes sufficiently sharp and is sufficiently sensitive.

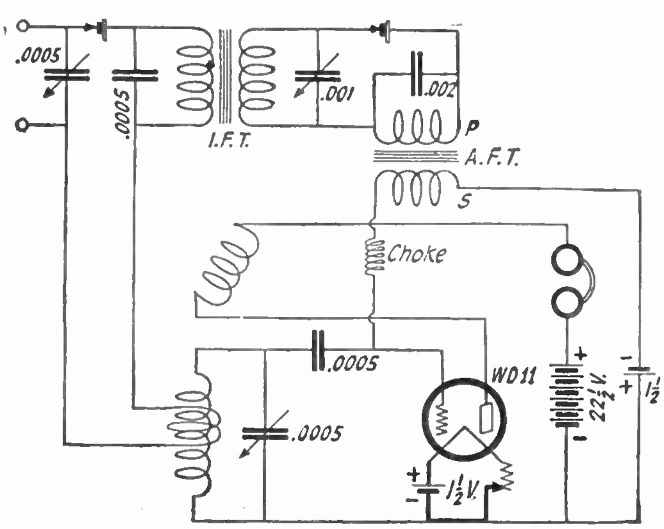


Fig. 5C. This circuit shows how it is possible to reflex the oscillator tube in a super-heterodyne in order to obtain an additional stage of audio amp'ification.

FUNDAMENTALS

(6) Mr. W. Kellow, Alhambra, Calif., asks:

Q. 2. Which way does the modulated current flow in the plate circuit of the detector, that causes the audible notes in the phones?

A. 1. The plate, or "B" battery, current can move only very slowly from the plate to the filament, until a signal comes in, when it quickly moves from plate to filament, in the vacuum tube, in unison with the signal variations, producing a pulsating direct current through the headphones.

Q. 2. Which way does the relative current flow in the grid circuit?

A. 2. From the grid to the filament, in the vacuum tube, since it is prevented from going in the other direction, due to the one-way, or valve, action of such tubes.

Q. 3. Please explain whether or not the half-cycle in the plate circuit comes from aerial or ground.

A. 3. The audio frequency half-cycle to which you refer is the sum of many full cycles in the aerial circuit occurring at radio frequencies.

CASCADE REGENERATION

(7) Mr. Lew M. Meder, Carson City, Nevada, asks:

Q. 1. Is it possible to make a cascade regenerative receiver having tuned impedance coupling for the radio frequency amplifier, but regeneration in both detector and radio frequency amplifier?

A. 1. Cascade regeneration is difficult to handle. The circuit is shown in Fig. 7 on this page.

To reduce the tendency of the set to generate parastic oscillations, it is quite necessary that the aerial grid and plate coils of the first radio frequency amplifier tube be placed in non-inductive relation to the balance of the inductances used in the set. The remaining two inductances, viz.: the tuned impedance of the detector circuit, and its relative rotor, are in inductive relation to one another.

To stabilize the control, one stage of audio frequency amplification has been added; this tends to reduce the effects of body capacity which would otherwise be objectionable to a much greater extent, unless special precautions were taken. The use of grounded frame condensers is particularly desirable in all tuned circuits. The variable resistor also assists in the stabilization.

The first three inductances may comprise the standard three-winding variocoupler having an untuned primary. The remaining two inductances may also be a coil of this type, with the untuned, or primary, winding left unconnected.

The value of the "C" battery will be determined by undividual conditions. Remember that its use reduces distortion increases the "B" battery life and reduces the tendency to oscillate.

Q. 2. I have been advised that placing the "B" batteries on a dry wood board on a radiator is not desirable, as it makes a capacity to ground and sometimes causes considerable feed-back to the input side of the set. Is this correct?

A. 2. In addition to the above and primarily, it will greatly reduce the life of the "B" battery due to the great acceleration of the action of the acids on the metals. "B" batteries should always be kept in a cool, dry location.

Q. 3. If it is convenient to give storage "B" batteries a booster charge every day, would there be any disadvantage in tapping off different voltages for the radio frequency amplifier, detector and audio frequency amplifier?

A. 3. Since the drain of the high voltage end of the battery would be subnormal and the drain on the low voltage end of the battery would be abnormal, the cells comprising the low voltage end of the battery would expand and contract and generate gases to a much greater degree than those at the opposite end, causing a loss of the active material due to its dropping out of the grids. This would result in much quicker depreciation of these cells.

That is an argument in favor of the expensive but more efficient arrangement of individual batteries for the three voltages you mentioned.

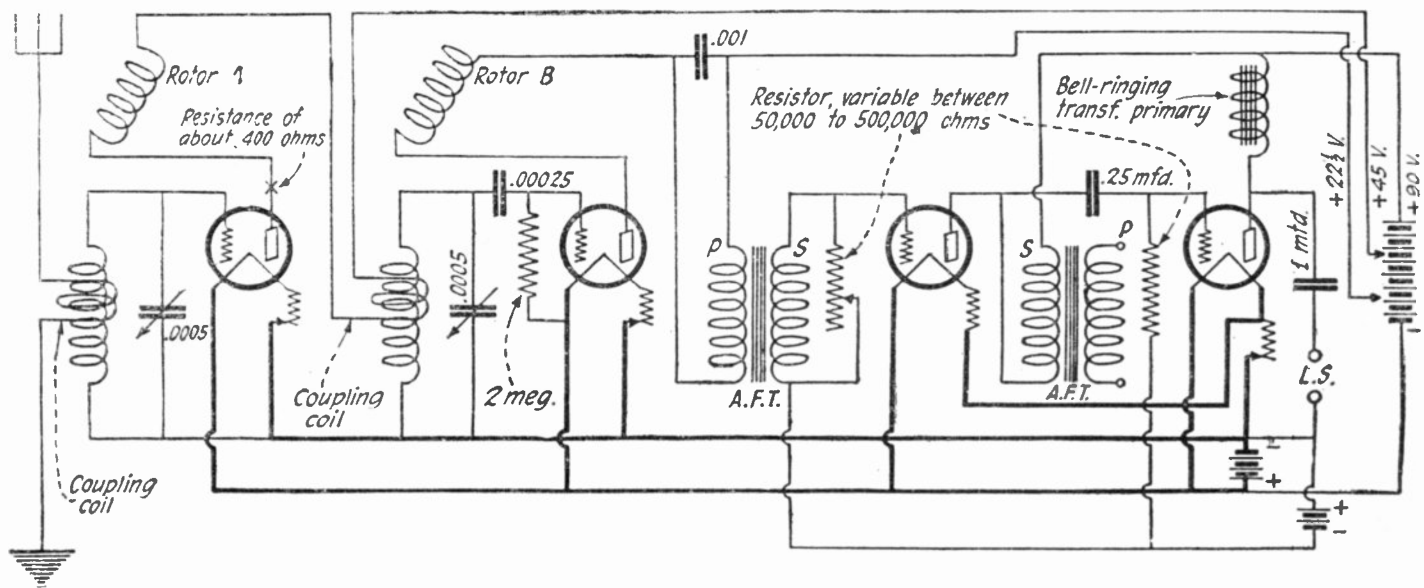


Fig. 7. This circuit shows how it is possible to gain cascade regeneration in a four tube radio receiving circuit.

SHORT WAVES

(8) Mr. Morris H. Clayton, Philadelphia, Pa., asks:

Q. 1. Would you recommend using a Gen-Win short wave coupler for the reception of stations around 11 meters?

A. 1. This coil should prove satisfactory.

Q. 2. What circuit would be satisfactory, using two or three tubes?

A. 2. See circuit No. 54 of the "Radio Hook-Ups" appearing in the October, 1924, issue of Radio News. Also see circuit No. 67 appearing in the same department of the December, 1924, issue.

Q. 3. What is the winding formula?

A. 3. Primary, six turns: secondary, 14 turns and tickler, 16 turns. The secondary is shunted by a condenser of about .0005 mf. capacity. The primary is in solenoid form. The primary is bare No. 14 wire silver plated to prevent corrosion. The secondary is No. 18 D.C.C. wire, stagger wound. The tickler is No. 18 D.C.C. wire spiderweb wound.

NON-OSCILLATING REGENERATIVE SET

(9) Mr. E. Bonavia, Victoria, B. C., asks:

Q. 1. Several times of late I have been listening to the local broadcast station with a crystal tuner, and while they were standing by with the generator running I have been able to tune in distant broadcasting stations and C.W. signals quite distinguishable that I could not hear before. Is my crystal oscillating? If so could you kindly explain how this happens?

A. 1. The reception you mention may have been the result of several causes. The operator at the broadcast station whose duty it is to keep a constant watch by listening in with a receiving set, may have been tuning to the stations you heard. A re-radiation of these signals may have been picked up by the transmitting aerial and superimposed on the carrier wave emanating from the transmitting antenna. We do not believe your crystal was oscillating.

Receiving sets in your neighborhood sufficiently close to effect your antenna may have been tuned to signals you heard, and re-radiated to your aerial. C.W. signals radiated by local oscillating receivers may be heterodyning with the transmitting station waves you mention, producing a beat which would be audible when rectified by your crystal detector.

Is it not possible that the signals which you refer to as being of a continuous wave transmitter, may have been the signals of a station transmitting I.C.W. (interrupted, continuous waves)?

Q. 2. How is a pickle bottle coil constructed?

A. 2. The construction of these coils is described on page 1178 of the January, 1925, issue of Radio News

Q. 3. Is it possible to construct a non-radiating regenerative radio receiver?

A. 3. It is possible to construct regenerative receivers that will radiate only from the inductances and not from the aerial. The entire system is thoroughly described in the article "Non-Radiating Regenerative Receivers," page 496 of the October, 1924, issue of RADIO NEWS.

FINE SUPER-HETERODYNE RESULTS

(10) Mr. Joseph Anvil, Oxford, Ohio, asks:

Q. 1. What would be considered good operation of a Super-Heterodyne?

A. 1. It is difficult to answer your question. Location, regardless of the set used, is a very important factor in determining the results with a set. We should say it was functioning satisfactorily if a set employing three stages of intermediate frequency amplification will operate the loud speaker on only the detector, when only a coil three inches in diameter is used as the pickup device, receiving the signals from stations located within a radius of 100 miles and having a power of about one K.W. Also, it should be possible to operate the loud speaker so that signals are clearly understandable in a large room, using a loop aerial about two feet in diameter, receiving the programs broadcast by a 1 K.W. station 1,000 miles away, using only the detector output preceded by three stages of intermediate frequency amplification. No aerial or ground should be used for this test.

Q. 2. What is the color code of Rasco radio frequency transformers?

A. 2. Blue, outside primary; red, inside primary; orange, outside secondary; green, inside secondary.

Q. 3. Does it make any difference, on amateur or broadcast wave-lengths, whether the variable condenser across an inductance is connected close to the inductance, or some distance from the inductance, granting that mechanical reasons make it necessary to place the coil at a greater-than-usual distance from its two connections to the tube?

A. 3. It would be more desirable to place the condenser at the greatest distance from the coil, so as to include as much of the coil leads in the oscillatory circuit tuned by the condenser, as possible. Otherwise, high frequency parasitic oscillations may be generated by reason of the inductance and capacity furnished by the leads not included in the tuned circuit. The effect of these oscillations is not always noticeable. The shorter the wave-length, the more pronounced these effects become. In transmitting circuits, these oscillations are often easily detectable, where the above precautions have not been taken, sometimes causing inoperation of the set.

GRID BIAS POTENTIAL

(11) Mr. Manuel Smith, Plainfield, N. J., asks:

Q. 1. Is it not possible to use the "B" battery to supply a "C" potential?

A. 1. The method is shown in Fig. 11. At first glance, one is inclined to believe that the potential applied to the grids will be positive in polarity but a little study of the circuit will show that this is not true. The by-pass condenser is quite essential. A common "A" battery may be used, but it is advisable to use a separate "B" battery.

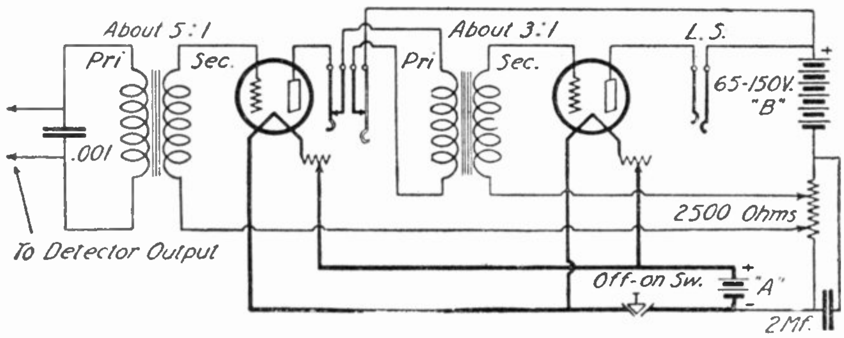


Fig. 11. "C" battery potential, but no "C" battery. Seemingly paradoxical, explained by the resistance in series with the "B" battery supply. The voltage drop is at negative potential.

NEUTRODYNE DATA

(12) Mr. Franklin J. Angevine, Dayton, Ohio, asks:

Q. 1. What is the diagram of connections employed in the Boonton Light Four receiving set (portable)?

A. 1. The circuit of this set will be found in Fig. 12. UV-199 tubes are used throughout. Ballentine variotransformers are used in place of the usual fixed transformers. These transformers are so constructed as to be variable in wave-length in a manner similar to the variometer. The primary is in two parts, as is the secondary. One-half of each winding is variable in inductive relation to the remaining half. This enables the determination of opposing or assisting fields, resulting in a wave-length control These transformers are varied in conjunction with the tuning condenser. By the use of these transformers, high amplification is had at one desired wave-length, without the usual requirement of considerable space for variable condensers.

Although no condenser is shown, it might be advisable to shunt a .001 mf. fixed condenser across the primary of the first audio frequency transformer.

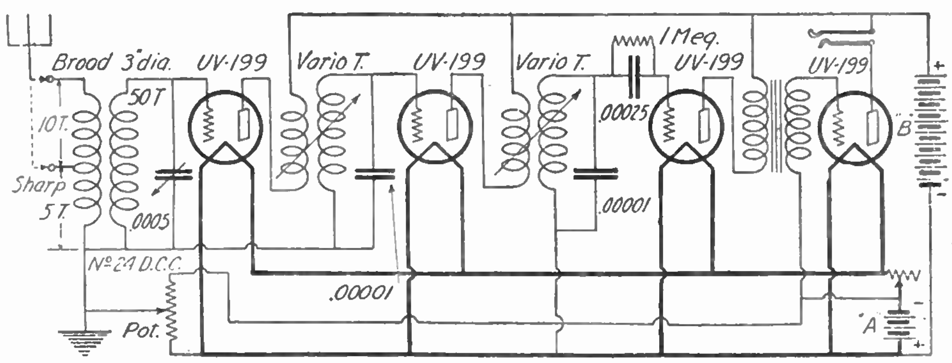


Fig. 12. Voltage step-up through the use of two-coil transformers, and tuned grid circuits without condensers, are outstanding features of this receiver. Loud speaker reproduction of local signa's, and loud headphone reproduction of very distant stations, using only dry cell tubes, is had.

This circuit may be used to include any make of fixed radio frequency transformers, although results will not be as good as when the secondaries are tuned in some manner. If desired, standard air-core radio frequency transformers designed to be tuned by means of shunt variable condensers may be used in place of the two variotransformers.

The aerial tuning transformers may be of standard type. A regular variocoupler would be satisfactory. The primary may be untuned, as shown, or not, as personal wishes dictate.

The weight of the outfit, with batteries and all, is in the neighborhood of 20 pounds.

Q. 2. Is there any way of increasing the efficiency of a Neutrodyne that is neutralized and functioning well, without adding tubes?

A. 2. Try connecting a crystal detector in the lead to the grid of the detector tube. A fixed crystal detector, known to be sensitive, would be the most convenient to use. Some experimenters find that a fixed condenser in series with the aerial will improve the quality of reception. even though the primary is untuned; the value is in the neighborhood of .006 mf. capacity.

If the radio frequency stages are connected to the same rheostat as the detector or audio frequency stages, better results will be had, although it increases the number of controls, by using a separate rheostat for the radio frequency tubes: one rheostat will be sufficient. A 20-ohm one will be satisfactory.

Locals will be received with less distortion and less interference, if the first radio frequency tube is removed from the socket. All sets will not respond to this treatment, but most sets will. If separate rheostats are used for each radio frequency stage, the filament of the first tube may be "turned out". Distant stations are seldom heard with this arrangement.

Do not forget the by-pass condenser from the plate of the detector tube, to "A" minus; .05 mf. is usually about right. A resistance variable between 25,000 ohms, in shunt to the secondary of the first or second audio frequency transformer often improves the quality of amplified signals, in addition to acting as a volume control. This is due to the imposed load being controlled and adapted better to the conditions of the particular amplifier used.

Q. 3. What is "Toll Broadcasting"?

A. 3. Broadcasting by rental agreement. Some stations charge a definite sum for a definite period, for the use of the broadcasting station and its personnel.

HAND CAPACITY

(13) Mr. Martin W. Allison, San Angelo, Texas, asks:

Q. 1. I have a home-made regenera-

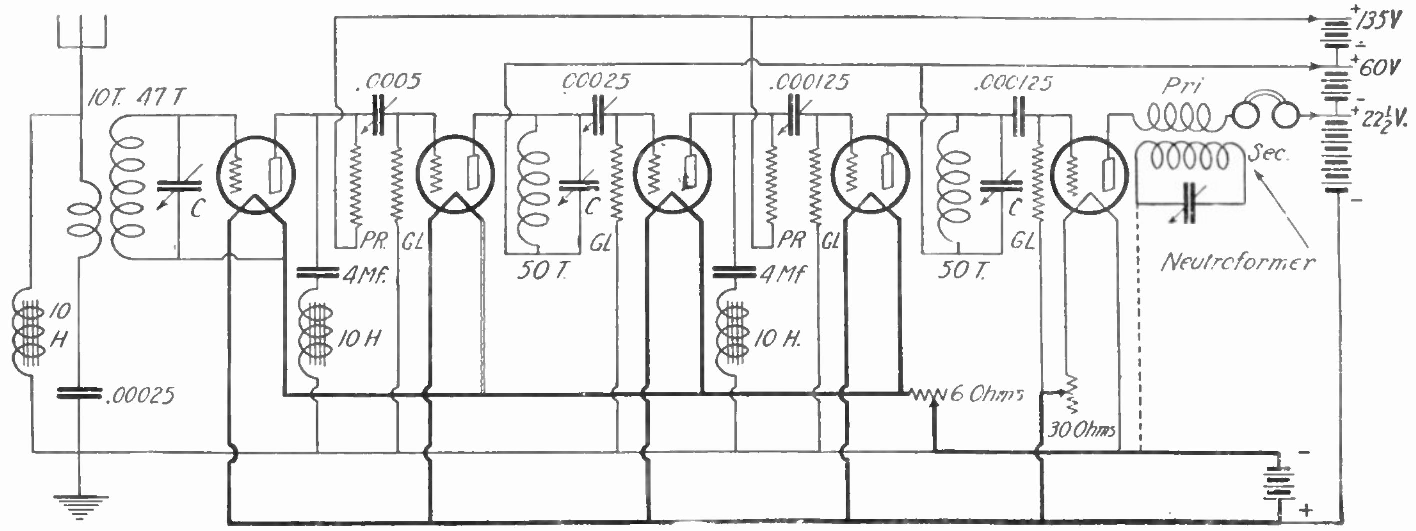


Fig. 14. This circuit is designed for the reduction of static effects to a minimum. During exceptionally strong static it may be advisable to disconnect the aerial and change the ground connection over to the antenna post. Note the neutroformer for regeneration.

tive receiver, using a Peerless coil. A zinc shield is used. How can extreme body capacity be eliminated?

A. 1. You do not state whether the capacity effect is most noticeable from condenser or coil. If from the former, try reversing the leads; the rotor plates should connect to the point of lowest potential (usually the filament). If from the latter, try reversing the leads to the coil rotor. Try grounding the filament circuit. It may be advisable to use a grounded-frame condenser.

Q. 2. Using a WD-12 tube in a Cockaday circuit, the range seems to be narrow, as only KFKX can be heard; how can the range be increased?

A. 2. That question, too, is not definite. The 23-plate condensers you are using should result in quite sufficient wave-length range, unless one or both condensers short-circuit at some positions of the plates. Test for this by means of the usual battery-headphones-condenser series connection. You may have a poor tube. Try it in a standard regenerative circuit. If more than a single dry cell has been connected to the tube (the cells being in series), your tube has probably lost its property of filament electron emission. Leaving the tube lit for a few hours, with the "B" battery disconnected, may restore the tube to its former standard of performance, but we doubt it.

Due to the slight amount of data furnished we find it most difficult to determine just why your set does not perform more satisfactorily.

Vary the plate potential. Finally, try another grid condenser and another leak. A variable one may be of benefit.

Q. 3. Would a UV-199 tube function better in the above circuit?

A. 3. Not unless your trouble is tube trouble. Tube for tube, we do not believe you would find much difference between the operation of either tube, as a detector, in the Cockaday circuit, if both vacuum tubes are good.

ANTI-X CIRCUIT

(14) Mr. Raphael Lacosta, Mexico City, Mexico, asks:

Q. 1. Static is very strong in my locality. What would be a good system to employ in a receiving set capable of good reception under this adverse condition?

A. 1. We are showing a circuit using weeding out arrangements of large and small condensers, resistance coupling and choke coils in Fig. 14.

Each resistance coupling serves to act as a blocking arrangement which prevents undesired oscillation of the tubes. If the inductances are placed in inductive relation to one another, it would be an easy matter to cause strong regeneration or oscillation, but sufficient regeneration or oscillation is obtained by the use of a neutroformer connected as shown. The regeneration then taking place is due to the capacity coupling between the elements of the tube, since the neutroformer is to be placed in non-inductive relation to the other inductances in the set.

The secondary of a high-ratio audio frequency transformer may be used for the iron core choke coils shown; the primary is left unconnected.

The maximum capacity for the variable blocking condensers is indicated. The value has not been stated in "number of plates," since plate sizes vary. The four microfarad capacity is readily obtained by connecting two condensers, each of two microfarads capacity, in parallel.

No. 24 D.C.C. wire, wound on a three-inch tube, will be satisfactory for the inductances. If neutroformers are used throughout, the primaries are left unconnected, where only the secondary is required as the tuned impedance, of which there are two.

The plate resistors (PR) are all of one-tenth megohm size. The grid leaks (GL) are all of one megohm size, with the exception of the detector grid leak, which is of two megohms size.

Keep all filaments and "B" battery voltages as low as is consistent with medium volume.

Use a fairly short aerial (about 30 to 50 feet) and a low one.

Q. 2. Some tuned radio frequency transformers are wound on what seems to be a white tube. What is this called?

A. 2. You probably refer to the tubes of Isolantite, a material much resembling an exceptionally fine porcelain.

DRY CELL TUBE SET

(15) Mr. James Hardwick, South Dartmouth, Mass., asks:

Q. 1. Will you kindly furnish me with

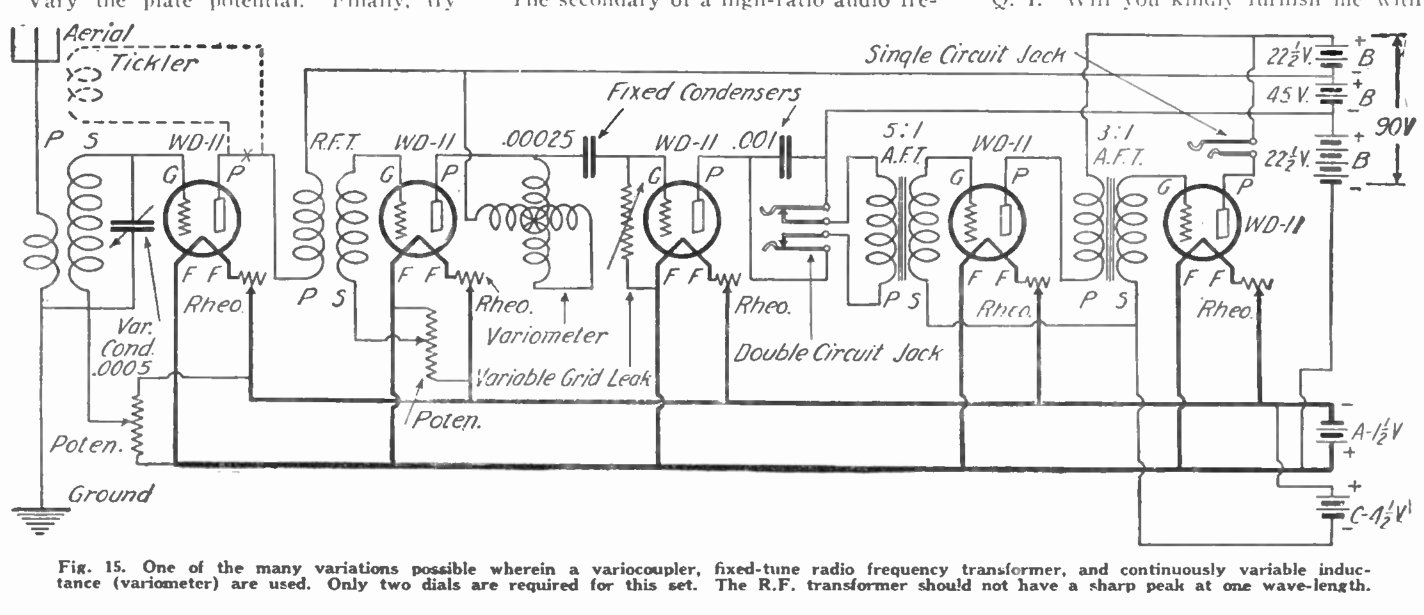


Fig. 15. One of the many variations possible wherein a variocoupler, fixed-tune radio frequency transformer, and continuously variable inductance (variometer) are used. Only two dials are required for this set. The R.F. transformer should not have a sharp peak at one wave-length.

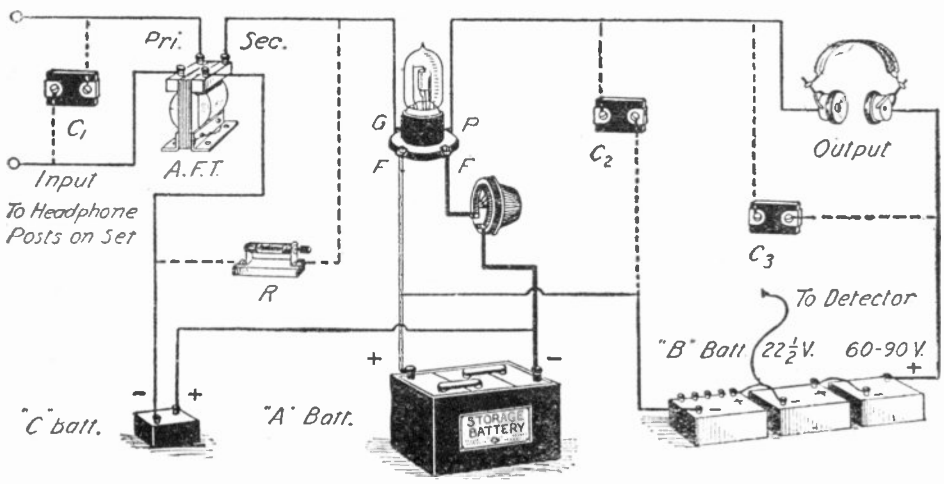


Fig. 16. Picture diagram of a standard audio frequency amplifier, showing tone quality controls in dotted lines. Connect "B" minus to "A" minus if the balance of set is so connected. A separate current supply may be used for this unit.

a schematic diagram of a set incorporating the following items I now have? A variocoupler, a fixed radio frequency transformer, a variometer, two audio frequency transformers, five WD-11 tubes and a variable grid leak.

A. 1. We are herein showing a circuit incorporating the parts you name and a few other necessary items. (See Fig. 15.)

You do not state whether your coil is of the two-coil or of the three-coil type. If the latter form of construction, it may be a good plan to connect the tickler coil as indicated by the dotted lines, resulting in a Superdyne effect that will enable you to move the potentiometer arm more toward the negative end, resulting in greater amplification. Since turning the tickler coil through a full circle will be the equivalent to reversing the connections on the tickler, it is not necessary to take especial pains as to which way the rotor is connected in the circuit.

Q. 2. Will the UV-712 audio frequency transformer work with the UV-199 tube?

A. 2. This transformer is quite suitable for amplification of code signals due to the high ratio of 9:1. It may also be used in the reflexed stage of a reflex set intended for broadcast reception. A lower ratio transformer is more suitable for an amplifier of broadcast programs.

Q. 3. Is there any difference between the grid leak and the grid return lead?

A. 3. Peculiarities of certain circuits

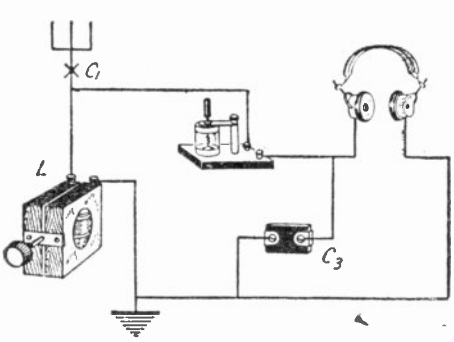


Fig. 16A. A complete radio set is shown. Anyone can make this receiver at slight expense. The few parts may be made or purchased.

modify the usual understanding of these two terms, which is that the grid return lead is the wire connecting the grid to the tuning inductance; a grid condenser is sometimes connected in series with this lead. The grid return lead is considered as that wire connecting the tuning inductance to the filament circuit.

PICTURE DIAGRAMS

(16) Mr. P. Cherubini, Rahway, N. J., asks:

Q. 1. Please show a picture diagram of an efficient receiver using only a crystal detector.

A. 1. We are showing three circuits on this page using a crystal detector but three different methods of tuning.

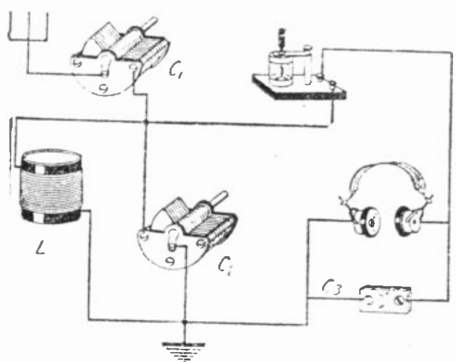


Fig. 16B. A two-dial crystal set. Winding the single coil inductance should present no difficulties to the experimenter. Sharp tuning is not a feature.

Fig. 16—A uses a standard variometer, "L." C-1 denotes a variable condenser of .0005 to .001 mf. which may be used to increase signal strength and reduce interference between stations. C-3 may be about .002 to .005 mf. capacity.

Fig. 16-B shows an inductance "L" of about 50 turns of No. 20 D.C.C. wire wound on a three-inch tube and shunted by a variable condenser "C-2' of about .0005 mf. capacity. The aerial variable condenser described above is shown as C-1. If desired the audio frequency amplifier shown, in reply to question No. 3, below, may be used.

Fig. 16-C shows a standard coupler as the tuning coil. The aerial tuning condenser may be in series with the aerial as at "X," or may be connected in parallel to the primary "P" as indicated by the dotted lines. This primary may consist of about 40 turns of No. 20 D.C.C. wire wound on a three-inch tube. One-quarter inch away from this coil, and on the same tube, are wound 50 turns of the same size wire. This is the secondary "S." If desired, about 60 turns of No. 30 S.C.C. wire may be wound on a 2½-inch rotor turning inside of the three-inch tube containing winding "S," the rotor winding constituting the primary.

Q. 2. Are the flat lead-ins placed between window sash and sill as efficient as the usual type requiring that a hole be drilled?

A. 2. During dry weather the flat lead-in is ordinarily quite satisfactory, but during damp weather the old style through-wall lead-ins of bakelite, Pyrex, hard rubber, or glazed porcelain are the best.

Q. 3. Please show a picture diagram of a one stage audio frequency amplifier that may be added to any set. I would prefer the use of General Radio No. 285 audio frequency transformers.

A. 3. This circuit is being shown in Fig. 16.

If desired, individual batteries may be used for this amplifier unit. The primary connects into any set in place of the headphones. If a dry cell tube is used, dry cell "A," "B" and "C" batteries may be used, resulting in a portable unit. If a storage battery tube is used, the amplifier may be used as the first, second or even third stage of amplification, the dry cell tube not being very good where the volume handled is very great, as in the latter instance.

Any good make of audio frequency transformer may be used. If it is desired to use this amplifier as the second stage in a Super-Heterodyne or the third stage in any type of receiver it will be necessary to use very good materials and exceptional care in the construction of the unit.

The values of the condensers shown will depend upon the set and the amplifier. If the number 285 audio frequency transformer is used, resistance "R," of two to five megohms will probably be needed: This often eliminates a high pitched whistle sometimes present. When other audio frequency transformers are used it may be necessary to use as low a resistance as 50,000 ohms. Therefore, a Bradleyleak may be used across the secondary of a No. 285 transformer and a Bradleohm of 25,000 to 250,000 ohms range when using other makes of transformers.

Distortion usually results when using a larger capacity than .00025 mf. across the primary of a number 285 transformer but for most audio frequency transformers capacity C-1 may be about .001 mf., C-2 may be .006 to .05 or .06 microfarad and C-3 may be .002 to 005 mf. capacity.

When using a "B" battery of about 90 volts, the "C" battery may be about 4½ volts, although other voltages should be tried.

If the audio frequency transformer has a metal case insulated from both primary and secondary it is good practice to ground this. This is accomplished, in effect, by connecting it to "A" minus.

MISCELLANEOUS

(17) Mr. Edwin Thompson, Okmulgee, Okla., asks:

Q. 1. Is there any advantage in revers-

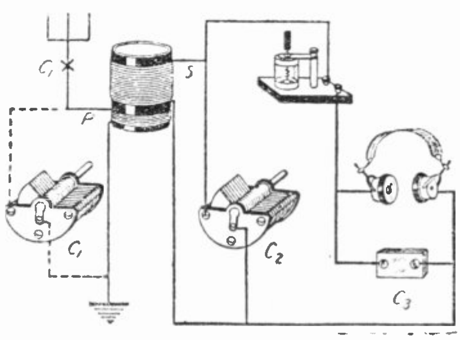


Fig. 16C. A very simple crystal set. The inductance coil shown may be a standard two-coil variocoupler either tapped or untapped.

ing loud speaker and headphone connections to the set?

A. 1. It is advisable to try reversing these connections when receiving a fairly weak signal as the volume is often increased considerably.

Q. 2. Why are some loud speakers made better by reversing the connections to the set?

A. 2. Practically every loud speaker and pair of headphones has strong permanent magnets. A heavy "B" battery current in the windings tends to assist these magnets when "poled," or connected one way, and tends to not only neutralize the magnetic field of these permanent magnets but to demagnetize these magnets as well, destroying the efficiency of the instrument.

Many loud-speakers and head-phones are marked to indicate which wire connects to the positive "B" battery connection. This wire is usually marked with a red thread called a "tracer."

WIRING DATA

(18) Mr. A. S. Marriott, Toronto, Ont., Canada, asks:

Q. 1. Is there any disadvantage in using spaghetti on all wires? Does spaghetti tubing absorb moisture?

A. 1. This insulation should be used only when there is danger of one wire touching another. Air is the best dielectric. When replaced by something else, dielectric absorption losses are greater. Also, parallel wires carrying currents of two different potentials act as two plates of a condenser. With air as a dielectric the condenser effect is a minimum. In some sets this condenser effect may make the receiver inoperative.

Q. 2. Which is best to use, No. 14 enameled wire, No. 18 annunciator (bell) wire or, round or square bus wire?

A. 2. Either the enameled wire or the bus wire. We do not believe there is any difference worth considering, in the use of square or round bus wire, unless one is wiring a set to operate on short waves, such as 50 meters or less. The annunciator wire has the disadvantage of causing considerable condenser effect due to the paraffined cotton thread used as a covering.

Q. 3. Where can I secure information on the re-broadcasting systems in use?

A. 3. Mr. Frank Conrad presented a paper on this subject before the Institute of Radio Engineers. The December, 1924, issue of the "Proceedings" of this organization contains a reprint.

PICTURE DIAGRAMS

(19) Mr. P. Cherubini, Rahway, N. J., asks:

Q. 1. Please show a picture diagram of a one-tube receiver that may be readily adapted to the standard radio receiving circuits now in general use.

A. 1. The picture diagram marked Fig. 19 shows how to connect a single tube in the form of a unit that makes it possible to try conveniently practically all of the more important circuits used in radio reception.

Any tubes may be used. It is best to use a storage "A" battery of six volts, with UV-201A, C-301A, Magnavox, DeForest or Schickering six-volt tubes. A 20- to 30-ohm rheostat may be used. If dry cell tubes of the UV-199 or C-399 type are used, three dry cells or two sections of a storage battery (four volts) may be used. Since these tubes require a special socket, it is necessary to use this socket, or else use an adapter that will accomodate dry cell tubes to sockets designed for storage battery tubes. Regenerative circuits may be used to make extremely efficient receivers, even with dry cell tubes of the WD-11, WD-12, C-11 and C-12 type, operating with a single dry cell or a single storage cell.

The single dry cell tube has made it possible for thousands of people to possess efficient radio sets that do not require rechargeable batteries. A single dry cell will operate a dry cell tube for a period of 90 to 100 hours. Since the dry cell costs less than 50c, the operating expense is very little. In estimating the cost, proper consideration must be given to the operating life and initial price of the vacuum tube and the "B" battery. Properly operated, the average life of the vacuum tube is about 1,500 hours, while the "B" battery is usually found to last from six months to a year, depending upon the make, size, demands and other factors.

One way of greatly lengthening the life of the tube is to use precaution in lighting the filament, remember, an increase of 10 per cent. in filament heat, beyond the rated heat, will decrease the life of the tube one-half!

The "B" battery, too, comes under consideration if one desires the least possible expense of maintenance. Heat accelerates the chemical action in "B" battery cells, so do not place the battery near a heater, or in the sun. "Keep in a cool, dry place." Never "short" the "B" battery for a fraction of a second to determine its worth for your set. Such a procedure has questionable value when the husky "A" battery is the victim.

The entire apparatus may be set up on

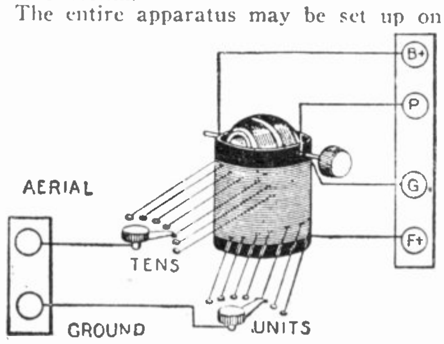


Fig. 19B. The "2-coil variocoupler with tapped primary" unit. This is submitted for those who wish to construct the simple 2-coil variocoupler regenerative circuit.

a table, while various combinations of the instruments are tried. After it has been finally decided just what circuit and equipment will be used in the final receiver, a permanent lay-out and wiring may be planned.

"Test clips" soldered to short lengths of wire are now obtainable, making a

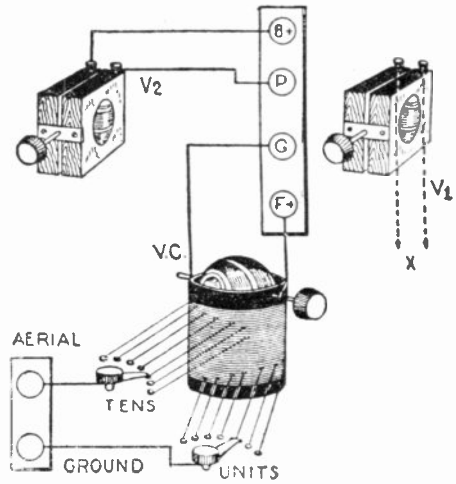


Fig. 19A. The "2-variometer, variocoupler" regenerative arrangement. This was once the standard of reception circuits, but a demand for simplicity of control forced the "untuned primary" receiver into the lead.

change in the circuit merely a matter of seconds.

The make of apparatus is optional. A variable grid leak is recommended. The "B" battery voltage should be kept as low as possible, if the greatest sensitivity is desired. Changing the "B" battery voltage necessitates a new value for the grid leak, hence the suggestion of a variable leak of "noiseless" type. (A poorly-made leak will constantly change in its resistance, resulting in crackling sounds and generally poor reception). The grid condenser and the phone condenser must also have the feature of "noiselessness." Poorly-made paper- or mica-insulated condensers permit a partial, intermittent current leakage that also results in crackling sounds—or total inoperation. A "B" battery containing one or more "dead" or inactive cells, an "A" battery in need of recharging, and vacuum tube sockets of poor construction can also cause crackling sounds or total inoperation.

Phone cords partly broken will cause crackling sounds. Shaking the cord will quickly check this possibility.

To return to battery voltages—we wish to state that 22½ volts is the usual plate potential for all detector tubes. If the regenerative circuit will not oscillate with this potential, it may be necessary to increase the voltage to 40 or 50. Beyond this it is not advisable to go, as sensitivity

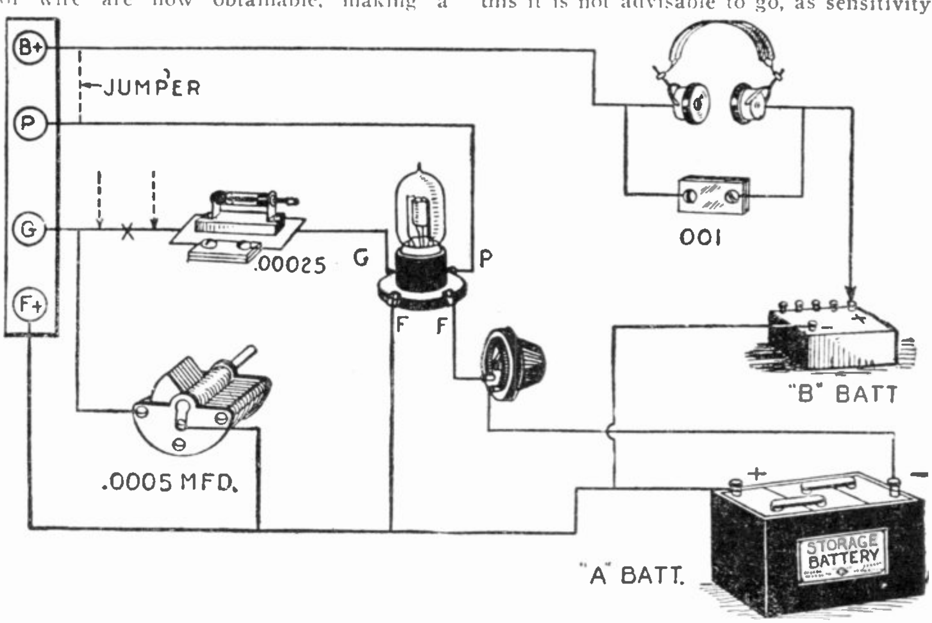


Fig. 19. This picture diagram of a tube unit and the diagram of one of the coil units shown above, should enable anyone to construct a very efficient 1-tube receiver. The completed set may be later enlarged to include audio frequency amplification if the owner desires to operate a loud speaker.

is then greatly decreased. If there is thought to be sufficient inductance in the plate circuit, and the circuit refuses to "perk," even with a phone condenser and a reversal of the tickler leads, try another tube; the non-oscillation may be due to too high a vacuum or too little emission of electrons from the filament. We have not suggested a reversal of the "A" battery leads as a way of assisting oscillation, since such a connection ("B" minus to "A" minus) has the effect of reducing the "B" battery voltage, which was not what

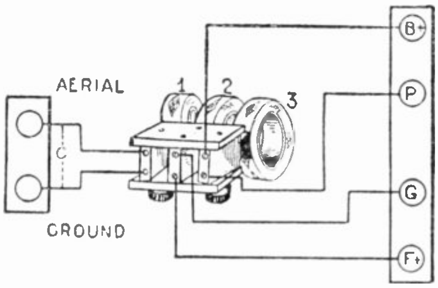


Fig. 19C. The "3-coil honeycomb" regenerative unit. The standard way of receiving long-wave stations.

we desired to do in the instance given.

The first of four standard regenerative circuits we intend to show in picture form is the one-time "standard." (See Fig. 19-A.)

2-Variometer, Variocoupler Diagram

This circuit requires five controls, two for the two variometers (V-1 and V-2), one for the variocoupler rotor and two for the switches. The grid lead of diagram 19-A must be broken at X and connected to the two X leads of grid variometer V-1.

Although the switches are marked "units" and "tens," there are only seven leads shown connecting to each switch. Some variocouplers have a total of 14 taps and others have a total of 20 taps. The "units" switch has a tap taken at every turn for the first seven (or ten) turns. The "tens" switch has a tap taken at every seven (or ten) turns, for 49 (or 100) turns. If the units-and-sevens tapping arrangement is used there will be a total of 56 turns—110 turns if the units-and-tens system is followed. Either will be satisfactory.

With the tapped primary of the variocoupler V.C. connected to a well-insulated copper aerial in one piece, and a good ground connection made to a well-scraped cold water pipe or a five-foot iron rod driven into moist earth, and the four binding-posts of the tuning unit, one has a complete receiving set.

Plate circuit variometer V-2 controls range, selectivity and volume. (Or, in one word, regeneration.) The rotating secondary of the variocoupler also assists in sharpening the tuning, maximum selectivity being obtained when the rotor is placed at "loosest coupling," the position shown in the diagram. Reversing the connections of plate variometer V-2 sometimes improves the reception.

If it is desired to have the set operate as a plain detector, without the regenerative feature afforded by the plate variometer, this instrument may be put out of operation by short-circuiting it by means of the shorting wire marked "jumper."

Note that the .0005 mf. variable condenser is not required if variometers are used to tune the grid and plate circuits of this set in the manner illustrated. The variometer is known as a "continuously variable inductance" and no other means of changing the wave-length is needed.

If the variocoupler rotor contains sufficient wire, the .0005 mf. variable condenser may be used to tune the grid circuit. Grid tuning variometer V-1 is then not needed.

2-Coil Variocoupler Diagram

The variocoupler described above may be used in constructing an effective receiver that does not require variometers. A lead from one end of the variocoupler tapped primary connects to binding-post "G." The other end of the primary connects to binding-post "F+." The variable condenser tunes the grid circuit so formed. The plate circuit is not tuned, as previously. "Regeneration" is controlled by means of the "tickler feed-back" supplied by the rotor. (See Fig. 19-B.)

If the primary leads are not securely fastened to the switch-points and the primary coil, there can be no reception of signals when the switch lever makes contact with the poorly connected taps.

As stated previously, minimum coupling is secured when the rotor is situated as shown. Maximum coupling is 90 degrees to either side of this position. Some variocouplers are of the "180 degree" type. With these, maximum coupling is in a position 180 degrees from the minmum coupling position of the rotor. Most of the 180-degree variocouplers have a stop that limits the amount of motion to 180 degrees. It is advisable to try reversing the rotor connections if such a coupler is used, in order to determine the best connection.

This is the most broadly-tuning circuit of the four, but if the set is situated some distance from powerful broadcasting stations, this objection is not serious.

The three circuits using variocouplers are all limited to the wave-length range to which the couplers will respond. This is usually about 200 to 575 meters. It is occasionally desirable to receive stations operating on wave-lengths as high as 30,000 meters. A few of the foreign broadcast stations operate on 2,000 and 3,000 meters. The most practical circuit for receiving all wave-lengths is the following:

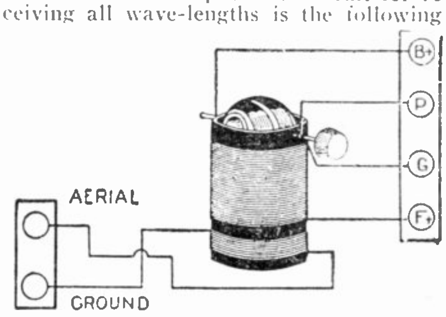


Fig. 19D. The "untuned primary" type of set. This is the standard regenerative circuit of today for broadcast reception.

3-Honeycomb Circuit

Circuit 19-C shows a standard 3-coil honeycomb mounting containing primary coil 1, secondary coil 2, and tickler coil 3. The size of these honeycombs will be found to be very nearly the same for a given wave-length range. A table showing the coil sizes for a given range will be found in the "I Want to Know" department of the January, 1925, issue of Radio News, page 1229.

In using the honeycomb reception system, it will be found necessary to employ a variable condenser connected from aerial to ground, as indicated by the dotted line and the letter "C." This condenser may have a maximum capacity of .0005 or .001 mf.

The flexibility of wave-length change afforded by the plug-in system may be extended to include "spider-web" coils wound on flat, slotted forms. Efficient reception is possible on 25 and 50 meters with the use of suitable spider-web coils.

Untuned Primary Receiver

Diagram 19-D illustrates the type of regenerative receiver most commonly used at the present time; it owes its popularity to its high selectivity, high sensitivity and ease of control. Only one dial is required for the variable condenser wave-length control and one dial for the tickler feed-back amplification control. It has been found (see the articles by Sylvan Harris in the February and March, 1925, issues of Radio News) that variable condenser losses are of less importance than

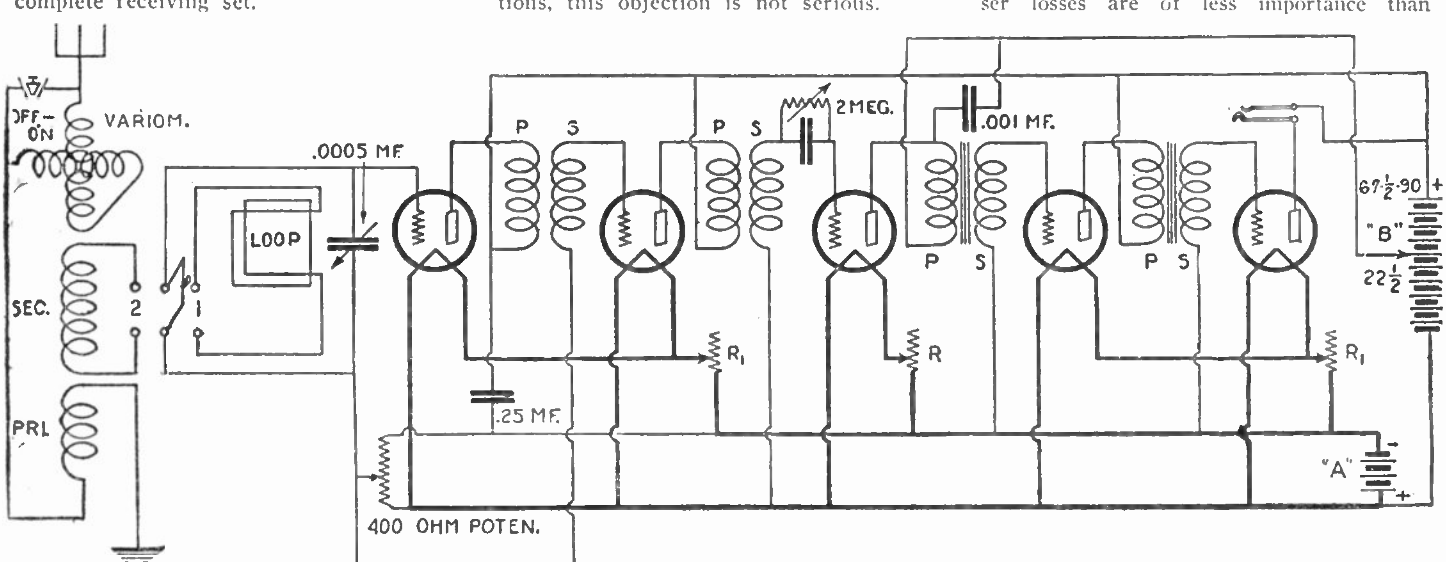


Fig. 20. A 2-dial radio frequency set. Either a loop aerial or a regular aerial and ground may be used. For good operation over the entire broadcast wave-length range it will be necessary to use a good make of radio frequency transformer. Dry cell tubes may be used.

inductance losses and, for that reason, one should take exceptional care to see that the coils used are of low-loss construction. The circuit using this form of coil has been heralded under a hundred aliases, its outstanding claim being its ability as a DX-er (long-distance receiver).

A satisfactory coil construction would be 10 turns of No. 18 annunciator wire for the untuned primary and 50 turns of No. 20 or 22 D.C.C. wire wound on a 3-inch tube. Wind both coils the same way and space the primary about 1/8 to 1/2 inch from the secondary. Any form of tickler coil may be used. About 20 turns of No. 26 or 28 D.C.C. wire on a 2½-inch rotable tube or ball will be satisfactory. The mechanical arrangement of the rotating element must be left to the ingenuity of the constructor.

Circuits 19-B and 19-D are extremely good for portable sets, or for sets located where conditions are not favorable for best reception. The use of substitute aerials in the form of electric light lines (a Ducon is used), fire escapes, inside-of-room aerials, wire fences, metal roofs, leader pipes, door-bell wiring, an insulated wire laid on the ground, an insulated wire buried one foot deep in the ground, and various other unusual conductors may often result in surprisingly good reception. If it is found very difficult to receive signals of readable intensity try connecting any one of the convenient aerial systems mentioned above to the end of the secondary marked "G" of the variocoupler shown in tuning unit 19-D.

5-TUBE SET

(20) Mr. Richard Walters, Shanghai, China, asks:

Q. 1. Please show a switching arrangement connected to the 5-tube radio frequency circuit shown in the "Standard Hook-Ups" department of the March, 1925, issue of RADIO NEWS, circuit No. 84.

I wish to be able to use either an outside aerial and ground, or a loop. A variometer and a 2-coil variocoupler are available.

A. 1. This circuit will be found in Fig. 20.

The usual 2-coil coupler, having about 10 to 15 turns on the primary and about 50 turns on the 3-inch tube secondary, may be used.

The variometer should not be in inductive relation to the coupler. With the variometer short-circuited, you are using the so-called aperiodic antenna system. With the variometer in use, you are using the tuned antenna system.

The loop aerial will require between 90 and 110 feet of wire. This may be stranded or solid wire. No. 14 B. & S. gauge is a good size. It may be wound in the "flat spiral" (over-grown spider-web coil) fashion, or on a box frame, like a direction-finding loop.

Ballantine vario-transformers may be used with excellent results. Any other make of transformers may also be used. The vario-transformers would have to be mounted in some accessible manner, as it is necessary to adjust these as different stations are tuned in. The vario-transformer has a variable primary operated and connected like a variometer. The secondary is made in the same manner.

Head-phones may be connected to the detector output by just touching the phone tips to the primary posts of the first audio frequency transformer.

The make and ratio of the audio frequency transformers are optional. We would recommend audio transformers of low ratio, when the detector is preceded by one or more stages of audio frequency amplification.

Phone-plug losses are often quite high at radio frequencies. Consequently, it is not advisable to use a phone-plug to connect the loop to the set; use two binding posts. The two loop leads should be loose, not together.

Q. 2. Is it possible for the "B" battery to cause a sound like that of "static?" If the answer is in the affirmative, is there any easy way of testing for the trouble?

A. 2. A run-down "B" battery may cause crackling sounds that cannot be distinguished from some forms of static due to an electrified condition of the air. You do not state whether you are using one or more tubes. If yours is a single-tube set, the first substitution method will not apply.

If you have two 45-volt "B" battery units, it is probable that only one is causing the trouble. Therefore, try one of the two batteries. In that case, the set

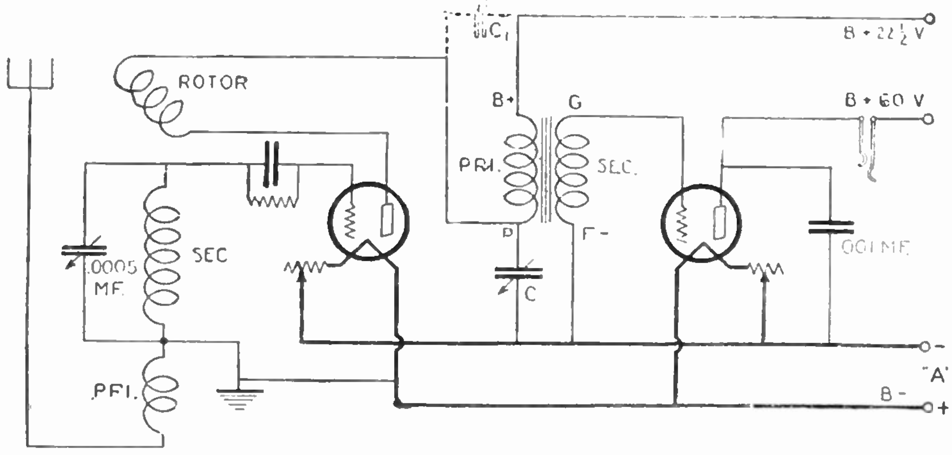


Fig. 21. A regenerative circuit employing the use of inductive and capacitative feed-back, termed "throttle control."

will be operating on only 45 volts plate potential, but the crackling sounds will be heard just the same, if the poor battery is connected into the circuit in place of the perfect battery.

A second, and sometimes not convenient, substitution method is to try a new "B" battery in place of the one, or ones, in the set.

If the voltage of the battery is determined by a high-resistance voltmeter, the needle will fluctuate if there are one or more defective cells. A poor battery will usually have an extremely low voltage reading.

If a pair of head-phones (really good phones should not be used for this test) are connected across the "B" battery, with a grid leak of high resistance in series, crackling is practically absent when the battery is good. A perfect grid leak is absolutely essential.

THROTTLE CONTROL OF REGENERATION

(21) Mr. V. Sia, Shanghai, China, asks:

Q. 1. What is "Throttle" control of regeneration?

A. 1. This is control of regeneration by means of a variable by-pass condenser connected across the primary of the audio frequency transformer connected in the plate circuit or, from the plate binding post of this winding to the "A" battery. This is made clear in the circuit diagram, No. 21.

Regeneration is controlled by means of variable condenser "C," which we may call the "throttle condenser." It may have a value of .0005 to .001 mf., the exact value being governed by the natural capacities of the instruments used. The distributed capacity, as it is called, of the audio frequency transformer, is represented as "C-1." If its value is large, only a small capacity variation will be necessary in "C," to start and stop circuit oscillation; and if small, the value of the other may be made larger.

The three-coil coupler is of standard type and may, for example, have the values stated below:

Primary, 6 to 15 turns at the filament end of the secondary. Secondary, about 50 turns of No. 24 D.C.C. wire wound on a 3-inch tube, at the end of the primary winding. It is not necessary to space the primary and the secondary more than 1/8-inch. Rotor, 20 turns of the same size wire on a 2½-inch tube or ball, placed at the grid end of the secondary and rotably arranged. If dry cell tubes having lower internal capacities are used, it will probably be necessary to increase the number of tickler, or rotor turns to about 35 to 40, in which case it may be more convenient to use a smaller size of wire. The exact number of turns for the tickler must be such that the rotor can be left in one position, almost full coupling, and not changed thereafter. The number of tickler turns must be so proportioned that throttle condenser "C" will fully control circuit oscillation at all wave-lengths, without recourse to an adjustment of "rotor."

It is advisable to operate this circuit with at least one stage of audio frequency amplification, as otherwise the capacity of the phone cords would become part of the "throttle" capacity and capacity effects would be very noticeable and annoying; every movement of one's head would vary the phone cord capacity and, thereby, the regenerative balance of the circuit.

Q. 2. What can I use to fill the unwanted holes in a panel used for experimental work?

A. 2. Black sealing wax may be used for black panels and the proper shade of brown sealing wax for brown panels. The proper degree of "mottling" may be obtained by the addition of a very slight amount of black sealing wax.

Q. 3. How are panels given a dull finish?

A. 3. The original polish of bakelite, formica or hard rubber panels is easily removed with No. 00 emery cloth. The graining is usually done with a left-and-right motion. If a somewhat finer finish is desired, the panel may be rubbed with very fine emery powder. For bakelite, a light machine oil lubricant may be used with the powder; on hard rubber, oil should not be used, plain water being much better.

DeFOREST D-10 REFLEX RECEIVER

(22) Mr. S. M. Marks, Salina, Kansas, wants to know:

Q. 1. Last summer I met a traveling man who always carried around with him a portable four-tube set, entirely self-contained, with batteries, loop, tubes, and

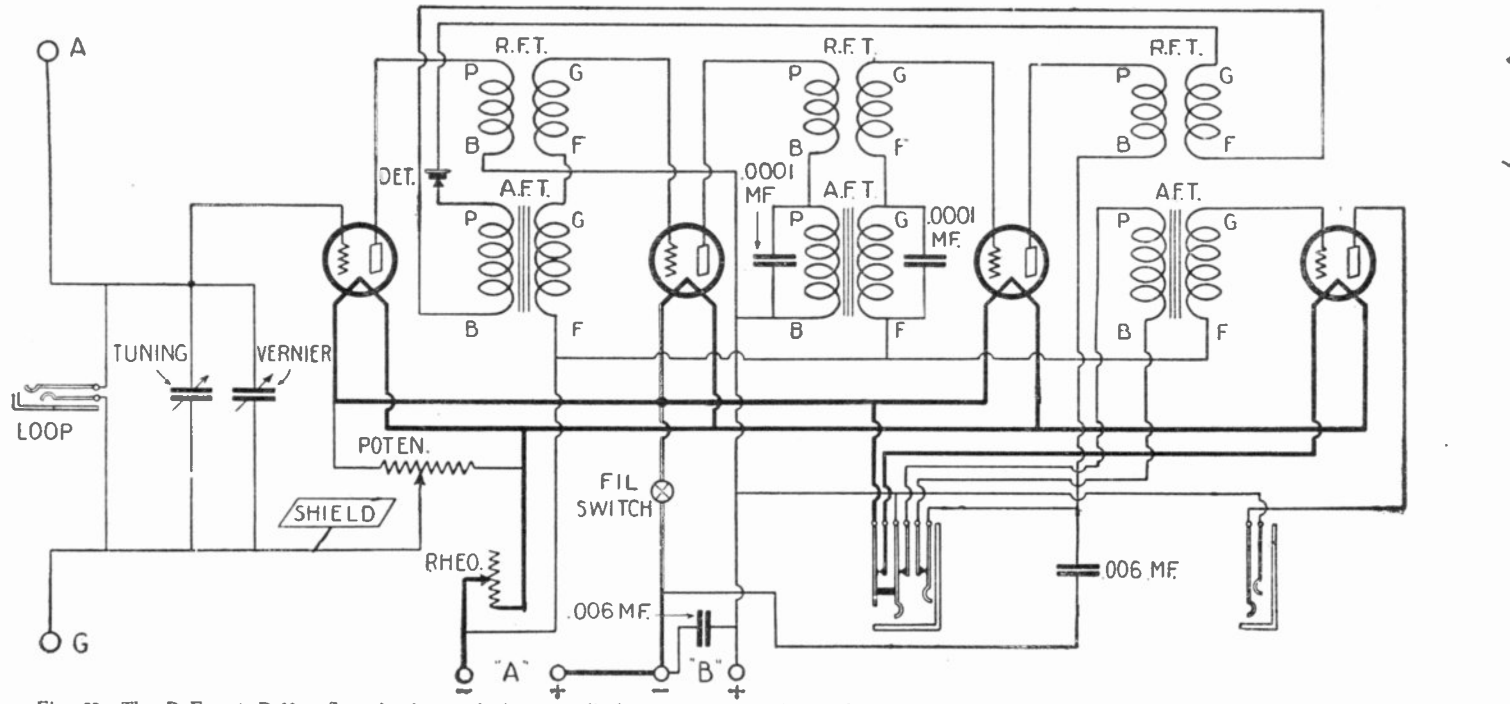


Fig. 22. The DeForest D-10 reflex circuit, employing 3 radio-frequency stages of amplification, crystal detector rectification, two stages of reflexed audio-frequency amplification and one straight stage of audio amplification. This is an excellent combination for portable types of receivers; and will be found to be exceedingly satisfactory and efficient when used in conjunction with a loop.

headphones, although loud speaker reception was easily possible. The receiver, he told me, was manufactured by the DeForest Radio Company, and was of the D-10 type. From the unusual way it operated, it would seem to be tremendously efficient; and I would like to construct a receiver similar to this, so that I can use it on vacations, trips, automobiles, tours, etc.

A. 1. The D-10 DeForest receiver is a portable reflex set constructed so that it may be used for just the purposes that you enumerated. The circuit diagram of this receiver is shown in Fig. 22.

The transformers indicated as R.F.T. are of the ordinary untuned type, such as the Acme, Erla, DeForest, All-American, etc. The audio-frequency transformers should preferably be of the low-ratio type, 5:1 for the center A.F.T. and 3½:1 for the end A.F.T.'s. The variable condenser used is an ordinary .0005-mf, preferably of the straight-line-frequency type, as this type of condenser will allow greater selectivity on the shorter wave-lengths. The vernier condenser is an ordinary 3-plate condenser: although the midget balancing condenser made for neutralizing purposes may be used successfully. When the set is to be used with an antenna and ground, it is necessary that an antenna inductance be connected to the posts marked "A" and "G" to obtain greater selectivity. The secondary winding of this coil is connected to the above-mentioned posts; whereas the primary winding should connect to the antenna and ground. These two may be wound on a 3-inch tube; the primary consisting of 10 turns of No. 22 D.S.C. wire and the secondary 44 turns of the same, wound half an inch away from the primary winding. A filament-control jack is used after the third tube, so that when the plug is placed in this jack the fourth tube automatically goes out.

THE LEMNIS RECEIVER

(23) M. G. N. Howard, Essex Junction, Vermont, asks as follows:

Q. 1. I would like to construct a receiver capable of unusual reproduction, its quality to be comparable with that obtained from a phonograph. I have the Lemnis Binocular coils on hand, and wonder if you could furnish me with the necessary constructional data and schematic wiring diagram of a receiver which you think will be entirely satisfactory as regards the above-mentioned characteristic?

A. 1. The diagram you request is shown in Fig. 23. We also include the illustration of a receiver incorporating the coils you mention, which was especially designed to reproduce musical notes faithfully. This advantage is largely due to the special amplifier incorporated. It consists of three stages of what is known as "autoformer coupling," resembling that of the impedance-coupled type of audio amplification. Six tubes are used in this receiver, two as tuned radio-frequency amplifiers, a detector stage, and the three stages of audio amplification. A 400-ohm potentiometer is used for controlling oscillations in the radio-frequency stages.

The parts necessary for the construction of this receiver are as follows:

- 3 Variable condensers, .00035-mf., preferably S.L.F.; and dials;
- 3 Lemniscate coils, L_1, L_2, L_3;
- 3 Autoformers; A_1, A_2, A_3;
- 1 Potentiometer, 400-ohm;
- 6 Automatic filament adjusters;
- 3 By-pass condensers, 1.0-mf.;
- 6 Sockets;
- 1 Panel, 7x21, and baseboard, 7x21x½;
- 2 Resistors, 1.0-meg.;
- 1 Resistor, ¼-meg.;
- 1 Terminal strip;
- Miscellaneous, such as wood-screws, nuts, bolts, etc.

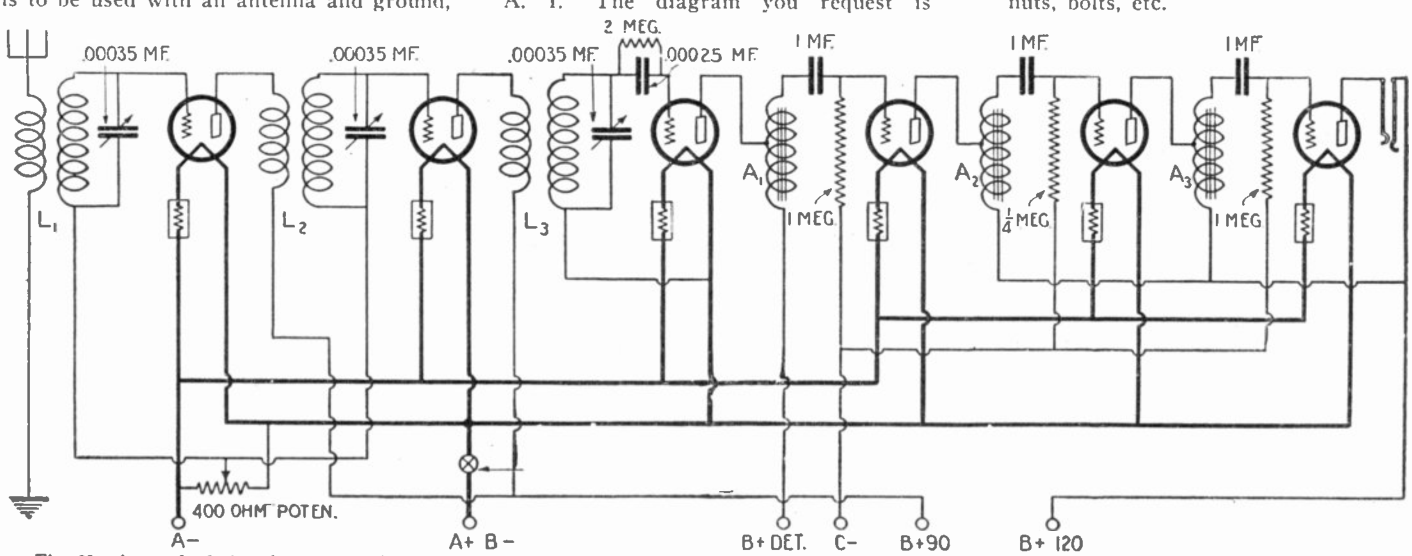


Fig. 23. A standard six-tube receiver designed especially to amplify musical notes without distortion. What are known as "autoformers" are used in place of the conventional audio transformers to couple the audio stages.

In the assembly and construction of this receiver, try to duplicate the layout as illustrated. The parts shown here are symmetrically and efficiently placed. When tuning the set, the potentiometer should be turned over to the negative side, and the three dials rotated "in step," until a whistle or squeal is heard, which is an indication that a station has been obtained. The potentiometer should then be turned slowly back towards the positive side, until the whistle clears up and the station is satisfactory.

THE ARKAY RECEIVER

(24) Mr. L. H. Riley, Geneva, N. Y., asks as follows:

Q. 1. A friend of mine is obtaining wonderful reception with a small four-tube receiver, which he says is termed the "Arkay" receiver, and which was described in some radio section of a newspaper. I wonder if you can furnish me with any data or information concerning the construction and wiring diagram of this receiver? I am very much interested, due to its high efficiency, and would like to construct one similar to that of my friend.

A. 1. The Arkay receiver, to which you refer, was described in the Newark *Sunday Call*, and the following is a reprint of the description of this receiver. All the necessary information is included.

"A stage of radio frequency, detector, and two stages of audio-frequency amplification are employed in this circuit. No 'trick' wound coils are employed. Single-layer inductances which can be constructed at home are ample. The two dials may be logged and after a short time the owner should be able to pick up many stations throughout the country. The set is quite selective and it has been possible during the tests to log DX through a great many locals. (See Fig. 24.)

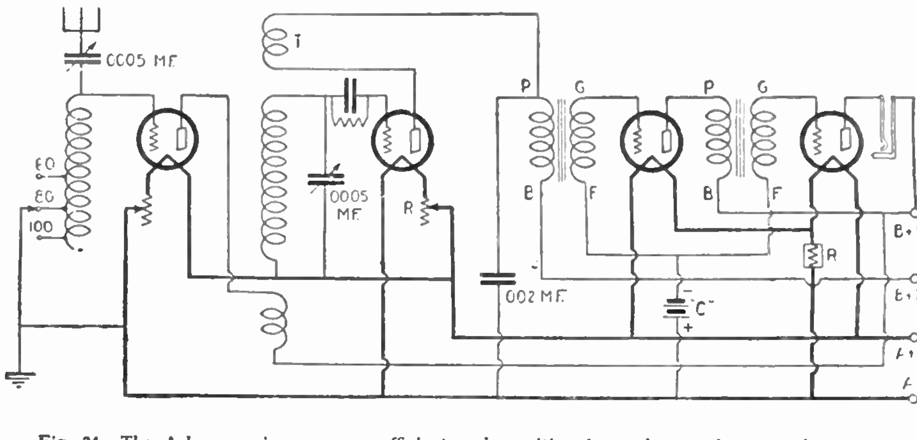


Fig. 24. The Arkay receiver, a very efficient and sensitive four-tube set, incorporating a stage of tuned radio-frequency amplification, the tuner of which is extremely novel, and a detector stage combining regeneration besides the usual two stages of audio-frequency amplification.

R.-F. Input Circuit

"Unlike the majority of tuned-radio-frequency receivers of the neutrodyne type which make use of an 'untuned-primary' coil underneath or alongside a secondary, the improved Arkay circuit employs a tuned primary coil directly coupled to the antenna circuit through a series condenser. In this manner a greater amount of radio-frequency current is obtained from the antenna than with the untuned primary coil. The latter system is not as efficient as the former, due to the losses which occur in coupling. The single-circuit idea appears to have considerable merit, and actual comparisons seem to favor this form of tuning for R.F. work.

"Radio fans who were owners of single-tube 'single-circuit' receivers will recall the remarkable distances covered with this type of set, compared with a receiver making use of a coupler having separate primary and secondary windings. The former outfit, while not much on selectivity, certainly took the prize for sensitiveness. This circuit employed as a R.F. amplifier carries with it the efficient qualities of the one-tube set.

"The following is a list of parts required to complete this set:

1 Panel 7 x 14 or longer;
1 Baseboard to suit panel;
5 Binding posts;
2 Variable condensers, .0005-mf.;
4 201-A Sockets;
2 Audio transformers; 1:6 and 1:2;
1 Self-adjusting rheostat, ½ ampere, and mounting;
4 201-A Tubes;
1 Grid condenser, .00025-mf., and 5-megohm leak;
1 .002-mf. fixed condenser;
2 3-inch tube forms, 4½ and 3½ inches long;
1 Binding-post strip;
2 30-ohm rheostats;
1 Single-jack filament control or cut-off switch;
6 Lengths of busbar wire;
2 4-inch dials.

Making the R.F. Coil

"The radio-frequency coil is easy to make and consists of a single layer of wire wound on a cardboard or bakelite tube; the lighter the tubing, the better. The coil employed in the set was 2½ inches in diameter and 5 inches long. As it may be difficult to get tubing of this size, it is suggested that a 3-inch tube be used in its place. Start about half-an-inch from one end of the tube and wind 60 turns of No. 22 DCC wire, taking a tap or loop at this point. Continue winding, taking another tap at the 80th turn, completing the coil at the 100th turn. Make sure to leave about an inch of wire at the beginning and end of the coil for connections. The coil should be mounted above the baseboard of the set on blocks of wood or by means of small brass rods; its end should point toward the front panel and be placed at the right of the baseboard.

"This coil is tuned by means of a .0005-mf., variable condenser, which is mounted on the panel a little to the left of the end of the coil. The taps are used for different aerials. No switch is employed for the taps, as this proper point will be determined by trial.

Secondary Coil

"The secondary coil has three separate windings. On one end is the R.F. 'reversed coil'; in the center is the secondary, which takes up most of the space; and on the remaining end is the detector-plate coil, T. The secondary coil, as well as the two smaller coils, are all wound with No. 24 DCC wire. A quarter of an inch separation is left between each winding on this form.

"Starting one-quarter of an inch from one end of a 3-inch tube, which should be 3½ inches long, wind tightly 14 turns of wire, making provision at the beginning and end for holding the wires in place. Two small holes will be satisfactory for holding the start and finishing wires. Leave at least an inch of wire for connections.

"Then skip about one-quarter of an inch and in the opposite direction wind the secondary of 45 turns of wire. Leave another quarter of an inch and wind in the same direction the detector-plate of nine turns. This completes the entire inductance.

"The secondary coil is mounted at right angles to the radio-frequency coil and at least five inches away so that the fields of the two coils will not interfere. Back of the secondary coil is the .0005-mf. variable condenser.

"The coil may be mounted on the condenser end-plate, provided the condenser has an insulated form. (The condenser used is a .0005-mf. straight-line wavelength type, with a hard-rubber end plate). Or the coil may be supported by means of the busbar wires which connect to its six terminals.

"Keep all wires out of the end fields of the secondary coils. Do not run wires through the coil or across the ends. Run them away from the windings rather than parallel or too close.

Four Binding Posts

"Battery binding posts are mounted on a small panel to the rear of the baseboard. There are four in number; the "A—" is also grounded. The antenna post is mounted on a separate small panel away from the battery and ground binding posts. This connection is brought out on the side near the .0005-mf. antenna tuning condenser, and run to the rotor plates.

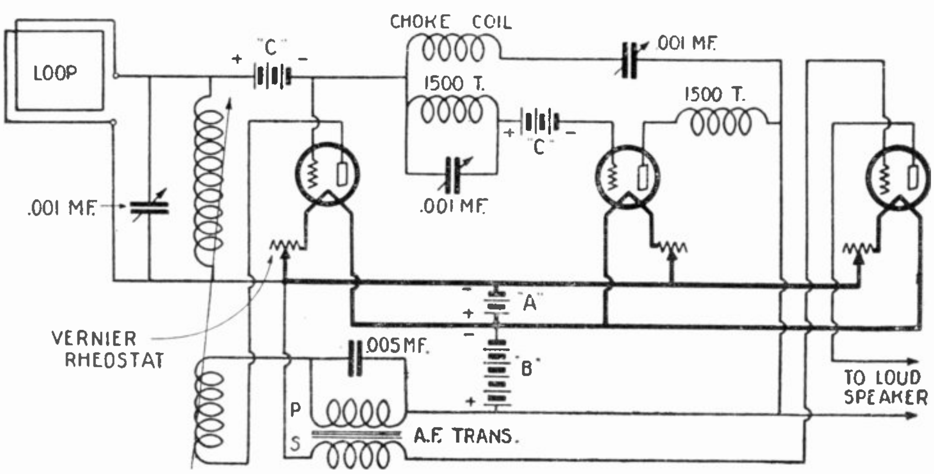


Fig. 25. A three-tube Super-Regenerative Circuit which the average constructor can build with the assurance that the troublesome defects, usually encountered in this type of circuit, are eliminated or minimized to a great extent. Very satisfactory loop reception may be expected, if this circuit is constructed properly.

"The by-pass condenser, .002-mf. is connected between the detector plate coil winding and the "A—" battery wire. The .00025-mf. grid condenser is mounted close to the detector tube socket, underneath the secondary tuning coil.

"A single-circuit jack with filament control can be employed for the output, or a 'cut-off switch' may be mounted on the panel, for extinguishing the filaments. The two audio transformers are mounted at right angles to each other. The shielding will allow them to be placed close together in case the set is made compact. The baseboard is 9 inches deep."

A WELL-DESIGNED SUPER-REGENERATOR

(25) Mr. S. K. Walker, North Bergen, N. J., asks:

Q. 1. Will you please furnish me with the circuit diagram of an efficient and well-designed Super-Regenerative circuit, one that you think would give satisfactory results?

A. 1. The accompanying diagram of the wiring connections, with detailed data, of a super-regenerative receiver are self-explanatory. (See Fig. 25.)

The loop aerial used in conjunction with this set is wound with 7-strand No. 22 twisted wire, 12 turns separated ½-inch on a 42-inch square. An aerial, 150 feet long, of No. 14 wire, which is connected to the top binding post of the loop, effects reception over a radius of about 1,000 miles. This distance increases by 150 miles as the operator learns to handle the set. One stage of audio frequency is added, to enable the use of a loud-speaker.

These are the necessary parts of the set:

One variocoupler of special design, consisting of tubing 4 inches high and 4 inches in diameter, with a regenerator inductance coil at the bottom, consisting of 35 turns of No. 22 DCC wire, and at the top of a stator winding of 26 turns of No. 30 DCC wire on each half. The rotor, which is 3 inches in diameter and 1½ inches long, is wound with 26 turns of No. 30 DCC wire. All this is mounted on a 4½"x4½"x⅞-inch wood block and shellacked.

One Air-choke Coil wound with 400 turns of No. 28 enameled wire on a 5-inch tube 8 inches long, supported by blocks cut to fit under each end and shellacked.

3 Variable condensers, .001-mf.;
1 Fixed condenser, .005-mf.;
3 Filament rheostats, one with vernier;
1 A.F. transformer;
3 Power-tube sockets;
3 UV-202 or UX-210 tubes;
1 Bakelite panel, 12x21x3/16 inches;
2 "C" batteries, 0-12 volts;
1 "B" Battery, 100-200 volts;
4 3-inch Dials;
2 Contact arms, 1½" radius;
6 Terminals for loop and battery connections;
2 Honeycomb coils, 1,500-turn.
30 Contact points;

SUPER-PLIODYNE 9-TUBE RECEIVER

(26) Mr. D. Stanley, Tuxedo, N. Y., asks as follows:

Q. 1. Please furnish me with the schematic wiring diagram of the Super-Pliodyne 9-tube receiver, which incorporates a special means of controlling oscillations in the R.F. stages, six stages of tuned-radio-frequency amplification, detector and two stages of audio. Also any constructional data or constants.

A. 1. This receiver is manufactured by the Golden-Leutz Co., Long Island City, N. Y., and the following information is published by their courtesy. All the variable condensers (C1, C2, C3, C4, C5, C6 and C7,) are .0005-mf. capacity. These condensers are all geared together, thus giving you one dial for control. The transformers employed allow broad tuning. This is the reason for the use of so many stages tuned simultaneously.

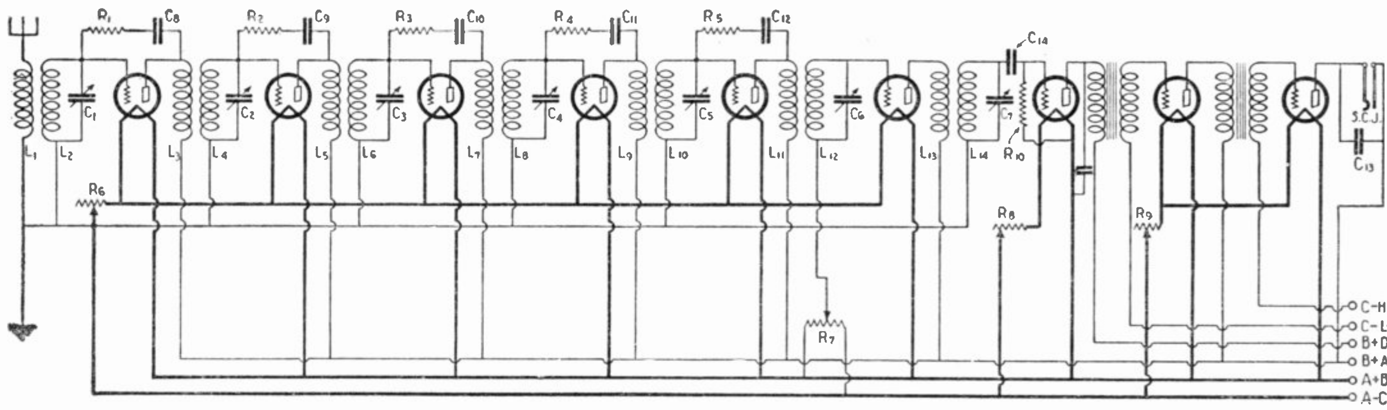


Fig. 26. Wiring diagram of the Super-Pliodyne 9-tube receiver, which employs six stages of tuned radio-frequency amplification, and incorporates a novel means of suppressing oscillations. The amount of radio-frequency amplification obtained is tremendous, resulting in a very sensitive and selective receiver.

The primaries (L1, L3, L5, L7, L9, L11, L13,) consist of 25 turns, wound on 1¾-inch tubing. The secondaries (L2, L4, L6, L8, L10, L12, L14,) consist of 100 turns wound on 2-inch tubing. No. 26 D.C.C. wire is used. The primary tubing is placed inside of the secondary tubing. The primary winding is spaced. Between every primary turn, allow a space equal to three turns, or about ⅛-inch.

The resistors (R1, R2, R3, R4, R5,) in the neutralized stages are variable, although not indicated as such. They vary from 20,000 to 120,000 ohms. The condensers in these stages are also variable, being of the regular midget type. C14 is the grid condenser, having a capacity of .00025-mf. R10 is the grid leak, having a resistance of from 1 to 3 megohms.

The filaments of all the R.F. tubes are controlled by a single rheostat, R6, which has a resistance of 6 ohms, and should pass 1½ amperes. The filament of the detector tube is controlled by a 20-ohm rheostat, R8. The filaments of the A.F. tubes are controlled by a single 10-ohm rheostat, able to pass ½-ampere. Tubes of 201-A or 301-A type are used throughout, with a 6-volt "A" battery. C13 is a .003-mf. fixed condenser. R7 is a 400-ohm potentiometer, used to control the oscillatory action of the tube.

Wiring the Receiver

The beginning of the primary winding is brought to the antenna post, and the other end to the ground post and to the beginning of the secondary winding L2. This same lead is extended to the arm of C14. The other terminal of this condenser is brought to the grid post. The beginnings of the secondary windings (L2, L4, L6, L8, and L10,) are also connected the rheostat, R6, and to the "A—C+" post. The rotor plates of all the variable condensers and the beginnings of the secondary windings of all the coils, except L12, are connected to this same lead. This gives all the tubes in these circuits a negative grid return. The beginning of the secondary winding, L12, is brought to the arm of the potentiometer, R7, and the resistance terminals of this potentiometer are brought to the "A+" and "A—." Although the grid return through the secondary winding, L14 is to "minus," a positive bias is obtained on this detector tube by connecting the grid leak in shunt to the grid and "A+."

The beginnings of these secondaries (L2, L4, L6, L8, L10, and L12,) are brought to the grid posts of their respective sockets, and the beginning of L14 to one terminal to the resistors in their stages, while the other terminals of these resistors are connected to the fixed condensers. The other terminals of these condensers are brought to the plates of their respective tubes. No such resistor and condenser are connected to the sixth R.F. tube, the potentiometer taking its place. The rheostats are all connected in the negative legs of the respective filament circuits which they control. The variable condensers are connected to shunt to the secondaries, the rotor leads going to the filament side and the stators to the grid side.

Batteries Required

The plates of the R.F. and the A.F. tubes should receive about 90 volts ("B+Amp."); that of the detector tube about 45 volts ("B+Det."). A 4.5-volt "C" battery ("low") should be used as a grid bias in the first stage of A.F. coupling, and a 9-volt "C" battery "High" in the last stage.

The first variable condenser can be controlled independently of the other six which may be ganged. This may lead to easier synchronization of dials and louder signals.

The complete set is housed in a totally-shielded cabinet, with the coils placed so that practically no field exists between them: this is to prevent interstage coupling and consequent uncontrollable oscillations of the tubes in these circuits.

If a power tube is desired in the last stage, it would be best to isolate the "B" and "C" voltages that connect to this stage. A voltage not exceeding 135 should be used for the UX112 tube, and about 175 for the 171 tube; 9 volts "C" battery for grid bias with the first tube and approximately 22½ volts "C" battery for the latter.

The amount of amplification obtained from this receiver is tremendous, which permits loop reception. The loop connections are made to the grid of the first tube and to the "A—" terminal instead of to L2.

OPERATING A SUPERHET.

(27) Arthur Manson, Kalamazoo, Mich., writes:

Q. 1. I would like your advice as to the best method of operation for my eight-tube superheterodyne.

A. 1. A superheterodyne is a very flexible type of receiving set and one which if properly operated will afford great satisfaction. It requires a certain technique of operation which is peculiar to itself alone, but it is not at all difficult to master the principles and to put them into effect. There are usually three active controls on the superheterodyne: The antenna or loop condenser, the oscillator condenser, and the potentiometer. The best method to proceed for tuning-in local stations is to adjust the potentiometer to a point considerably below the oscillation point and to run over the wavelength range with both condensers until foreign signals are picked up, when the process may be concluded by tuning the condensers more carefully to the point of maximum audibility. This process will hold for local reception under ordinary conditions, and if the tubes are kept from oscillating, there will be no interference with the reception of neighboring listeners. When the set is adjusted in this fashion, carrier waves will not be heard, hence there will be no squeals floating around uninvited. For "DX" work, it is quite necessary to bring the set to the point of maximum sensitivity, which is attained when the tubes are adjusted to a point just below oscillation. The best way to tune in a "DX" station is to advance the potentiometer until the carrier-wave whistle may be heard on rotating the oscillator and loop dials. While the potentiometer is still adjusted so as to cause the tubes to oscillate, the set may be sharply tuned to a point between the two peaks of the carrier wave whistle, and then the potentiometer should be retarded to stop the oscillation. The next step is to retune the set by means of verniers or other fine adjustments, to bring the signal in as loud as possible, with the potentiometer retarded to eliminate distortion.

SHORT-WAVE SUPERHETERODYNE RECEIVER

(28) Mr. L. Jenkins, Peoria, Ill., inquires as follows:

Q. 1. I am contemplating constructing a short wave receiver which will prove to be the "ultimate thing" in short-wave reception. I thing a short-wave superheterodyne set would do the trick, if I could get the correct constants. Can you furnish me with the design data of the various coils necessary, schematic wiring diagram, etc.?

A. 1. A very efficient short-wave Superhet. set has been designed by George J. L. Eltz, Jr., and published in the Proceedings of the Radio Club of America. The following is the description:

"The reception of short-wave radio signals, both telephone and telegraph, has been almost universally accomplished by means of the single-circuit regenerative receiver. This type of receiver, while it has been practically abandoned for the reception of longer wavelengths, is excellent in operation on about 3000 K.C. (wavelengths of 100 meters, or under). Indeed, so well has the single-circuit receiver operated that perhaps sufficient attention has not been given to other methods of reception. With this thought in mind, Mr. Eltz decided to investigate the possibilities of the superheterodyne method of reception and, as a result, the receiver described was evolved. The receiver was constructed and first operated in October, 1925.

"The ordinary 'super' used for broadcast reception has two tunings: first, the loop or antenna circuit and second, the oscillator circuit. This short wave 'super' has only one tuning arrangement, in which is combined both the tuning operations indicated above. This method of tuning was selected because of its simplicity and because it makes possible the construction of what is practically a single-control set.

The "Autodyne" Circuit

"The intermediate frequency chosen is 22 kilocycles, which, while too low a frequency for good telephone reception, when simple tuned circuits are used, is satisfactory for C.W. or telegraph signals. The selection of this frequency necessitates detuning the set 22 kilocycles from the incoming signal; but at the frequencies corresponding to wavelengths of 100 meters or under, this detuning is of no importance in decreasing signal strength.

"The reader will recognize the description above as applying to the 'autodyne' or 'self-heterodyne' type of 'super'. The beat note of 22 kc. is created in the same manner as in the broadcast set, but at a lower frequency. For the reception of short-wave telephone signals, the amplification and detection of the 22-kc. beat note is accomplished in the usual manner. When C.W. signals are to be received, another beat note must be created, either by means of another oscillator tube or by a self-heterodyne beat note in the second detector tube. This latter method has been selected, a beat note of 1,000 cycles being chosen as the most satisfactory. This detuning of the second detector circuit, while it may appear to be inefficient because of the low intermediate frequency, is not so bad as it seems, since the amplification in the intermediate circuit is very great and there is plenty of energy to spare.

Description of the Set

"The first detector and oscillator circuit may be any of the conventional short-wave receiving circuits. The one chosen is shown in the diagram (Fig. 28-A). Two variable condensers are shown but all the tuning is done with the one in the grid circuit. The condenser in the plate circuit must be set for each band of frequencies covered; for instance, from 7096 to 6663 kc. (40 to 45 meters), or from 6663 to 5996 kc. (45 to 50 meters), etc. This setting is not critical, the only requirement being that the tube oscillate strongly but not so violently that it blocks.

"The coils, condensers, choke coil, etc., are identical with those which would be used in the construction of a regenerative set. The variable condenser in the grid circuit must be provided with some means of close adjustment, as the setting is rather critical. The plate-circuit condenser can be set with an ordinary knob or dial, without trouble.

"The choke coil consists of 100 turns wound on a wooden form 1-inch in diameter and 2 inches long. A honeycomb or similar coil of 150 or 250 turns will also serve very nicely. The intermediate transformer must be one capable of amplifying the rather low frequency of 22 kc.

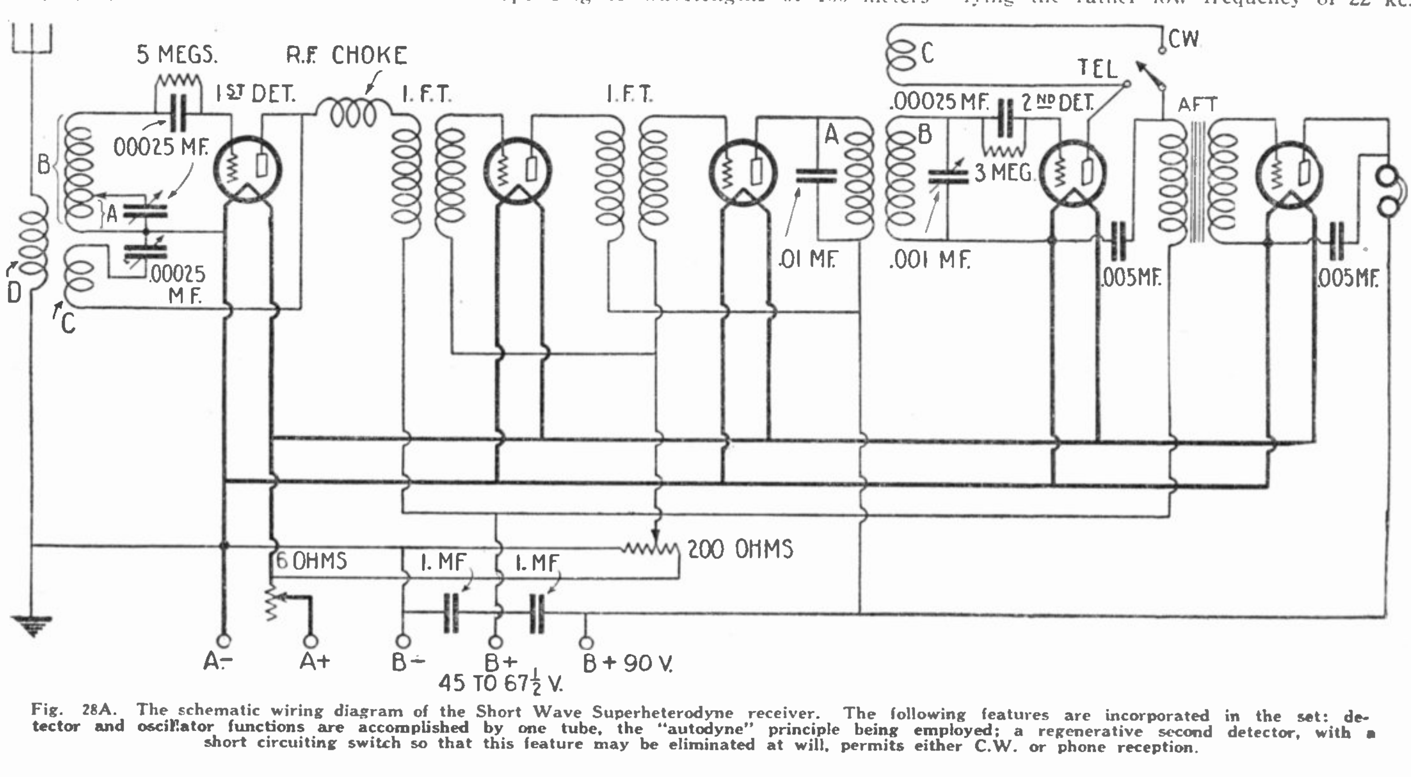


Fig. 28A. The schematic wiring diagram of the Short Wave Superheterodyne receiver. The following features are incorporated in the set: detector and oscillator functions are accomplished by one tube, the "autodyne" principle being employed; a regenerative second detector, with a short circuiting switch so that this feature may be eliminated at will, permits either C.W. or phone reception.

"The coils used in the antenna, grid and plate circuits are made by winding bare copper wire of No. 16 gauge over a form on which are placed four narrow strips of celluloid, equally spaced. The wire is spaced with string and, when completely wound, the string is removed and the wire cemented to the strips by means of liquid celluloid. The construction of this type of coil is familiar to any one who has followed the development of the short-wave regenerative receiver.

"The number of turns required for each coil, for the respective wavebands, is as follows:

Meters	A	B	C	D
40	4	13	3	6
50	6	28	4	6
80	8	28	4	8

"The diameter of the coils is 3 inches, for whatever frequency band the coil is designed to cover. Three coils were used by the author to cover the amateur bands. The figures given for the coils are only approximately correct, as the method of wiring, mounting, etc., all affect the capacity of the coils and, in consequence, the number of turns required to cover a given frequency-range.

"Where the operator or constructor has a satisfactory regenerative receiver already in operation, there is no need to change, even though the circuit differs from the one shown. The only requirement is that the primary of the first intermediate transformer be free of a capacity shunt greater than 0.00025-mf.

The Intermediate Amplifier

"The complete circuit of the receiver is shown in Fig. 28-A. By reference to this circuit, it will be observed that two untuned intermediate transformers are used, and one tuned or filter transformer of special construction. The intermediate transformers used in this set were those manufactured by the General Radio Company (type number 271). These particular transformers have a flat characteristic which permits a considerable gain at 22 kc. Others of different make but of nearly similar characteristic are probably available.

"No particular description of the intermediate circuit is required. The circuit is a conventional one and the same precautions observed in the construction of any superheterodyne should be followed. To prevent undue feed-back in the untuned circuits, space the tubes and transformer liberally and keep them in line.

The Filter Circuit

"Because of the low intermediate frequency, the filter transformer must be of a special design. By reference to the circuit diagram it will be observed that three coils are used here also. The coil in the plate circuit, of the tube preceding the detector, and the coil in the grid circuit of the detector comprise the tuning or filter circuit. The coil in the plate circuit of the detector tube is the feed-back coil by means of which the beat note of 1,000 cycles is created in the second detector tube.

"The specifications of these coils are given in Fig. 28-B; No. 32 D.S.C. wire is used throughout. In winding these coils no particular care need be used; random winding is perfectly satisfactory. Approximately the number of turns specified, however, should be wound, otherwise the frequency of the intermediate circuit will be changed. In this figure, the spacing between coils is shown, but it must be variable to determine the best setting. No hard and fast rule can be given on the point, as the arrangement of the circuit, placing of the coils, etc., will have some effect. Once adjusted, however, there is no need for further change. The coils shown make a rather small assembly. If the space occupied is no factor, honeycomb, duo-lateral, or other form-wound coils of similar nature can be used: a 600-turn honeycomb coil for A, with a 1,500-turn honeycomb for B and a 400-turn honeycomb for C. The spacing may be somewhat greater than that specified for the home-made assembly.

"The variable condenser shown across the grid coil is of 0.001-mf. capacity. Because of the rather large space occupied by a 43-plate air condenser of this capacity, a variable mica condenser was chosen. The air condenser is probably better from a standpoint of efficiency. The condenser across the grid coil determines the frequency of the beat note which is heard in the telephone. Keep this frequency as low as possible since, the lower the note, the more closely will the primary and secondary circuits be in tune.

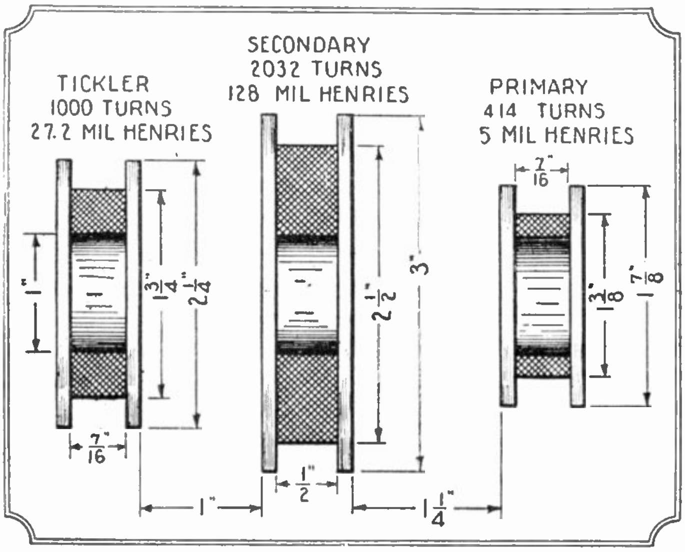


Fig. 28B. Here are the details and specifications for the construction of the various coil windings employed in the filter transformer for the short-wave super-heterodyne receiver. The distinctive feature of this filter transformer is the third, or tickler, winding which is employed for obtaining regeneration in the detector stage. By means of this it is possible to obtain continuous-wave reception. This transformer has a very sharp characteristic at about 22 kc., which is the intermediate-frequency used in this super-heterodyne.

"If telephone signals are to be received, a switching arrangement should be provided to permit cutting the plate coil of the second detector in and out of the circuit. Radio telephone signals can be received when the second detector is oscillating; but reception is extremely difficult as the "zero beat" method must be used, and the slightest change in frequency at either the receiver or transmitter causes an audio beat.

"No particular instructions are required here. Any good audio transformer is satisfactory. If radio telephone signals are to be received, as well as C.W., the transformer should be of good design. For C.W. reception only, a transformer having a high ratio between primary and secondary is best; since, although some distortion may be introduced, the amplification is higher and the distortion is of no importance.

"Two fixed condensers are shown in the audio circuit. These condensers are required as a by-pass for the 22-kc. frequency, which otherwise would feed back through the head telephones and the body to the input and cause trouble.

General Comments

"The particular receiver to which the foregoing remarks apply was one with complete shielding of the intermediate, second detector, and audio circuits. The coils comprising the first-detector circuit were not shielded but acted as loops for the reception of moderately distant stations.

"The principal advantage in the shielding came in the elimination of long-wave interference. Subsequently, it was found that by regulation of the amount of regeneration in the untuned intermediate transformers, practically the same result could be obtained, and at no sacrifice in sensitivity. It is recommended that the set be first made unshielded; and the shielding may then be applied if the long-wave C.W. interference is bad. In another model of this same receiver, constructed by Mr. C. R. Runyon, no shielding was used and results were entirely satisfactory.

"If a good antenna is used, the distance possibilities of the short-wave superheterodyne are limited only by the static level. For the reception of signal from a certain station or stations, where it may be possible by changing the transmitting frequency to remove the interference caused by double tuning, the superheterodyne receiver is most satisfactory.

"In operation, the plate condenser is set for strong oscillation and all the tuning is accomplished with the grid condenser. Here the action differs from that of the regenerative set, with which it is necessary to adjust the plate condenser for each frequency. Because of this single control the manipulation of the receiver is simpler and the possibility of picking up stations is increased."

FIVE TUBE MULTIPLEX

(29) Mr. L. Davis, San Francisco, Calif., asks:

Q. 1. Please publish circuit diagram, and constructional data on the five-tube Multiplex receiver.

A. 1. As it is a five-tube radio-frequency circuit, operating from a loop, the tuning of the Multiplex is very sharp. The inherent selectivity of the receiver is aided materially, first, by the directional effect of the loop, and, secondly, by the variable primary coupling of the double-rotor coupler. Whereas, in a great many sets, one has only the variable condensers to rely on for separation, in the Multiplex he can loose- or close-couple the primary coil and bring in or eliminate a signal almost entirely by changing the direction of the loop. With these three elements varying the selectivity of the receiver, we certainly should achieve a degree of sharp tuning.

Suppose one wishes to employ the receiver as a five-tube antenna-operated outfit. In a great many locations the directional effect of the loop will not be required and we shall undoubtedly gain signal strength by using the outside aerial. Here an antenna coupler or adapter comes in handy, converting the five-tube loop set to a five-tube aerial-operated receiver. Certain loops now on the market are equipped with such an adapter.

However, the flexibility of the Multiplex does not stop here. When the plug from the loop is disconnected from the input jack, the first tube in the circuit is auto-

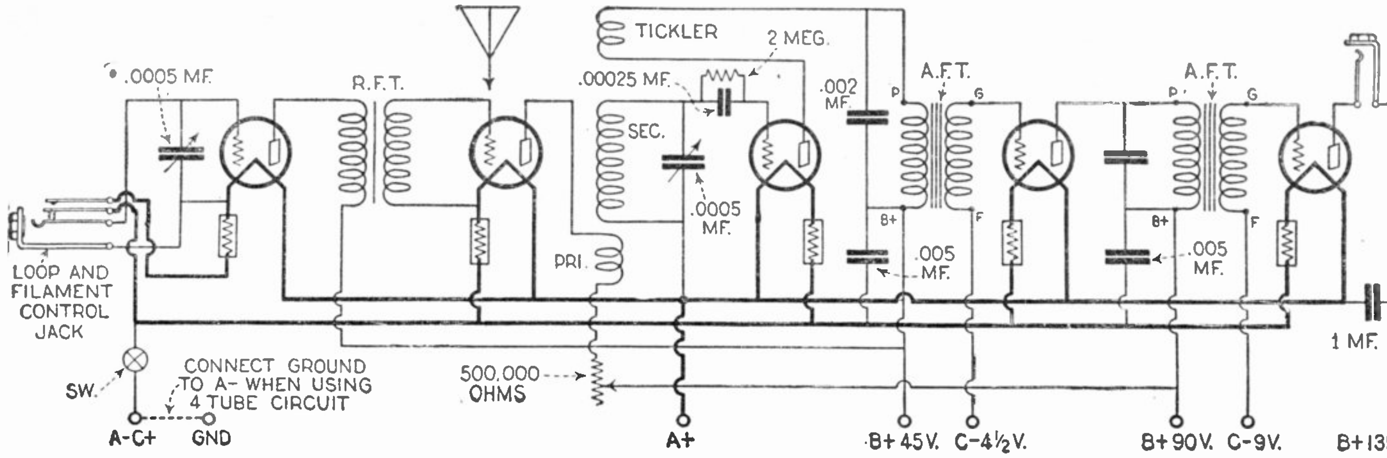


Fig. 29. Circuit diagram of the Multiflex 5-tube receiver, which was originally described by Wendall Buck, in the New York Sun. It operates from either a loop or outside aerial with excellent results. The regenerative detector facilitates the reception of extreme DX.

matically extinguished. The set then becomes a single-tuning-control four-tube outfit for antenna operation. Using but one tuning condenser, the selectivity of the four-tube set in the average location is still splendid. The variable-primary-coupling feature is still available, as in the five-tube circuit. It has been found that, in city locations removed a mile or two from the nearest powerful broadcaster, the four-tube combination does very well in separating all the local stations.

This volume and quality are secured with a simple combination of four 201-A tubes and a 112 in the output stage. The maximum "B" voltage necessary is 135 volts.

A glance at the schematic circuit diagram in Fig. 29 indicates the simplicity of the receiver. Few five-tube circuits today are much easier to handle. A simple tuned-loop circuit, fixed R.F. amplification, a regenerative detector and two stages of well-designed A.F. amplification, well by-passed; that is all there is to it. The cost of the necessary parts is moderate, and the job of assembly and wiring is far from a complicated or involved one.

An automatic filament-control jack takes care of the optional-tuned loop stage, lighting the first tube when the loop is plugged in and extinguishing it when the loop is disconnected. When the loop is not used the antenna connection is made to the binding post marked "Input," which in turn connects to the grid of the R.F. tube. The ground connection is made to the "A—C+" post. With the four-tube circuit only the secondary of the fixed R.F.-transformer is employed, the primary being thrown into the circuit when the loop is plugged into the circuit through the jack on the left of the panel.

The filament control of the tubes is automatic. The receiver can be readily adapted to the use of 199-type tubes by simply changing the amperites in the filament legs of the circuit.

The following is the list of parts necessary for the construction of this receiver:

2 A.F. transformers;
2 variable condensers, .0005-mf.;
1 double-rotor coupler (an ordinary three-circuit tuner will do);
1 untuned R.F.-transformer;
4 amperites, type 1-A;
1 amperite, type 112;
5 sockets;
1 single-circuit jack;
1 single-circuit filament-control jack;
1 variable resistance, 500,000-ohm;
1 by-pass condenser, 1-mf.;
2 fixed condensers, .005-mf.;
1 grid leak, 2-megohm;
1 filament switch;
1 grid condenser, .00025-mf., with leak mounting;
2 vernier dials;
8 binding posts, marked "Input"; "A—C+"; "A+B—"; "45V+"; "C—4½"; "90V+"; "C—9"; "135V+";
1 panel, 7x21;
1 wooden baseboard, 7x20x7 inches;
1 binding-post strip.

REFLEX NEUTRODYNE

(30) James J. Ashton, Pensacola, Fla., asks:

Q. 1. Can you give me a diagram for adding one stage of audio frequency amplification to my four-tube reflex Neutrodyne receiver?

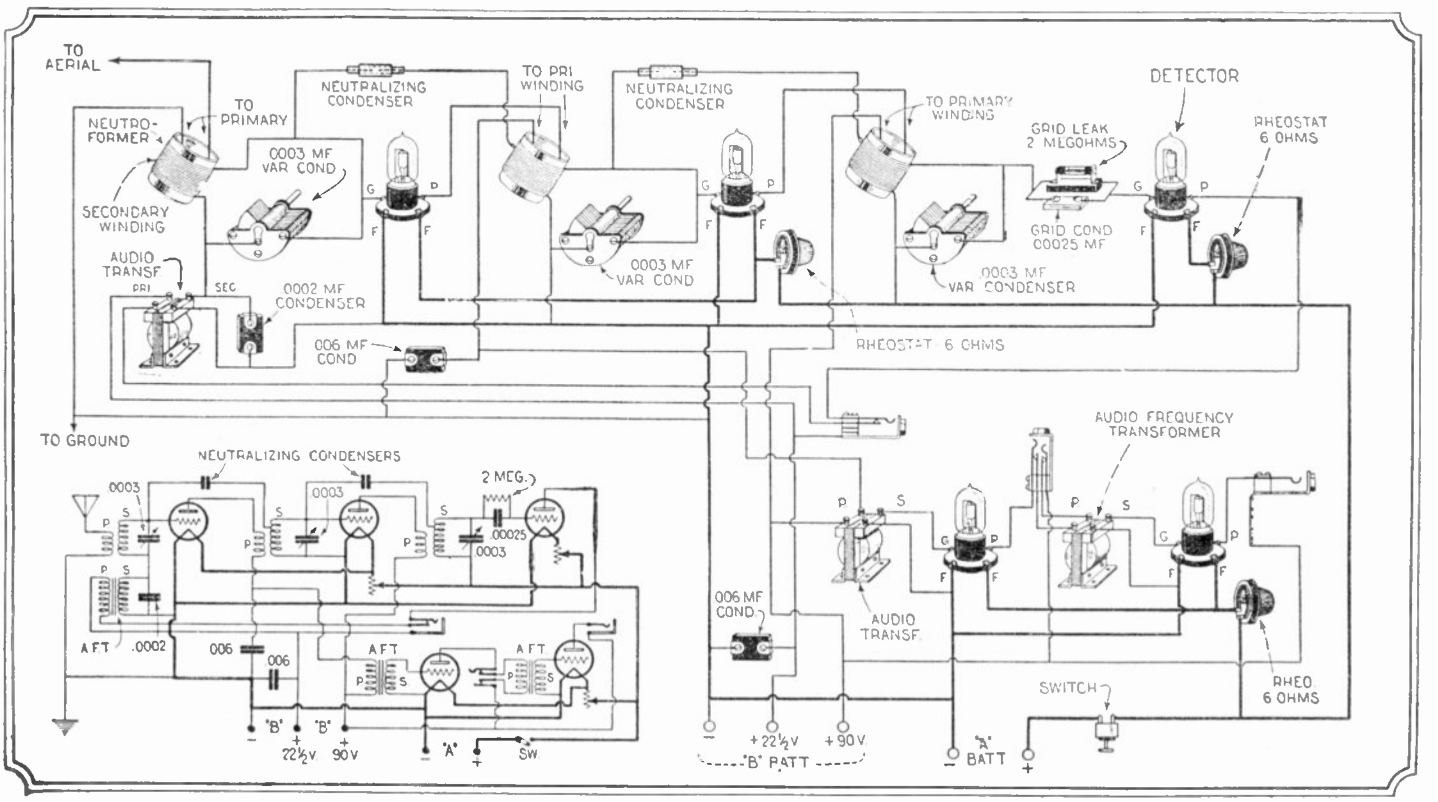


Fig. 30. Those who have a four-tube reflexed neutrodyne will find that an added stage of audio-frequency amplification will vastly improve the volume on distant stations. The diagram shows explicitly how this can best be done. It is best, perhaps, to rewire the set completely for superior results.

A. 1. The diagram in Fig. 30 gives in full detail the exact wiring that is employed to add one additional stage of audio frequency completely, so the diagram shows the circuit as one complete set. The only additional parts you will need will be a double circuit and single circuit jack, a four to one audio frequency transformer, a six ohm rheostat and a standard socket.

BODY CAPACITY

(31) Q. 1. A. Johnson, Minneapolis, Minn., is employing a regenerative tuner of the so-called three-circuit type and finds that he has considerable trouble holding the signals when he places his hand on the variable condenser dial. Furthermore, when he tunes in a station and removes his hand from the dial, the station usually disappears. He asks us to tell him how to eliminate this trouble.

A. 1. Undoubtedly reversing the connections to your secondary tuning condenser will eliminate most, if not all, of your trouble. In other words, the rotary plates of the condenser should be connected to the ground. By doing this, the parts of the variable condenser that are near at hand will be placed at ground-potential so that the capacity effect of the hand will be reduced to zero. If, for some reason, this connection does not overcome the effect which you have noticed, try shielding the panel. Do not allow the metallic parts of the condenser to touch the metal shield, which should consist of a sheet of tinfoil fastened to the panel with some adhesive, such as shellac. This shield should be connected to the ground.

AUDIBILITY STANDARDS

(32) Q. 1. Miss Daisy Cooper, Oxford, N. C., inquires if there is a definite standard for audibility and quality of signals recognized by the radio fraternity.

A. 1. Here is the table usually employed:

Signal Audibilities

R1—Faint signals, just audible.
R2—Weak signals, barely readable.
R3—Weak signals, but readable.
R4—Fair signals, easily readable.
R5—Moderately strong signals.
R6—Strong signals.
R7—Good, strong head-phone signals. Would be readable through heavy QRN and QRM.
R8—Very strong signals. Medium loud-speaker volume.
R9—Extremely strong signals, strong loud-speaker volume.

Q. 2. We are asked to print the recently developed Donle circuit.

A. 2. The diagram above is the adaptation of the Donle circuit employed by the manufacturers of a well known "Catacomb" amplifier. We are unable to furnish the complete constants for the impedance units, but we presume that they are designed to match the impedance of the tubes to be used. Hi-mu tubes may be used to advantage in all circuits using either impedance or resistance coupling for audio-frequency amplification.

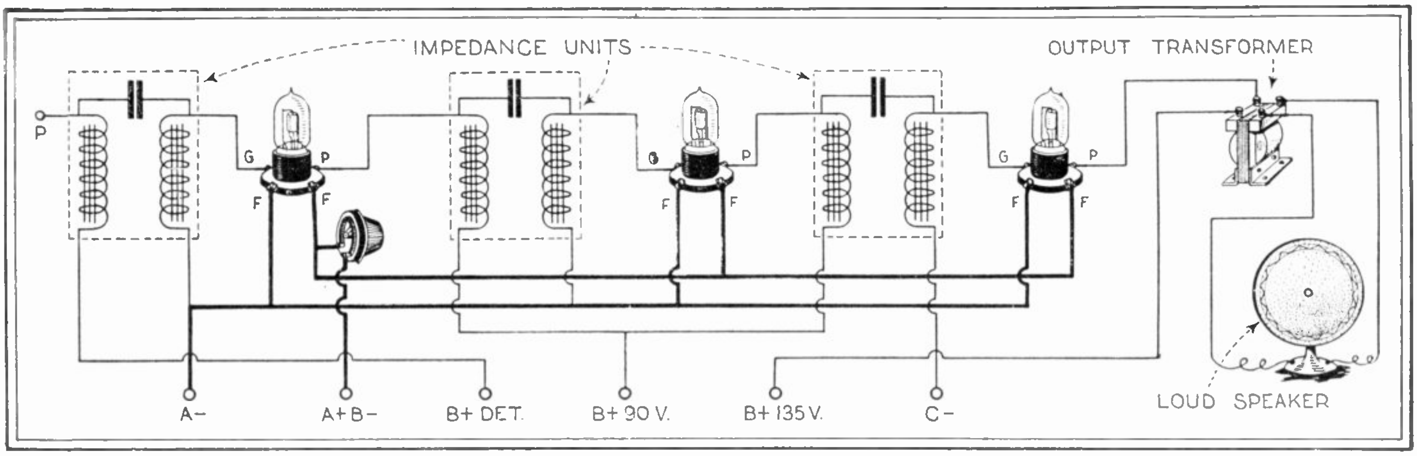


Fig. 32. Several manufacturers have recently introduced amplifiers employing the Donle system of impedance coupling, the circuit diagram of which is given above. The amplification available with this system is nearly equal to transformer coupling, and is almost completely distortionless.

PHASE ANGLE

(33) George F. Dowell, Chatham, N. J., asks:

Q. 1. Kindly explain in full what is meant by phase angle?

A. 1. Ordinarily in taking up the study of electro-motive force and current, the element of time is not always taken into account. It is only done so when we speak of electricity in terms of energy, kilowatt hour, horse power hour, etc. In direct current, phase angle does not exist, since the current and voltage generated rise and fall together. In alternating current circuits, both the current and the voltage are alternating, that is, each rises from zero to a maximum value in one direction and back to zero and maximum in the other direction. These two alternations are what is known as a complete cycle. When the current and voltage start from zero and reach a maximum at the same instant and return to zero and reach a maximum in the opposite direction at the same time, they are said to be in phase. Whatever their positive or negative values may be, whether one is larger than the other, the voltage must reach its maximum or minimum at the same time the current does, if both are in phase.

However, if the voltage reaches a maximum before the current does, the voltage is said to be leading the current and the current is said to be lagging. Usually, it is spoken of as either lead or lag of the current referred to the voltage where circuits comprise inductance or capacity. Even in our receiving sets such conditions exist and there is always a phase difference between the current and voltage. It is customary to measure this difference in degrees. Thus, when the phase angle difference is known to be 90°, the current is either leading or lagging the voltage; when one is maximum, the other is zero. The radian, an arc whose length is equal to that of the radius of its circle (5 F. 296°) is often used.

Where a circuit comprises resistance only, the voltage and current are always in phase. If it were possible to eliminate the resistance from a circuit leaving inductance only, the current would lag the voltage by 90°; also, if the resistance were removed from a circuit leaving capacity only, the current would lead the voltage by 90°. However, since resistance is always present in any circuit, the 90° phase angle is never obtained. When the current lags or leads, the predominant value of inductance or capacity determines this.

The action of a current affected by inductance may be compared to inertia in mechanics. When near the end of a single alternation, with the resultant decrease in current value, the inductive effect tends to oppose this diminution and continue the flow. This effect can be readily observed by breaking the circuit composed of a large inductance in series with an alternating current source. Promiscuous arcing across the key contacts will also show the great tendency of the current to continue its flow. The same applies when the current is reaching its maximum value. It is choked down or opposed by the inductance and at any one instant the momentary value of the current is less than the momentary value of the voltage divided by the resistance. Thus either capacity or inductance tends to smooth out an alternating current and the difference between the instantaneous values of current and the voltage is what is known as the phase angle between them.

SHORT WAVES

(34) Charles Reiser, Asheville, N. C., asks:

Q. 1. Can you please state whether it has been actually found that the short waves are superior to the longer ones?

A. 1. When Marconi first placed wireless transmission on a practical basis, many years ago, he propounded the theory that the long waves were the best and showed why he believed it. It has been some time since Marconi's first experiments and gradually the radio fraternity is coming to the realization that the short waves are much superior to the longer ones. One reason for this is the great proportional difference in frequency range on the shorter waves between a given number of meters. Thus, between 90 and 100 meters, there is a difference of nearly 340,000 cycles, whereas for the same number of meters difference, between 400 and 410 meters, the difference is but 18,000 cycles. It can be seen at once that there is nearly 20 times the difference in frequency between this given wave-length range on short waves than for this given range on longer waves. Thus the tuning is unusually sharp as we approach the lower waves and unless apparatus of low loss and careful design is employed, their reception is very limited. Again, signal strength seems much more intense and the degree of clarity becomes more distinct. Since tuning is so extremely sharp, interference is practically unknown, although occasionally, it is possible to pick up a harmonic from a powerful long wave transmitting station. Due to the great chances for leakage at these high frequencies, special care must be taken in the use of the various insulating materials to be employed. Large sized wire should be used in the tuning coils, No. 16 seeming to be very efficient for the shorter wave.

BODY CAPACITY

(35) Richard Larson, Kansas City, Mo., wants to know:

Q. 1. What is the body capacity and how can I overcome it? It causes me a great deal of annoyance and I would like to know whether there is anything wrong with my circuit.

A. 1. Body capacity, or hand capacity, is the term applied to the property of the human body which makes it act as a member of an electric condenser. Your body is not a good condenser. Compared to the variable condensers in a receiving set it has an extremely small capacity. The trouble is that even an extremely small variation in either the capacity or inductance of a set can throw fine tuning out of adjustment.

Each time the operator's hand takes hold or lets go of a knob in the process of tuning, the capacity of the set varies by a small amount, because some of the body capacity is communicated to the set while the hand is in contact with it. Then you know too well what happens.

A very fine adjustment of the total capacity of a set can be obtained with modern vernier knobs rotating the parts of the condensers, which supply practically all of the capacity of the circuit. In the same way a very fine adjustment of the total inductance is obtained by rotating the parts of the coils which supply nearly all of the inductance in the circuit. Thus these two elements in the set itself can be very closely controlled.

Some radio enthusiasts who can build anything from a pocket crystal set to a superheterodyne do not know just why this adjustment of capacity and inductance values is so important in its effect on reception. As the voltage supplied to the set by batteries or lighting circuit is constant, minimum resistance means maximum current. With the maximum current flowing through the set, you have reached the point of resonance—the point at which signals are strongest.

Attempts have been made to eliminate body capacity by various methods, but the most effective has been the protection of the panel, or in some cases of individual parts of the set, with a metallic shield. The shield, until recently, had to be applied either by the user or by the dealer, but an "anti-capacity" panel of hard rubber is now being made with a shield vulcanized in place. Shielding, while decreasing the effects of body capacity, does not detract in any way from the quality or volume of the tone.

In order to make shielding thoroughly effective, care must be used in making connections in the circuit. The grid and plate terminals are most sensitive to body capacity effects. Keep the parts of the coil or apparatus to which the grid or plate is connected as far as possible from the panel. The filament circuit must be properly grounded. When variable condensers are mounted on the panel, connect the rotor plates to the ground or filament side. There are variable condensers on the market with end rotor plates, which can therefore be termed self-shielding. With a series condenser in the antenna, the rotor plates should be connected to the antenna; with the condenser in the ground circuit, the rotor plates should be connected to the grounded side. A condenser across the secondary should have the stationary plates connected to the grid.

Body capacity manifests itself more

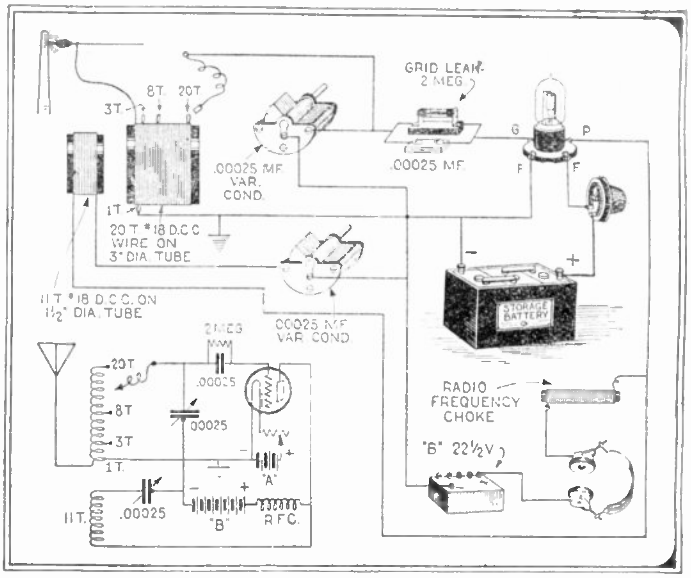


Fig. 37. Short waves are rapidly coming into use for broadcasting purposes, on account of the greater carrying powers and less fading experienced on these waves. The circuit shown is the latest Reinartz type.

readily when the receiving tubes are overloaded, either by too much filament current or too high plate voltage.

PROGRESS OF RADIO

(36) William J. Fink, Washington, D. C., asks:

Q. 1. Will you kindly give me information regarding the date upon which radio was first used practically as a recognized means of communication?

A. 1. December 12th, 1901, witnessed Marconi's first attempt at trans-Atlantic radio communications. Listening in near St. Johns, N. F., he was able to pick up the now famous letter "S" broadcast from the 50-kilowatt spark station at Poldhu, located on the southwest tip of England.

It may be, perhaps, interesting to relate some of the experiences which Marconi encountered when he arrived for the preliminary tests.

On December 10 of the same year, four days after his arrival with two assistants, a wireless receiving station was set up and a hexagonal kite made of bamboo and silk was sent aloft over the Grand Banks to hold the antenna wire high in the air. Due to a strong wind which prevailed at the time, the wire snapped and the kite was lost out at sea. Undismayed, Marconi next tried a 14-foot hydrogen balloon, but again the wire broke and tangled up on the ground as the balloon disappeared in a fog.

Undaunted, on the morning of the memorable December 12, another kite was successfully raised to an elevation of 400 feet and at noon the English station, more than 2,000 miles away, was distinctly heard sending the letter "S."

Several days elapsed in which confirmation of the signals was made and, thoroughly satisfied that trans-oceanic transmission and reception was possible, Marconi gave a statement to the press that messages could be sent through space without the use of wires or cables, but also included the rather discouraging remark that this mode of conveying intelligence would have little practical value.

At that time, 24 years ago, but one antenna was to be found in this country with which to pick up the powerful Poldhu station's signal. And now another series of tests were recently carried out with English broadcasting stations in which many hundreds of American radio fans plainly heard programs broadcast from the British Isles. There are now thousands of homes throughout the United States with antennae on their roofs through whose use, joy and pleasure are received. Marconi worked under much greater difficulties than we with our multi-tube super-sensitive receivers and depended upon the erratic action of the old-fashioned coherer; the average broadcast listener of today using a simple crystal detector receiving set is incomparably ahead of the coherer days of 1901. Indeed, in comparison with Marconi's first experiments the simplest sets of today are almost miraculous.

Whereas the commercial trans-Atlantic stations of today use as high as 250 kilowatts of energy, the famous letter "S" was successfully transmitted with but one-fifth this power.

The last figures from official sources show that there are at present approximately 600 radio broadcasting stations in this country alone. Of this number, there are less than a dozen using 1,000 watts of power, about 100 using between 500 and 1,000 watts, while the remainder are composed of stations using as low as a single 5-watter.

SHORT WAVE RECEIVER

(37) Q. 1. A. Larsen, Denver, Colo. Please publish a good circuit for a short wave receiver.

A. 1. The diagram is given in Fig. 37. The winding is made in the popular basket weave form about three inches in diameter. Wind three turns, then tap, also placing taps at the eighth and twentieth turns. The tickler consists of a one and one-half-inch diameter coil placed about one inch below the filament end of the secondary. The secondary condenser is of .00025 mf. and the regenerative condenser is of .00025 or .0005 mf. capacity. These condensers must be of the latest design low-loss variety. The R.F. choke consists of about 100 turns of wire wound on a short length of wooden dowel. The wave-length range of the receiver described is from about 20 meters up to 150 meters. The tube must be removed from the base and leads soldered on the connecting wires so as to lower the capacity and also to make the tube non-microphonic.

T.A.T. SYSTEM

(38) Q. 1. Mr. Irving Waldman, Brooklyn, N. Y., asks about the T.A.T. system and a circuit for it.

A. 1. By the T.A.T. system is meant that there are three circuits; the first one is a tuned circuit, the second is aperiodic and the third is tuned. This may be seen more clearly from the diagram given in Fig. 38. The constants are given with the diagram, and you should find no difficulty in making this receiver operate. The reason for the aperiodic circuit between the two tuned ones is so that the circuit will not oscillate and therefore will not radiate

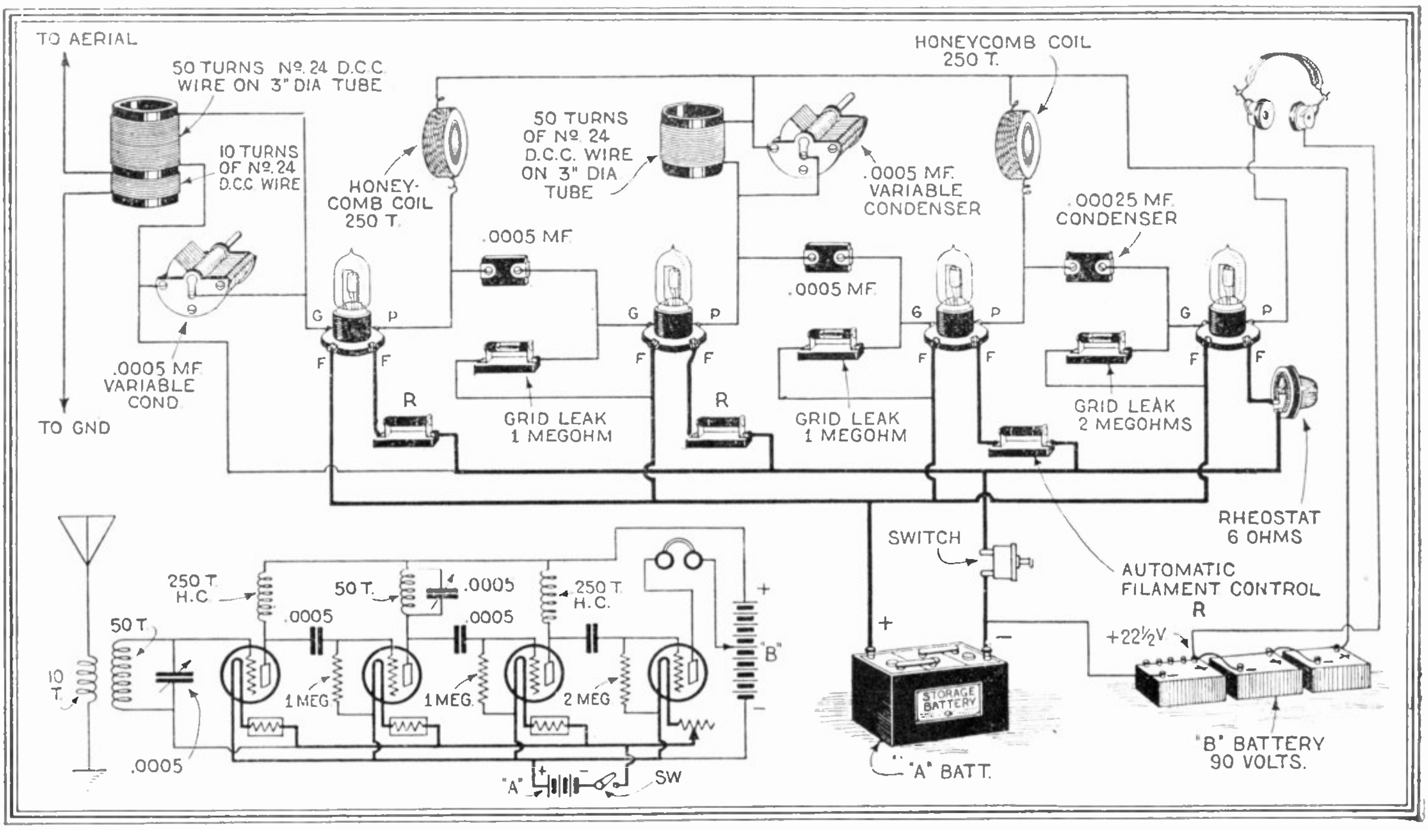


Fig. 38. The above diagram shows what is called the T. A. T. system. It is used very much in England because it does not oscillate. The reason for this is that an aperiodic circuit is placed between two tuned ones. By following the diagram an efficient and unusual set can be constructed.

or cause interference in neighboring receivers.

LOSS OF VOLUME

(39) Q. 1. Edward Heron, Jr., Perote, Ala., sends a diagram of his receiving set which is a standard two-variometer and variocoupler type and says that after the set had been in use for some months, stations faded out and could not be brought up as loud as formerly. He asks our opinion as to the trouble.

A. 1. There are several possibilities here. First, your batteries may be worn out and this point should be investigated immediately. Then there is a further possibility that the electronic emission of your vacuum tube has decreased with a resulting decrease in efficiency of the set. This would account for the signals not coming in as loud as formerly. Furthermore, the resistance of your grid leak may have changed due to atmospheric conditions whereupon a change in signal strength would be noticeable. We would advise you to look into these things carefully, checking the strength of your batteries first.

LONG WAVE R.F. RECEIVER

(40) Q. 1. John Heap, Taylor, Texas, is at present employing a five-tube receiving set comprising two stages of radio frequency amplification, a detector and two stages of audio frequency amplification. The radio frequency amplification is transformer coupled. He asks: How can

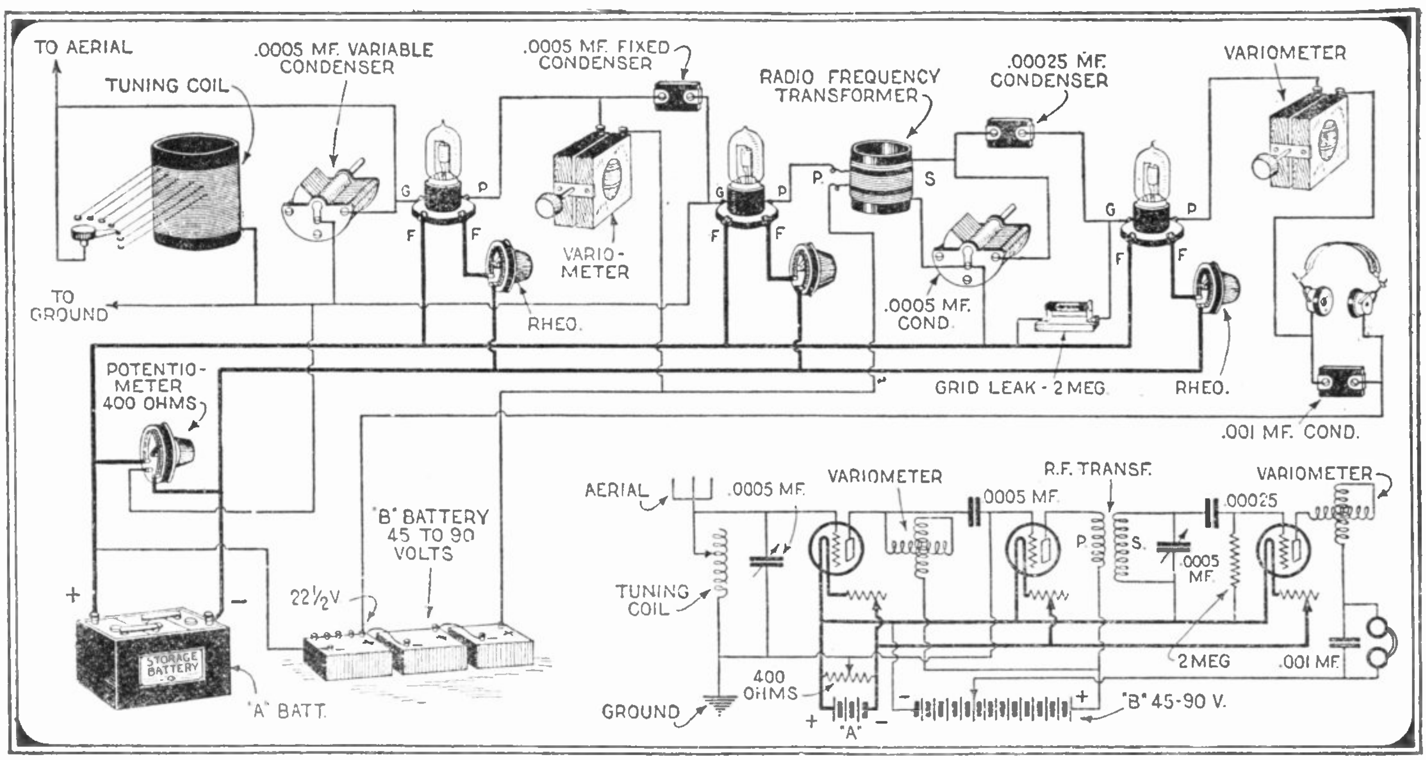


Fig. 41. A circuit diagram of two stages of tuned radio frequency amplification with a vacuum tube detector. The correct constants are given on the diagram. This circuit is quite selective and is an excellent one for the "DX hound" who does not care for ear-splitting volume.

honeycomb coils be placed in this circuit to reach a wave-length of 1,600 meters?

A. 1. Such a procedure is not at all advisable with a set of the type you are using. In order to accomplish this work, you would not only have to load the primary and secondary circuits of the initial tuning element, but would also have to insert different radio frequency transformers to cover the higher band of wave-lengths. Such a procedure would necessitate your entirely rebuilding the set.

As the movement of the day is in the direction of short wave-lengths, why do you look for long wave reception?

TUNED R.F.

(41) Q. 1. K. Edler, Washington, D. C., sends us a circuit of a two-stage radio frequency and detector set wherein the first stage of R.F. is tuned by means of a variometer and the second by means of the coupling coil and condenser. He has been unable to accomplish satisfactory reception with this circuit. He requests us to check over the circuit and let him know what is wrong.

A. 1. We reproduce the circuit in Fig. 41 with the necessary additions and changes. You did not have any grid or blocking condenser in the grid circuit of the second radio frequency amplifying tube nor grid leak in the detector circuit. Neither was there a fixed phone condenser. We have made these corrections on the drawing herewith.

INCREASING SELECTIVITY

(42) Q. 1. Robert Smith, Detroit, Mich., desires to obtain better selectivity with a standard type of receiving set employing a three-circuit coupler. The set is connected to an antenna system, having a total over-all length of 140 feet.

A. 1. Since you desire to leave your set in its present form, the only way you can materially increase your selectivity is by sacrificing some volume. The method to use is to cut down your antenna so that the over-all length including the lead-in is not more than 75 feet. You should then be able to tune in "DX" without much trouble.

REGENERATIVE LOOPS

(43) Q. 1. E. V. Donald, New York City, asks whether it is practical to use regeneration in a single tube which operates with a loop aerial. The entire set is to be used for reception over short distances.

A. 1. This work can be easily done, although it must be realized that a set of this nature cannot bring in any DX. It will probably give satisfactory results up to a distance of 25 miles under good conditions. We are showing two circuits for doing it in Fig. 43. In one a standard loop is used. Regeneration is obtained by means of the tuned plate method. Either an inductance coil and a variable condenser or a variometer may be used in the plate circuit.

In the other, a loop with center tap is employed. The number of turns in this part of the circuit should be experimented with until the best results are obtained. A rheostat that can be critically adjusted should be used, as the regeneration may be controlled more easily from this point.

Still a third method which may interest experimenters in the use of two loops, one in the grid circuit, as usual, and the other in the plate circuit, the two loops being inductively coupled. Feed-back regeneration is thus obtained.

RADIO AND WEATHER

(44) Q. 1. Heinrich Polsfut, Sawyer, N. Dak., asks us whether or not in our opinion radio broadcasting affects the weather in any way.

A. 1. Radio broadcasting has no effect whatsoever upon the weather. Investigation shows this to be a fact and there is no authentic record of radio waves of any description having any such action.

GRID RETURN

(45) Q. 1. Ted R. Parish, Belmont, Nebr., wants to know what is meant by the term "grid return."

A. 1. By the grid return is meant the connection which begins at the grid, goes through the secondary circuit and terminates at the positive terminal for the detector tube and negative terminal for the amplifier tube.

INCREASING WAVE-LENGTH

(46) Q. 1. William G. Parkes, Nashville, Tenn., says that his broadcast receiver will only receive from stations over a band of 200 to 360 meters and asks how he can change the set so as to tune in broadcasting stations up to 550 meters.

A. 1. Would advise that in order to increase the wave-length reception range of your set, you should wind an additional 30 turns on the primary, increasing your aerial if possible also. Replace the grid vario-meter by means of a 43-plate condenser which is shunted across the secondary. This will increase your wave-length range sufficiently for your purpose. Would advise a 43-plate vernier condenser.

PORTABLE SET

(47) Q. 1. Andrew S. Edison, Cleveland, Ohio, asks for some details on building a portable set that can be incorporated in a suitcase.

A. 1. A radio receiving set employing two or three stages of radio frequency amplification either tuned or untuned, a detector and two stages of audio frequency amplification may be incorporated in a suitcase and used with a loop aerial to very good advantage. Standard parts may be used in a set of this nature and circuits for the same have been published in past issues of RADIO NEWS. We regret to say that we do not have any blueprints covering a set of this nature.

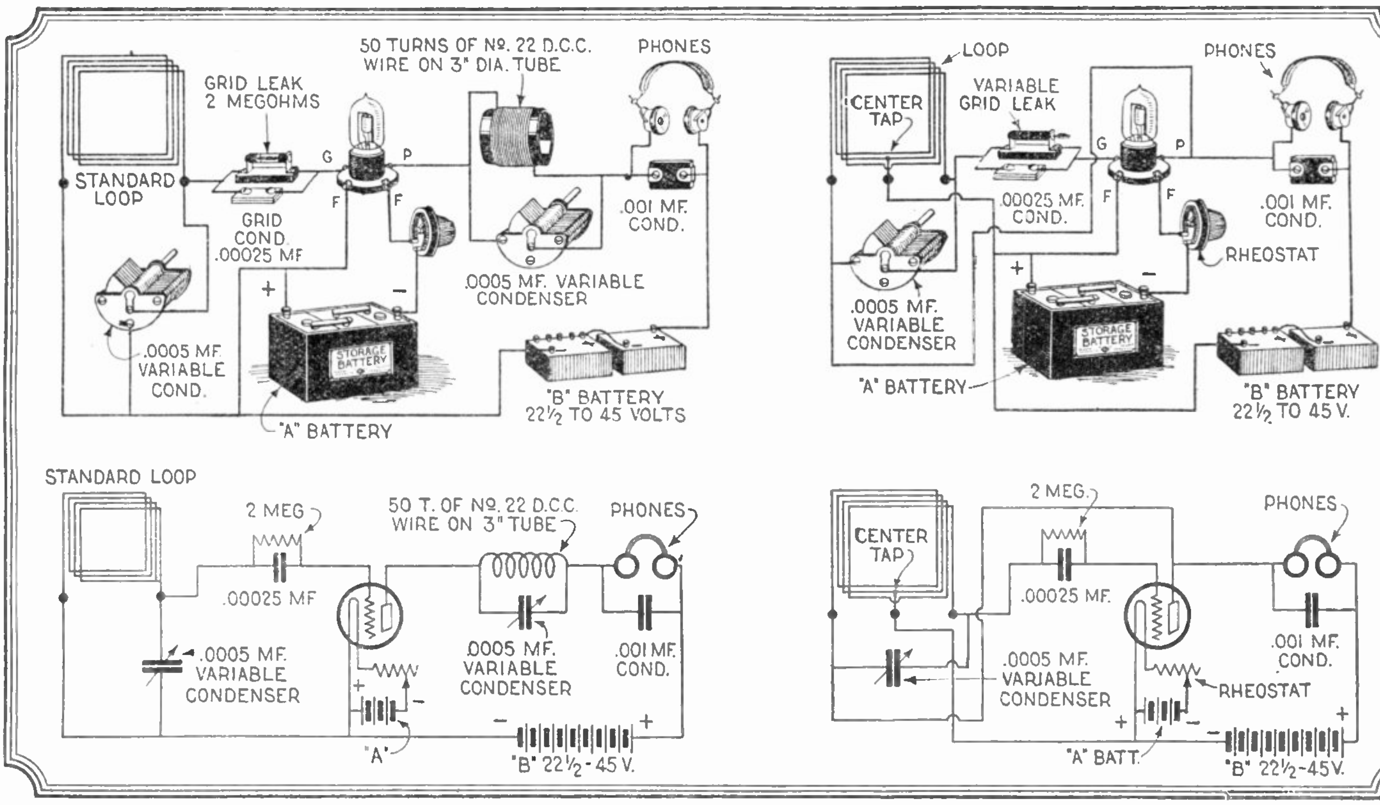


Fig. 43. Some very interesting results can be obtained with a single tube and a loop aerial when regeneration is employed to build up the signal strength. Two circuits for this work are given above. One uses a standard loop and the other a home-made type with a center tap.

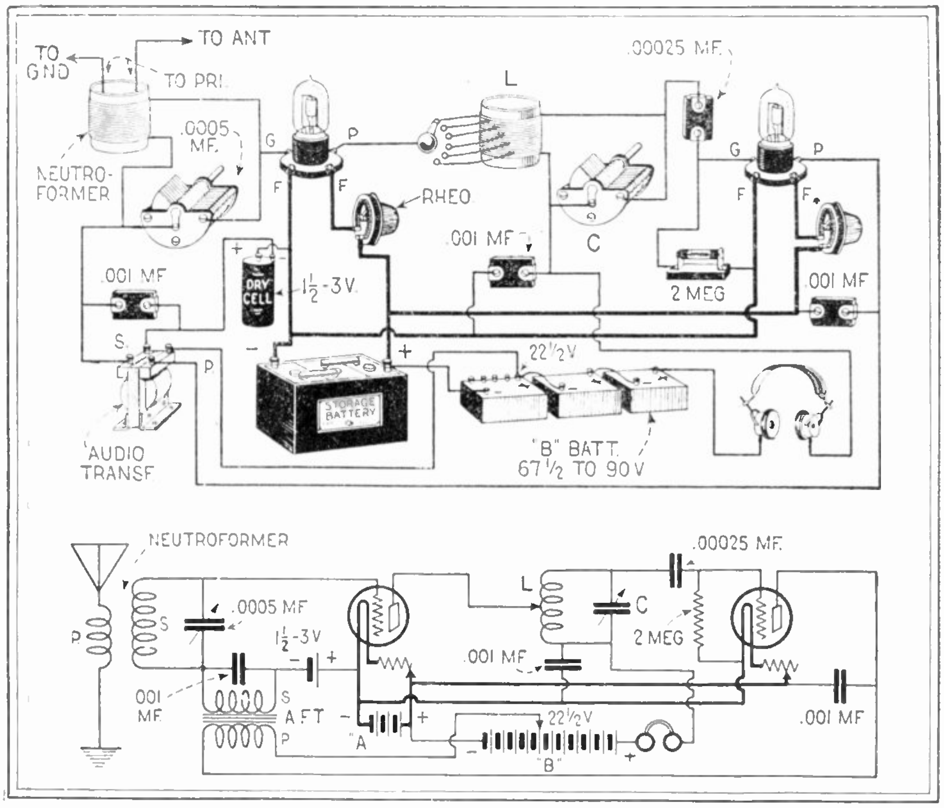


Fig. 50. Here is a novel type of two tube reflex receiver giving the effect of one stage of radio frequency amplification, detector and one stage of audio frequency amplification. Use good instruments in a set of this nature and you will be assured of good results.

REGENERATION

(48) Q. 1. Ivon Shepard, Temple, Okla., asks for a simplified review of the theory of regeneration.

A. 1. The general theory of regeneration is that the current in the plate circuit will produce a current in the grid circuit of the same tube, when the plate circuit is coupled to the grid circuit. This induced current causes the grid potential to vary, in phase with the fluctuations of the plate circuit. This results in amplification of the original current in the grid circuit. By balancing the losses of the circuit against the oscillation abilities of the tube, it is possible to produce the maximum amount of regeneration, which is the maximum amplifying characteristic of the tube, just before oscillation takes place. Oscillation of the tube circuit is usually undesirable in radiophone receiving circuits. Very nearly maximum regeneration is the most desired condition of the circuit but not so much should be used as to cause distortion.

INTERPLANETARY RADIO

(49) Q. 1. Felix Grandich, New York, N. Y., asks: When various attempts have been made to communicate with the planets by radio, is a ground connection used, and if so, why?

A. 1. In the proposition you mention, a ground or counterpoise must be used. The reason for this is that a condenser must be formed at the transmitting end and this is realized by the use of an aerial as one plate and the ground as the other.

Q. 2. Is the "radio roof" or Heaviside layer an accepted explanation for various vagaries of radio waves?

A. 2. The "radio roof" is still the subject of a mooted question among various radio experts and in our opinion, it is a quite probable explanation of the eccentricities of short waves.

REFLEX

(50) Q. 1. George Watkins, San Francisco, Calif., asks for a reflex circuit not employing a crystal detector but in which the first tube is tuned by a standard neutroformer and the detector circuit by the tuned impedance method.

A. 1. The required circuit will be found in illustration 50 as requested. The antenna circuit is tuned by a neutroformer and the coil, L, and the condenser, C, constitute the tuned impedance circuit for the detector tube. The coil, L, consists of approximately 60 turns of No. 22 D.C.C. wire on a 3½-inch tube and the winding should preferably be tapped every 10 turns; the amount of inductance in the plate circuit is controlled by means of a switch. The condenser, C, has a capacity of .0005 mf. The rest of the instruments in this circuit are standard.

REFLEX TROUBLE

(51) Q. 1. Edward Evers, St. Louis, Mo., says that he has built a reflex circuit but cannot get any results with it. He describes his trouble and our composite reply is given below.

A. 1. We give you the following suggestions in order to clear up the difficulty you are experiencing with your receiver. Try removing the by-pass receiver across the phones. It may be shorted. Make sure that you have a sensitive crystal. Perhaps your sole trouble is due to a very poor contact on the crystal or that it is entirely worthless. Clean the tube contacts, tighten up the variable condenser bearings, blow off the dust from the plates, see that the connections are tightly soldered and make sure that you are using a good grid leak. Try increasing the plate voltage to the amplifier tube and try reversing the polarity of the "A" battery.

EXPERIMENTAL LOOP RECEIVER

(52) Q. 1. Wm. H. Schwingel, Dansville, N. Y., has a Neutrodyne receiver on hand and desires to make up another set with a loop aerial that can be used for experimental purposes. He asks our advice as to the best type of circuit to employ in this experimental set.

A. 1. Possibly the best three-tube receiver for you to make up for experimental use on a loop antenna would be one using two stages of tuned radio frequency amplification and a vacuum tube detector. If you want to do so, you can convert your Neutrodyne so that it can be used on a loop by disconnecting the secondary or grid and filament connections of the first neutroformer and connecting the two terminals of the loop to the set. In other words, the loop is connected in place of the secondary of the first neutroformer. The variable condenser is left in the circuit and will be found to be connected across the loop. The condenser will then tune the loop circuit in the same way as it formerly tuned the first radio frequency circuit.

A satisfactory loop may very easily be home-made. No special precautions are necessary as insulated wire is usually used, but if you desire to make it of the most efficient type, provide hard rubber or bakelite spacers for the wires.

RADIO PHONE AND CODE RECEPTION

(53) Q. 1. Winston Clay, Kansas City, Mo., asks whether or not the same type of radio receiving set can be used for receiving radio broadcasting and also receiving code.

A. 1. There is no difference between a receiving set which will receive broadcasting and one which will receive code signals.

S.L.F. CONDENSERS

(54) Q. 1. Frank Allen, Atlanta, Ga., asks: If I changed my present type of straight-line capacity condenser for one having a straight-line frequency curve, can I expect any greater selectivity from my receiving set? The set under discussion is of the three-circuit type.

A. 1. Generally speaking, you cannot expect to increase the selectivity of an inherently broad tuning set by the mere addition or substitution of an S.L.F. condenser for an S.L.C. type. The only thing that an S.L.F. condenser will do for you will be to spread out the shorter wavelength stations so that they can be more easily separated. It will change the relative positions of stations on the dial as compared to an S.L.C. condenser, and it will, furthermore, tend to bunch the high-wave stations closer together than they were formerly. At this point it is found that an S.L.F. condenser will be a detriment in a broad-tuning set because the higher power stations on the high waves will cause more interference with each other, when an S.L.F. condenser is used. However, for average sets, an S.L.F. condenser is an advantage, inasmuch as it allows better reception of short wavelength stations.

LOCATION

(55) Q. 1. Wm. F. Shollenberger, Lebanon, Pa., says that in his particular locality few of the receiving sets can tune in Philadelphia stations. He asks whether this trouble can be banished and also wants us to recommend some type of radio receiving set to him.

A. 1. Very possibly the fact that few if any of the people in your town can tune in Philadelphia is because of local conditions. Such conditions cannot be changed. Since you say that you know little about radio, we would suggest that you purchase a complete set ready made. An excellent type is what is known as the three-circuit tuner with a detector and two stages

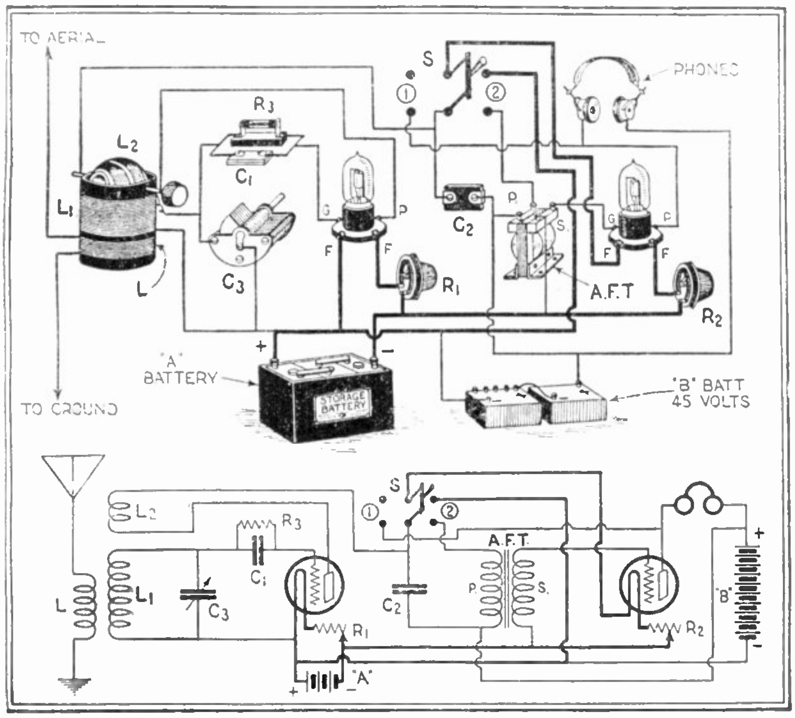


Fig. 59A. With the circuit diagram shown above, it is possible to employ either one or two tubes and to automatically control the amplifier tube filament.

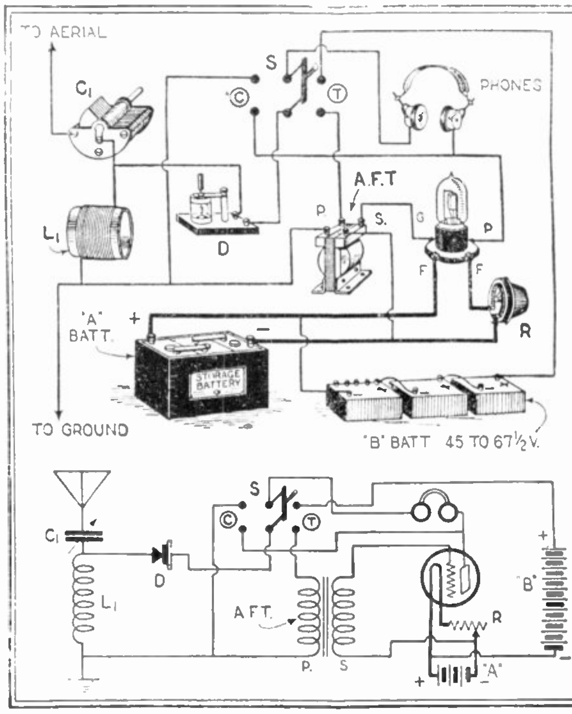


Fig. 59B. With this system, the crystal detector may be used alone, or by means of switch S it may be used with an amplifier.

of audio frequency amplification. Such a set can be used on an ordinary outside aerial that any of your friends can show you how to erect and it will give excellent results.

CONSTANT FREQUENCY

(56) Q. 1. J. K. Windell, Charleston, W. Va., asks whether or not it is possible to use the characteristics of a vacuum tube to maintain a tuning fork in vibration at a constant frequency.

A. 1. This is entirely possible and the diagram given in Fig. 56 shows the connections for this work. This system is patented and is used extensively in electrical testing work. The tuning fork is driven by means of two electromagnets, A and B, which may be taken from ordinary 75-ohm receivers in order to set up this circuit for experimental use. This circuit is not self-starting, but the tuning fork must be vibrated first in order to set up currents in the vacuum tube circuit. By doing this, the movement of the upper prong induces a current in the grid coil. This, of course, starts up a momentary plate current which causes the magnet in the plate circuit to attract the other prong. This action takes place many times per second, the exact number depending upon the natural frequency of the tuning fork. In the circuit shown, an ordinary audio-frequency transformer is employed so that instruments under test or circuits to be tested can be connected into the circuit without disturbing the constants of the vacuum tube and tuning fork circuit itself.

It is interesting to note that several amateurs have experimented considerably with this system of maintaining a constant frequency for use in transmission. The results have been very gratifying.

SUPERHETERODYNES

(57) Q. 1. M. David, Johannesburg, S. Africa, says that he has noticed circuits of several Superheterodyne receivers in various publications and that they all appear to be a little different from each other. He asks if the one appearing in the April, 1925, issue of *Science and Invention* is correct, as it, too, appears to be somewhat different from others.

A. 1. There are several different types of Superheterodyne hook-ups and in most of them there are small differences in the connections of the oscillator. The one that you mention as appearing in *Science and Invention* is correct and will give good results.

Q. 2. How should I wind intermediate frequency transformer?

A. 2. The winding of intermediate frequency transformers is a rather difficult and tedious process. Furthermore, the results obtained are seldom satisfactory, due to inaccuracies in windings. We would advise you to purchase a set of these coils ready made.

LACK OF VOLUME

(58) Q. 1. Lewis Doty, Cleveland, Okla., is using a receiving set of the Reinartz type from which he does not get as much volume as he desires. He is only using 67½ volts on the amplifiers and desires to know how the volume can be increased.

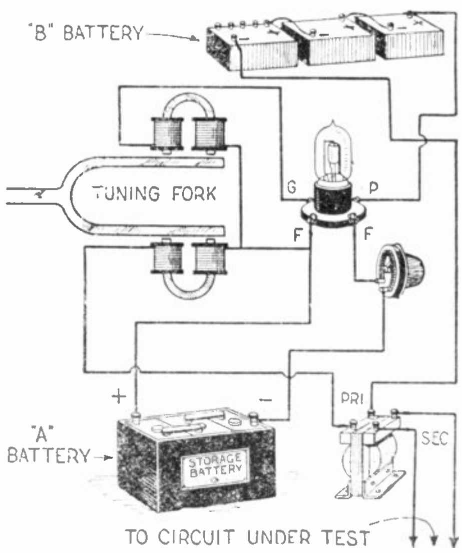


Fig. 56. A system for maintaining a constant frequency, using a tuning fork and a vacuum tube, is shown above.

A. 1. Increase the "B" battery potential to 90 volts. An extra stage of audio-frequency amplification can be added. Inasmuch as you employ UV-199 tubes, you cannot expect great volume.

Q. 2. Can a loop be used with this set?

A. 2. It is advisable to use an aerial and ground instead of a loop which at best will work only on local stations.

DUPLEX CIRCUITS

(59) Q. 1. Albert King, Bronx, N. Y., asks: Kindly show two-circuit diagrams by means of which the following effects can be obtained. (A) Show how two tubes can be hooked up with a single double-pole double-throw switch so that either the regenerative detector tube can be used alone or so that the detector and one stage of audio-frequency amplification can be employed. This should be arranged so that the filament circuit of the audio tube will be automatically extinguished when the detector is being used alone. I do not want to use jacks. (B) Show a standard single coil crystal detector circuit, with one stage of audio-frequency amplification, and a double-pole double-throw switch so arranged that the crystal detector can be used either alone or with the amplifier. In this case the tube need not be extinguished automatically as this will be controlled by a push-pull switch.

A. 1. The requested circuit diagrams are given in these columns. Referring to Fig. 59A, all of the constants are standard. L, L1 and L2 are a standard three circuit tuner. C has a capacity of .00025 mf., R1 and R2 are rheostats. R3 is a 1 to 5 megohm grid leak, C2 has a capacity of .001 mf. and S is a double-pole double-throw switch. When the switch is thrown to position 1, the detector is used alone and when in position 2, both tubes are employed and the filament of the second tube is lighted.

In Fig. 59B, the requested crystal circuit is shown. C1 may be a .0005 mf. condenser, L1 a standard tuning coil to cover the broadcast wave-length band, D, the

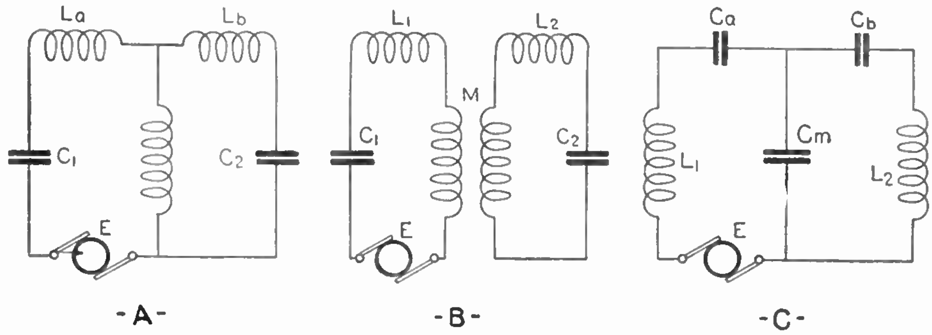


Fig. 61. The three types of coupling used in transferring energy from one circuit to another are shown above. A indicates the type known as direct coupling, where the circuits are connected together by conductors. B illustrates inductive coupling, while C represents capacitative coupling.

crystal detector and 5, the switch. At position C of switch S, the crystal is used alone and at position T, the vacuum tube is used as an audio-frequency amplifier for the crystal detector. With the latter combination good quality is had with increased volume.

"LC" TABLE

(60) Q. 1. Louis Terrin, Washington, D. C., asks: Kindly give the LC values to be used in tuning units from 10 to 500 meters. Also a list of the corresponding frequency in kilocycles of various wavelengths.

A. 1. The table appended gives all the required information. The value LC is the product obtained by multiplying the inductance of a coil in microhenrys by the capacity of a shunt condenser in microfarads. When using this table suppose that we have a condenser with a maximum capacity of .0005 and we desire to obtain the inductance of a coil that will enable us to tune to a maximum wavelength of 200 meters with maximum condenser capacity. Referring to the table, we find that the LC value for 200 meters is .01126. Dividing this by the maximum capacity of the condenser or .0005 mf., we find that the coil to be used with this particular condenser should have an inductance of 22.5 microhenrys.

TYPES OF COUPLING

(61) Q. 1. F. White, Baltimore, Md., asks how the current in the primary circuit of a radio set gets to the secondary circuit.

A. 1. There are three methods by which a change in voltage in one circuit may be made to cause a corresponding change in another circuit coupled to it. The three methods are shown in the diagram Fig. 61.

MEASURING SMALL CURRENTS WITH THE VACUUM TUBE

(62) Q. 1. Mrs. R. E. Garriett, Pittsburgh, Pa., inquires if there is any known method of measuring extremely small currents with accuracy.

A. 1. Although it is not a matter of general knowledge, laboratory tests have shown that the vacuum tube is a valuable instrument of precision for use in measuring currents almost infinitesimally small. Fig. 62A on the next page shows one of the circuits developed by the bureau of Standards for this purpose. The coil, L, is inductively coupled to the circuit which carries the current to be measured, while a sensitive galvanometer is connected in series with detector D. A local current is generated by the oscillation of the vacuum tube circuit, the frequency of which is regulated by the tuning condenser C. A note is produced in the telephone, T, by the beats between the impressed and the local currents. The condenser C4 must be adjusted for maximum deflection of the galvanometer.

L. W. Austin, in the *Journal of the Washington Academy of Science* states his conclusion that the deflections are proportional to the square of the high frequency current flowing in the circuit being measured. This also means that the current in the telephone is proportional to the first power of the high frequency current. This law holds only for the oscillating condition. When the audion is not oscillating, the deflections are approximately proportional to the fourth power of the high frequency current.

This constitutes a method of remarkable sensitiveness for measuring small high frequency currents. Austin found that for signals of minimum audibility on the simple audion, the oscillating audion gave audibilities 300 to 1000 times as great; that is, it would measure currents hundreds of times smaller. For convenience in measuring radio currents received from distant stations, the shunted telephone is used in connection with the oscillating vacuum tube. The arrangement shown in Fig. 62B is that used by Austin in this type of work. The shunt, S, is used on the telephone T2. The audibility is approximately proportional to the current in the antenna. The sensitivity is always measured at the time of use in comparison with a silicon detector and galvanometer, which combination is in turn calibrated by comparison with a thermo element. This arrangement has been used to make quantitative measurements on undamped waves from radio stations 4000 miles away, the least high-frequency current detectable in the receiving antenna being .000000004 ampere.

INTERFERENCE ELIMINATION

(63) Q. 1. Mr. A. L. Brown, New York, N. Y., writes us for information regarding the elimination of interference in the congested districts of the metropolitan area.

A. 1. On the next page in Fig. 63 is shown a series of diagrams illustrating the best approved methods of eliminating undesired signals. The first diagram shows an "Acceptor" circuit, where the auxiliary coil and condenser are tuned to the wanted signal, thus tending to raise it above the interference level. The second coil and condenser in parallel "reject" the undesired signal by trapping it and preventing it from energizing the antenna circuit of the set. The third circuit by passes the undesired signal to the ground, while the primary circuit of the set may tap off any desired frequency. The fourth, "Absorbtion" circuit, utilizes the principle of the fourth circuit in the Cockaday set, in vogue a year or so ago. The fifth is a "Relay" circuit, where the antenna is tuned and an intermediate trap is used between the receiver and antenna circuit. The sixth circuit illustrates one of the most efficient methods of tuning a set which is equipped with an aperiodic primary. The seventh circuit is that employed by the designers of a commercial filter called the "Filterola." The makers claim that the signal is amplified, with the usual elimination of undesired frequencies. For the broadcast wave lengths the coil and condenser used in these trap circuits may conform in each case to the following specifications: The coil, 55 turns of No. 26 double silk covered wire on a 3-inch form; the condenser, .00035 or .0005 mf. low-loss variable. The better the construction of the coil and condenser, the better the results to be expected.

Chart for Determining the Wave-length, Frequency and LC Value for Radio Frequency Circuits

(L is in microhenries and C in microfarads.)

Wave Length (Meters)	Frequency (Kilocycles)	LC Value	Wave Length (Meters)	Frequency (Kilocycles)	LC Value	Wave Length (Meters)	Frequency (Kilocycles)	LC Value
10	30,000.00	.0000282	65	4,615.00	.001188	230	1,304.00	.01489
11	27,273.00	.0000340	70	4,286.00	.001378	235	1,287.00	.01555
12	25,000.00	.0000405	75	4,000.00	.001583	240	1,250.00	.01622
13	23,076.00	.0000476	80	3,750.00	.001801	245	1,255.00	.01690
14	21,426.00	.0000552	85	3,529.00	.002034	250	1,200.00	.01760
15	20,000.00	.0000634	90	3,333.00	.002280	255	1,177.00	.01831
16	18,748.00	.0000720	95	3,158.00	.002541	260	1,154.00	.01903
17	17,646.00	.0000813	100	3,000.00	.002816	265	1,132.00	.01977
18	16,667.00	.0000912	105	2,857.00	.003105	270	1,111.00	.02052
19	15,788.00	.0001016	110	2,727.00	.003404	275	1,091.00	.02129
20	15,000.00	.0001126	115	2,609.00	.003721	280	1,071.00	.02207
21	14,284.00	.0001241	120	2,500.00	.004052	290	1,034.50	.02366
22	13,635.00	.0001362	125	2,400.00	.004397	295	1,017.00	.02450
23	13,042.00	.0001489	130	2,308.00	.004757	300	1,000.00	.02533
24	12,500.00	.0001622	135	2,222.00	.005130	310	967.70	.02705
25	12,000.00	.0001755	140	2,144.00	.005518	320	937.50	.02883
26	11,538.00	.0001903	145	2,069.00	.005919	330	909.10	.03066
27	11,110.00	.0002052	150	2,000.00	.006335	340	882.40	.03255
28	10,713.00	.0002207	155	1,935.00	.006760	350	857.10	.03448
29	10,343.00	.0002366	160	1,875.00	.007204	360	833.80	.03648
30	10,000.00	.0002533	165	1,818.00	.007662	370	810.90	.03854
32	9,374.00	.0002883	170	1,765.00	.008134	380	789.50	.04065
34	8,823.00	.0003255	175	1,714.00	.008620	390	769.20	.04277
36	8,333.00	.0003648	180	1,667.00	.009120	400	750.00	.04503
38	7,894.00	.0004065	185	1,622.00	.009634	410	731.70	.04733
40	7,500.00	.0004503	190	1,579.00	.01016	420	714.30	.04966
42	7,143.00	.0004966	195	1,538.00	.01071	430	697.70	.05204
44	6,818.00	.0005446	200	1,500.00	.01126	440	681.80	.05446
46	6,522.00	.0005960	205	1,463.00	.01183	450	666.70	.05700
48	6,250.00	.0006485	210	1,429.00	.01241	460	652.20	.05960
50	6,000.00	.000704	215	1,395.00	.01301	470	638.30	.06219
55	5,454.00	.000852	220	1,364.00	.01362	480	625.00	.06485
60	5,000.00	.001014	225	1,333.00	.01425	490	612.20	.06759
						500	600.00	.07039

The chart for determining wave-length, frequency and LC values often comes in handy for use in various radio calculations. Clip this table out and keep it for reference.

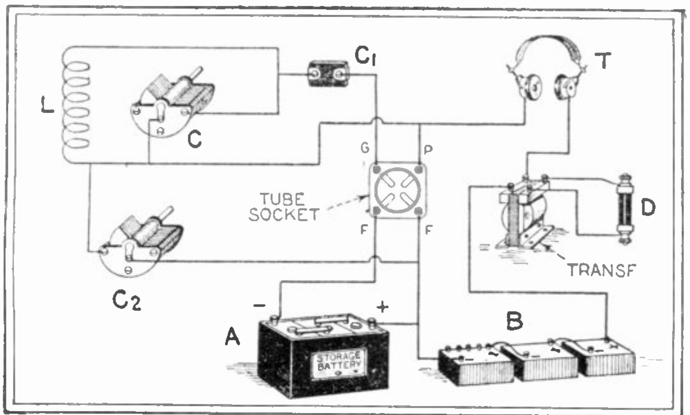


Fig. 62A. One of the circuits used by the Bureau of Standards in the measurement of currents too small to actuate the ordinary measuring apparatus.

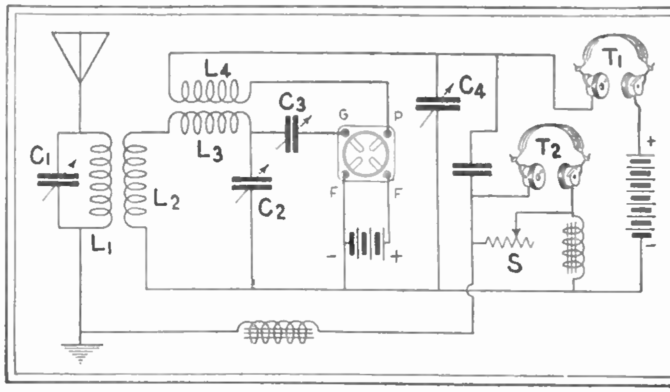


Fig. 62B. This hook-up is designed to be used in measuring the amount of energy received from transmitting stations at distances as great as 4,000 miles. The station is tuned in by using phones T1, while T2 is used for measurements.

NEUTROFORMER DATA

(64) James Rubbenrout, Atlanta, Ga., says that as a last resort he is writing to us for all information concerning data pertaining to the winding of neutroformer coils. It seems that all those parties whom he has asked disagree as to the number of turns that should be employed in the primary winding. He asks:

Q. 1. I want reception from 200 to 600 meters, that is to cover all broadcasting wave-lengths. How can I accomplish this?

A. 1. For the most efficient neutroformer a self-supporting coil, wound with a large size wire such as No. 12, silver-plated to reduce skin effect and which winding is staggered, similar to the winding of a low loss coil, should be used. However, as there are too many technicalities to be overcome in the construction of such a coil, the nearest approximation to it can be obtained by using a secondary tube which measures three inches in diameter and whose winding will consist of 65 turns of No. 22 double cotton covered pure copper wire. The primary will be 2¾ inches in diameter and should be wound at one end with 15 turns of No. 18 double cotton covered wire. Both tubes should be 3½ inches long and of a non-porous, non-hygroscopic, non-absorptive insulating material such as bakelite or a very good grade of formica. If at all necessary, the coil should be impregnated with collodion. The secondary has a tap taken off at the 15th turn. This tap connects with the neutralizing condenser.

Q. 2. Can you show me how to hook up a Magnavox loud speaker as a detectaphone?

A. 2. A two-stage amplifier from any radio set is used, the input being directly connected to the Magnavox. A pair of phones are connected to the output.

A QUALITY SUPERHETERODYNE

(65) Mr. Geo. Taber, Cornwall, N. Y., asks:

Q. 1. I am desirous of constructing a superheterodyne combining the latest type of R.F. amplification with an audio amplifier designed for quality reproduction. Could you supply me with complete information and schematic wiring diagram of such a receiver, employing preferably 9 tubes, with push-pull amplification in the last stage?

A. 1. As we all know, a superheterodyne is considered the most sensitive set yet developed, and, if good results are to be obtained, it must be so designed that it is not encumbered with internal parasitic noises. Then again, a set of this type must possess unusual selectivity to overcome the terrific congestion on the present-day broadcast waveband. Another drawback, due to the exceptional sensitivity of a good superheterodyne, is that the input energy of the audio amplifier is excessive when receiving local stations. Nearly all audio amplifiers, and even the second detectors in these sets, are incapable of holding such a great amount of energy without serious distortion. These are but the few of the problems which have come up in relation to superheterodyne receivers.

The superheterodyne we are about to describe was designed by Mr. A. E. Poté and originally described by him in the New York *Herald-Tribune*. In this receiver an entirely new form of I.F. amplification is employed. Reference to the schematic diagram will show that the I.F. amplifier is of the choke coil-impedance-coupled type, very similar to an ordinary impedance-coupled audio amplifier, R.F. chokes having a value of 500 millihenries are used in the plate circuits of the three I.F. tubes V2, V3 and V4 and the first detector tube V1. Standard-type resistors R1, R2 and R3 are used in the grid circuits.

This particular I.F. amplifier is not peaked at any one frequency; in other words, it is perfectly impartial to all frequencies and will amplify one equally as well as another. To put it in another way, this type of amplifier has no selectivity whatsoever. It would seem that we are losing efficiency and selectivity here; however, here is where the band-pass filter or filter transformer comes into play. This filter, indicated as L5 in the diagram, is tuned to 45 kc. and allows a 10,000-cycle band of frequencies to pass. This includes just the normal audio frequency band which we desire to get through and no more. The filter is connected in the usual manner in the input circuit of the second detector tube V5.

Referring to the schematic wiring diagram Fig. 65, the antenna circuit is tuned to a signal and the oscillator circuit adjusted to produce a beat-frequency of 45 kc. This frequency is passed through the first detector tube V1 and amplified in the I.F. amplifier; but this will amplify any other intermediate frequency just about as well as 45 kc. As mentioned above, there is no selectivity whatsoever present in these stages. The band-pass filter now separates the 45 kc. from all the rest of the frequencies and lets it pass through, with 10,000 cycles on each side of it, to take care of speech and music. In this manner all of the selectivity is gained by the use of the band-pass filter, without any of the usual trou-

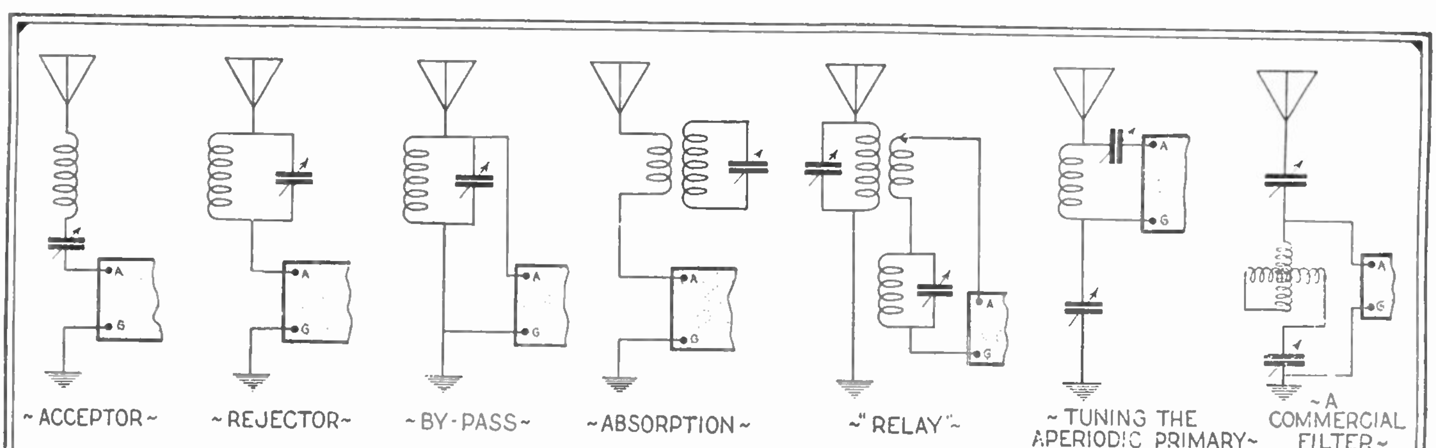


Fig. 63. The seven circuits illustrated in the diagram above cover the basic principles used in the design of interference eliminators or wavetraps. It will be found that each type is best suited to a condition, and a judicious selection is possible only after a reasonable amount of experimentation. In most cases the absorption filter will be found sufficiently practical for use in all but the most congested localities.

bles experienced when employing tuned or untuned transformers which are hard to stabilize.

No potentiometer or other form of oscillation control is used for stabilizing the I.F. amplifier; nothing of this sort is necessary, since the tubes are operated at maximum efficiency at all times and work with a negative bias on the grids. As stated before, the band-pass filter is tuned to a frequency of 45 kc. This was found to be about the best point of operation,

quencies, an R.F. choke L2 having a value of 85 millihenries is connected in the plate circuit of the first tube to keep the R.F. currents out of the amplifier circuits.

A choke of 85 millihenries is also connected in the oscillator "B" battery lead, to keep the oscillator currents out of the common battery circuit. Two more chokes L4 of 500 millihenries are used in the common plate and grid leads of the intermediate amplifier to keep any of the I.F. currents from leaking into the bat-

course, I understand, is common with superheterodyne receivers. Nevertheless, I wonder if there is some conventional means of installing a wave trap, or some other absorbing system, by which the second reading could be eliminated. This would allow me to obtain other stations, as the present dial reading on the oscillator condenser for various stations leaves me no room to obtain distant reception.

A. 1. A means for eliminating the double reading on the oscillator dial ob-

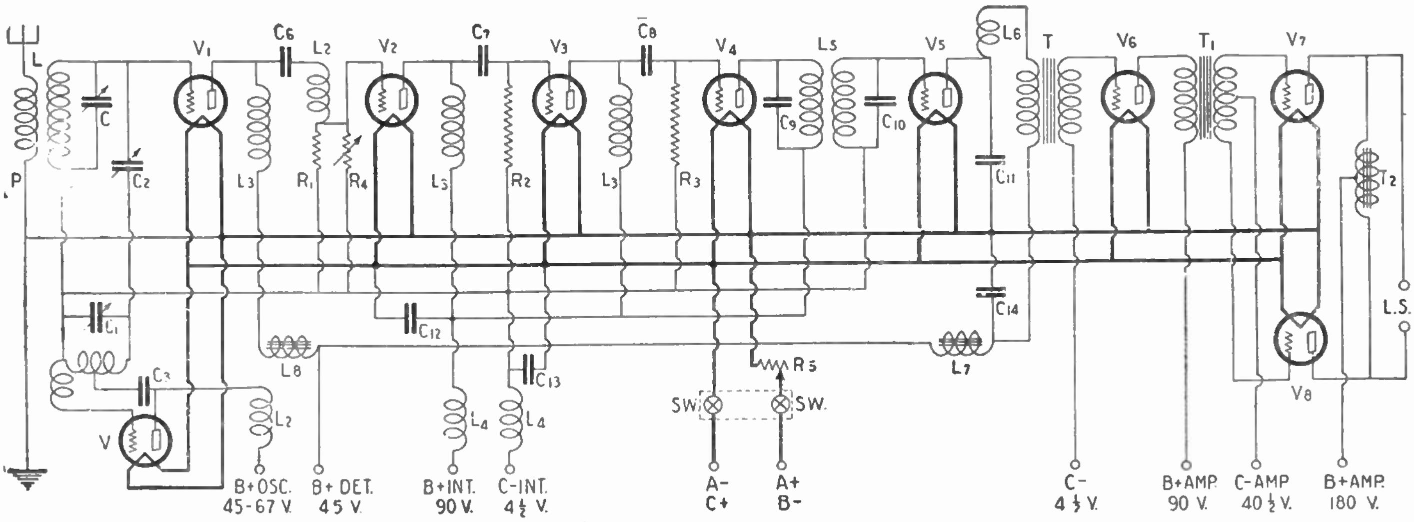


Fig. 65. Circuit of an improved superheterodyne which employs impedance-coupled intermediate-frequency amplifiers and a push-pull audio amplifier.

but it is obvious that, since the choke-coupled amplifier itself is not tuned to any definite intermediate frequency and amplifies one band as well as the next, the band-pass filter can be tuned to some other frequency if it is found desirable. This can easily be done by altering the values of the fixed condensers C9 and C10, which in this particular case are .001-mf.

The A.F. circuit is rather unique. This superheterodyne is so sensitive that it was found necessary to employ plate rectification in the second detector tube V5 in order to eliminate distortion due to overloading. Consequently the grid leak and condenser were dispensed with and the grid return of this tube run to a "C" battery having a negative value of 4½ volts. Incidentally, the same "C" battery is used to bias the grids of the I.F. tubes. The audio amplifier consists of one stage of transformer coupling and a push-pull stage using two power tubes of the 171 type. The reason for this arrangement is the fact that, when not more than one stage of transformer amplification is used, distortion is practically eliminated without decreasing the volume perceptibly.

Semi-power tubes of the 112 type could be used in the push-pull stage of this receiver, but they are not large enough electrically to handle the load. The 171 tubes, however, are perfectly satisfactory; the two of them used in this manner are equal to a power tube of the 210 type and will require only 180 volts of "B" battery. It will be noted from the diagrams that a push-pull impedance T2 is used at the output, rather than another push-pull transformer. This is by far the best method; this is the first time it has been employed in an audio amplifier. It takes the place of the usual type of output impedance or output filter and, in one sense, it is a cheaper arrangement, as no blocking condenser is required.

All the tube filaments are controlled by a single power rheostat R5, as there is no necessity for critical filament adjustments. The volume is controlled by a 500,000-ohm variable resistor R4 connected across the grid resistor of the first I.F. tube V2. Since the choke-coil I.F. amplifier is capable of amplifying high fre-

tery circuit; also two A.F. chokes, L7 and L8, to keep the A.F. currents where they belong.

The following is the list of parts necessary for the construction of this receiver:

1 antenna coupler, L;
1 double-wound oscillator coupler;
3 I.F. impedances, L3;
2 chokes, 500-millihenry, L4;
2 chokes, 85-millihenry, L2;
1 band-pass filter, 45 kc., L5;
1 R.F. choke, 250-millihenry, L6;
1 A.F. choke, 30-henry, L7;
1 A.F. choke, 3.5-henry, L8;
2 variable condensers, .0005-mf., C, C1;
1 neutralizing condenser, 45-mmf., C2;
2 by-pass condensers, .001-mf., C3, C12;
4 fixed condensers, .002-mf., C6, C7, C8, C11;
2 fixed condensers, .001-mf., C9, C10;
1 by-pass condenser, 1-mf., C13;
1 by-pass condenser, 4-mf., C14;
1 by-pass condenser, 2-mf., C15;
3 resistors with mountings, .05-megohm,
1 audio transformer, T;
1 push-pull transformer, T1;
1 push-pull impedance, T2;
1 voltmeter, 0-8 volts;
1 switch, D.P.S.T.;
7 vacuum tubes, type 201-A, V, V1, V2, V3, V4, V5, V6;
2 vacuum tubes type 171, V7, V8;
9 sockets, UX;
1 Seven-wire battery cable and plug;
2 tip jacks for loud-speaker connection;
2 binding posts (antenna and ground);
2 vernier dials;
1 bakelite panel, 8x24;
1 sub-base panel, 11x23;
2 mounting brackets;
1 roll of flexible hook-up wire.

ELIMINATING OSCILLATOR DOUBLE-READING EFFECT

(66) Mr. L. Miller, Brooklyn, N. Y., asks as follows:

Q. 1. I have a superheterodyne receiver which I feel sure would be very efficient and satisfactory, if it were not for the double-place-reading effect obtained on the oscillator dial. This, of

tained on all superheterodyne receivers has been completely described in the Saturday Radio Section of the New York *Sun*. We are reprinting below the description of this device, and feel sure that the information will be of much value to superheterodyne set users who experience the same difficulty as Mr. Miller.

"The floating-beat-note hook-up, an automatic frequency-changing system, is put forward as a cure for the one fault of that king of all receiving sets, the superheterodyne. It does away with the double-beat note, that inherent and annoying habit of the super in bringing in a station at two different points on the oscillator dial.

"Like Venus, the superheterodyne was born into this world all but perfect. Either by accident or a *tour de force* on the part of its inventor, Major E. H. Armstrong, it emerged from his laboratory in Paris in 1918 in so mature a form that it has been susceptible to little improvement since. Unlike other receiving circuits of note in this rapidly changing period of radio art, it continues to increase in vogue. Of the true super, it can be said it will do anything any other set will do, and throw away the antenna to boot. That is, it will do anything on a small loop that any other set can do on a good antenna. And, in addition, it possesses an inherent degree of selectivity never attained by any other combination of tuned circuits.

"But—there is the fly in the ointment—the double-beat note. A station will come in equally well at two points on the oscillator dial. And the upper beat note of one station will very frequently collide with the lower beat note of another station, or vice versa, and very seriously upset, by this interference factor within the receiver, the much-prized selectivity. So serious may this double-beat-note trouble become that different wave-length transformers are recommended for different locations.

"Prof. Walker Van B. Roberts of Princeton, originator of the popular Roberts set, said in one of his writings how nice it would be if all broadcasting stations in the country were on the same wave-length and at the same time couldn't interfere with each other! In such a radio paradise one could design a receiver for a single frequency without any compromises and it would always work at its best. Having said so much, Prof. Roberts went on to say that this is just what the super-heterodyne does—it reduces the signals of all stations to a single frequency and then passes them on to a detector and amplifier built to handle only that frequency. It is the 'frequency changer' of the super that accomplishes this miracle: the rest of the super is merely a fine receiver, with two, three or four stages of fixed radio frequency, a detector and one or two stages of audio. Taken from this point of view, the super is not such a complicated animal.

Function of "Super"

"How the frequency changer works is shown schematically in Fig. 66-B. First, let us say the receiver is designed to function at 6,000 meters, or 50 kilocycles. Properly designed, it will respond to this wave-length and no other, within easily-controllable limits. That is where the selectivity of the super comes in.

"The frequency changer, which is to change all wave-lengths within its tuning range into one (that of 6,000 meters or 50 kilocycles), consists of a so-called 'first detector' and a 'heterodyne,' or oscillator. The first detector receives the tuned signal

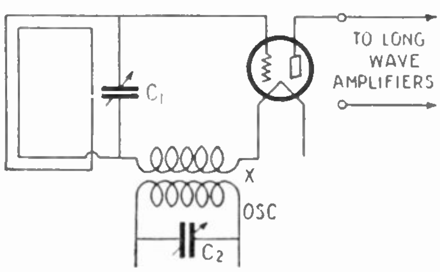


Fig. 66B. How the frequency changer of a super-heterodyne is shown in this schematic diagram.

from the loop, like any other single-circuit tuner, being tuned by C1. The 'heterodyne' is merely a second tube in an oscillating condition, like an ordinary regenerator that has spilled over. This tube is tuned by C2, not to the signal itself, but to 50 kilocycles above or below the signal. Let us say that C1 is tuned to 600 kilocycles (500 meters), then C2 would be tuned to 550 or 650 kilocycles. These signals are mixed together on the grid of the first detector tube through the coupler X, the oscillations cancelling each other out until there are only 50-kilocycle frequencies left: the output of this tube thus becomes 50 kilocycles. Thus we have taken a signal of 500 meters and, by a simple process of subtraction, we have changed it into a signal of 6,000 meters to pass on to our one-wave-length receiver.

"These are the only tuning controls there are on a super: one for wave-length and one for the heterodyne. The first dial is very broad, like any other single-circuit tuner; the second is as sharp as a razor, unlike any other tuner known. The heterodyne dial has, as we have stated, the single weakness of a double-beat note: that is, it can be tuned either above or below the frequency of the signal, so long as the difference between the two frequencies remains 50 kilocycles,—or whatever wave-length the receiver is designed for.

"The floating-beat-note system is suggested as a means of doing away, not only with the heterodyne dial itself, but also with the troublesome double-beat note. It accomplishes this at a sacrifice of the inherent selectivity of the standard super-heterodyne. It is therefore necessary to add selectivity to the tuned signal itself, which may be done by using a stage of tuned radio frequency before the 'first detector.'

"A schematic diagram of the floating-beat-note device is shown in Fig. 66-A. Tube A is a radio-frequency stage, B is the 'first detector,' and C is a fixed oscillator (heterodyne), oscillating at the exact frequency for which the receiver is designed. Thus, in the above instance, tube C would be tuned to oscillate permanently at 50 kilocycles.

"Tubes A and C are connected in parallel across the tuned loop. The operation is as follows: the incoming signal, say of 600 kilocycles, is tuned by C1; this signal divides between tubes A and C equally. The half signal passing through tube A is amplified at radio frequency and rendered highly selective by C2, and passed on to the grid of tube B. The half signal passing through tube C is mixed with the fixed oscillations of this tube, 50 kilocycles in this instance. The output of this tube thus becomes automatically 600 minus 50, or 550 kilocycles, the same heterodyne value which would be achieved in a conventional super by manual tuning. The output, 550 kilocycles, is mixed up with the 600 kilocycles signal on the grid of tube B, through the coupler X, in the same manner as in Fig. 66-B.

Many Forms Possible

"Since this is accomplished by the use of a fixed oscillator, instead of the tuned oscillator, several interesting schemes for this fixed oscillator immediately suggest themselves to the experimenter. The fixed oscillations may be generated by: a separate local oscillator tube, as in the super, or an oscillating crystal. The latter method (*i.e.*, the quartz crystal) suggests the most interesting possibilities, though it also injects technical difficulties to tax any but the advanced amateur.

PICTURE DIAGRAM

(67) Mr. Clyde Council, Red Springs, N. C., asks:

Q. 1. Please publish the Radio Act of Congress of August 13, 1912. I understand this act contains the regulations covering radio communication.

A. 1. The act to which you refer takes up many pages in the booklet called "Radio Communication Laws of the United States," published by the Government Printing Office, Washington, D. C. This publication may be procured from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the price of 15c per copy.

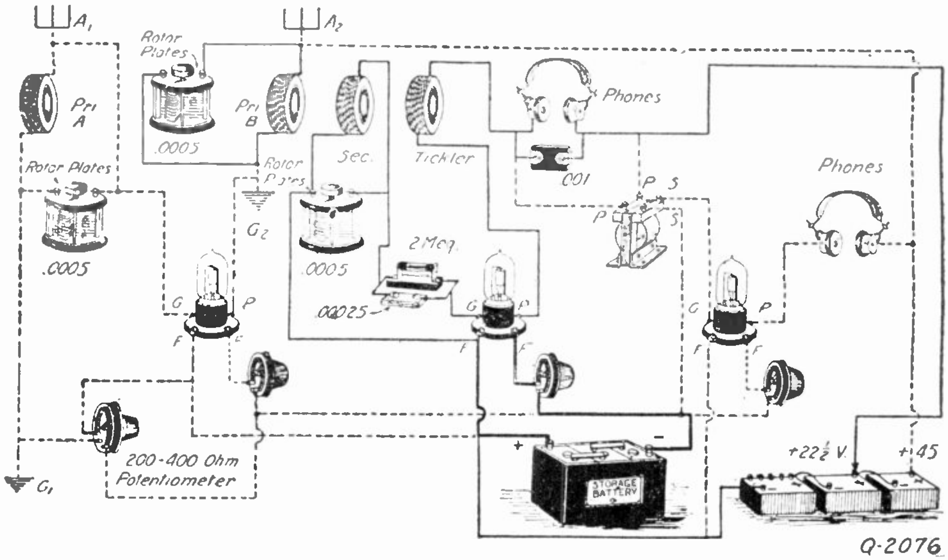


Fig. 67. Picture wiring diagram of three-tube regenerative receiver using honeycomb coils.

Q. 2. Please publish a picture diagram of the standard three circuit tuner, using honey-combs.

A. 2. This circuit will be found in these columns. The size of the honeycomb coils required may be readily determined from the following table of wave-lengths obtainable when standard honeycomb coils

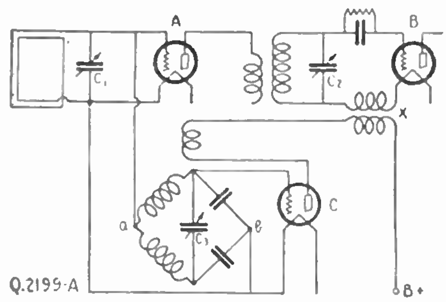


Fig. 66A. Schematic wiring diagram showing the floating-beat-note system used in some super-heterodynes.

are shunted by variable condensers of .001 mf. capacity. If condensers of .0005 mf. capacity are used, the maximum wave-length will be approximately half the value shown. The minimum value will be determined by the minimum capacity of the condenser used.

Number of Turns	Wave-Length
25	130—375
35	180—515
50	240—730
75	330—1030
100	450—1460
150	660—2200
200	930—2850
250	1300—4000
300	1550—4800
400	2050—6300
500	3000—8500
600	4000—12000
750	5000—15000
1000	6200—19000
1250	7000—21000
1500	8200—25000

If only the detector tube is used, the aerial and ground connect to primary B. If the radio frequency unit is added, the aerial and ground connect to a honey-comb coil placed in non-inductive relation to the other three honeycomb coils. Primary B then becomes the coupling coil that couples the output of the radio tube to the detector input.

If an audio frequency amplifier is added, there should be no difficulties. This method of adding an audio frequency amplifier unit may be applied to any set having the same battery connection system.

Popular Circuits

SIGNAL CORPS SUPERHETERODYNE

(68) Mr. M. E. Rachel, Dunlo, Pa., asks:

Q. 1. What is the Diode tube?

A. 1. This is a vacuum tube having only two elements—filament and plate. It is technically known as the Fleming valve, in honor of the inventor.

Q. 2. Will you kindly show the Signal Corps Super-Heterodyne circuit attributed to Jackson Pressley?

A. 2. We are showing the circuit diagram in Fig. 68. An oscillator, center tapped, is used having the correct values for the intermediate frequency transformers and loop used. The I. F. T. condenser values shown are correct for Ultraformers. Since the oscillator variable condenser is always at higher-than-ground potential, a grounded-frame condenser will be required to eliminate hand capacity.

The balancing condenser, BC, is adjusted in the following manner. Place the headphones in the circuit of the oscillator tube at "X" and place the oscillator dial at about the middle of the range. The loop tuning condenser and balancing condenser are then varied until the usual click is absent, or heard only faintly. Condenser BC may comprise three large plates, total, arranged as is the usual compensating condenser used to control resistance-coupled radio frequency amplifiers.

From a study of this diagram it will be seen that the bridge principle originally described in the August, 1924, issue of RADIO NEWS, in the article, "The Tropadyne Circuit," by Clyde J. Fitch, has been employed. In the latter circuit, the balance is obtained by means of a variable grid leak placed between the free end of the oscillator coil, and the filament. Since there are no capacities in shunt with the oscillator tuning condenser, in this design, a wider tuning range may be covered.

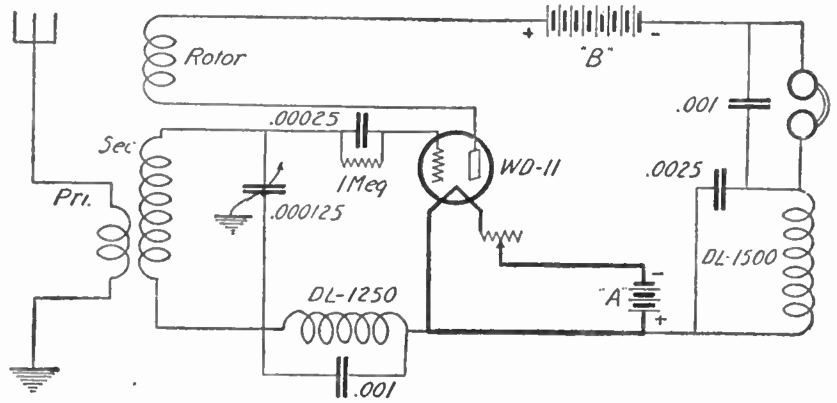


Fig. 69. Super-regeneration, or regeneration, at short wave-lengths? By a slight change, the experimenter has either available, at will. We will welcome reports, addressed to this department, on reception conditions in various parts of the world, at short wave-lengths.

Q. 3. What is an "electro-dynamic" loud speaker?

A. 3. A loud speaker having a coil of fine wire suspended in a strong electromagnetic field. The fine coil of wire is fastened to the diaphragm and connects to the output of the radio set. The strong electromagnetic field is created by connecting the winding of the electromagnet to a source of direct current. The field of the fine wire coil, produced by a received signal, reacts against the field of the electromagnet very strongly, producing a mechanical motion of the coil, and hence of the diaphragm also.

SUPER-REGENERATION

(69) Mr. Boyd Wilson, Toledo, Ohio, asks:

Q. 1. Do double grid tubes operate as well as single grid tubes?

A. 1. In the main, no. There are circuits where double grid tubes are of greater value than single grid tubes. The principle of the double grid tube is correct, but the great majority of these tubes are not made as perfectly as the three element tubes. The special construction of the better known three element tubes is not available to the present manufacturers of four element tubes.

For experimental purposes, the available four element tubes will usually be found satisfactory.

Q. 2. Is it possible to use Super-Regeneration on the short wave-lengths?

A. 2. It has been found that Super-Regeneration on the short wave-lengths seems to be a considerably better proposition than Super-Regeneration on the regular amateur or broadcast wave-lengths. The standard circuit will be found above in Fig. 69. The circuit used is that of the standard regenerative receiver with the addition of the coils DL-1250 and DL-1500, with their accompanying capacities. These two honeycombs are in variable inductive relation. When receiving short wave-lengths between 50 and 110 meters for the primary, six turns of No. 20 D.C.C. wire wound directly over the secondary will be satisfactory. The secondary may consist of about 15 turns of No. 24 D.C.C. wire wound on a three-inch form. It will be advisable to use some special form of low loss winding, such as the pickle bottle, spiderweb, honeycomb, lattice, or Morecroft type.

The winding method for the latter form of coil is similar to that shown on page 55 of the July, 1924, issue of RADIO NEWS. However, the method of using insulating strips should be applied to the secondary winding as well as to the primary winding. The tickler may be wound on a solid tube in a manner similar to the primary coil construction shown in the above mentioned article.

An application of this circuit will be found on page 32 of our contemporary magazine, QST, for October, 1924.

Q. 3. Is it possible to use a .0005 mf. grounded-frame condenser, to eliminate capacity effect, as the oscillator condenser of the Tropadyne, instead of the usual .001 mf. variable condenser?

A. 3. Yes. Instead of the usual 20 to 24 turns of No. 20 S.S.C. wire, for the plate, and 29 turns for the grid (3" tube), use 20 turns of No. 24 S.S.C. wire in the plate and 51 turns in the grid. Tap in the center. A standard two-coil (or a three-coil, if the primary is left unconnected), vario-coupler may be used with increased efficiency. The fixed resistance should be between ¼ and ½ megohm.

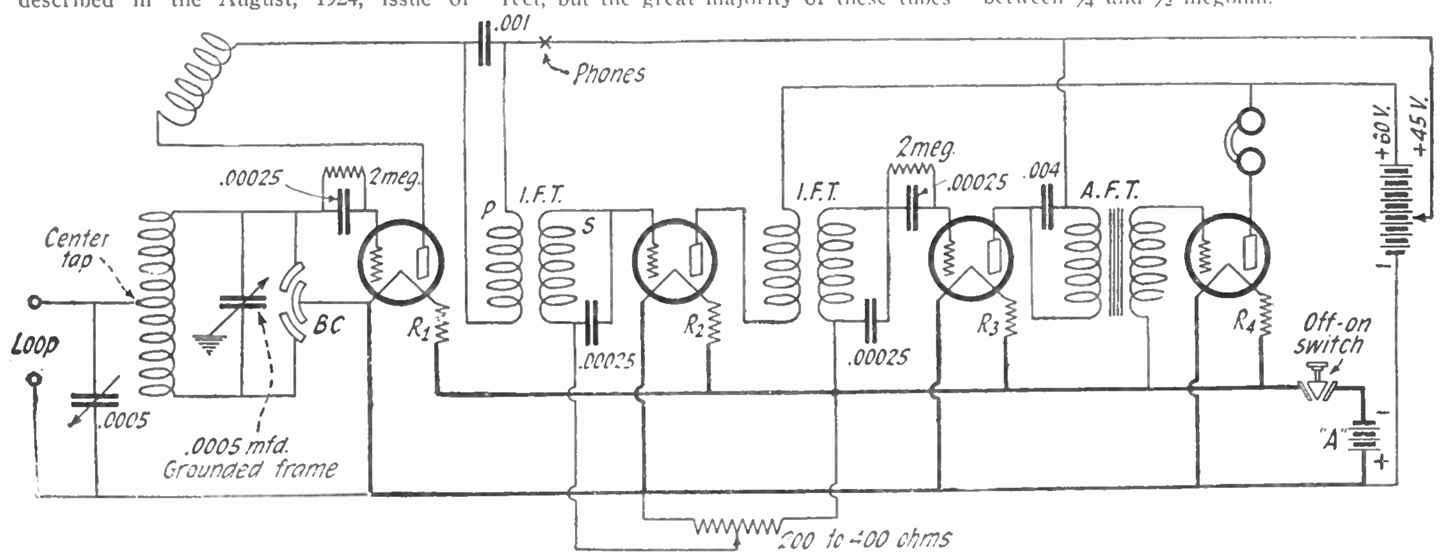


Fig. 68. A variation of the Tropadyne principle described in the August, 1924, issue of RADIO NEWS is here illustrated as the new Signal Corps Super-Heterodyne. Additional stages of intermediate frequency amplification may be added if desired.

AUGMENTOR CIRCUIT

(70) Mr. Lee W. Gaines, Steubenville, Ohio, asks:

Q. 1. What system of connections is used in the "Augmentor" circuit of Francis Hoyt?

A. 1. The diagram of connections is shown in Fig. 70.

On a tube three inches in diameter wind 12 turns of No. 20 D.C.C. wire, to form coil "A". Coils "B" and "C" are about the same, viz: 25 turns of No. 22 or No. 24 D.C.C. wire wound on the same tube as primary "A". Coils "B" and "C" are placed either side of coil "A", but separated about one or two turns. Rotor "D" may consist of a spiderweb or a cylindrical winding of about 30 turns, on a tube 2¼ to 2½ inches in diameter.

Since both the movable and stator plates of the variable condenser connect to points of high potential, it is not possible to eliminate hand capacity by grounding any part of the ordinary variable condensers. Grounded rotor condensers are no different, in this respect. Grounded frame condensers, however, will be entirely free from capacity effect.

Although not shown in the original diagram, it may be advisable to connect a variable condenser of .001 mf. capacity across the primary of the first audio frequency transformer, as shown by the dotted lines.

This circuit resolves itself into one stage of tuned radio frequency amplification, detector, and one stage of audio frequency amplification, with variable coupling (the rotor) between the radio frequency tube and the detector.

Q. 2. Would there be an increase of volume by using direct aerial coupling, instead of inductive coupling?

A. 2. Yes. But tuning would be more broad.

Q. 3. Why are not Neutrodyne receivers on the market having three, four or five stages of radio frequency amplification?

A. 3. The construction of such sets has been accomplished in the laboratory, but there are too many variable elements to make such a set a successful commercial proposition. This is in addition to the greater difficulty of quickly adjusting the additional tuning dials, were one dial retained to tune each stage of radio frequency amplification.

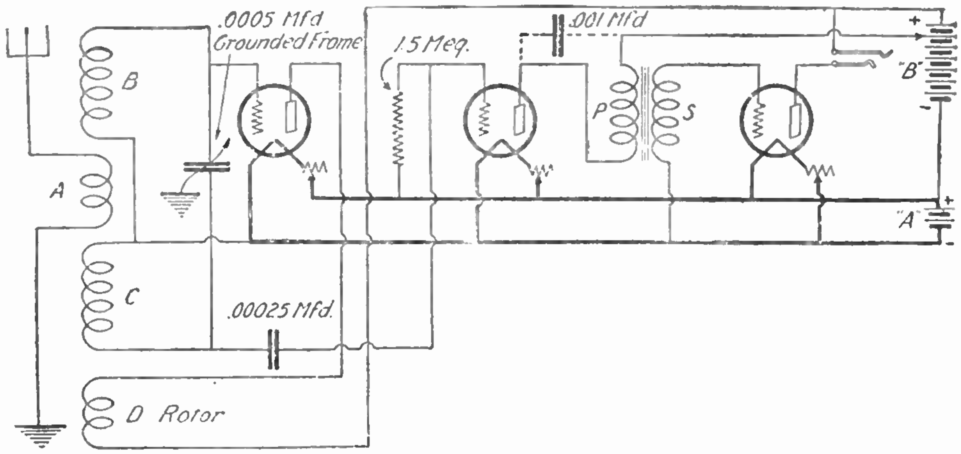


Fig. 70. An unusual circuit. Note that only one condenser is required for tuning. This is a circuit which the experimenter will welcome. It might be classed as a push-pull system, where feed-back is produced (lowering the resistance of the grid circuit) at one-half cycle, and detection at the other half cycle.

BROWNING-DRAKE CIRCUIT

(71) Mr. James Nall, Washington, D. C., asks:

Q. 1. What is meant by the expression, "directing traffic"?

A. 1. The "traffic" referred to is the code messages transmitted and received by commercial and amateur operators. Anyone appointed to determine the most expeditious method of disposing of the messages received and transmitted by the various stations is spoken of as "directing traffic".

Q. 2. What is the Browning-Drake circuit?

A. 2. The Browning-Drake circuit shown in diagram No. 70, is seen to incorporate one stage of radio frequency amplification, neutralized, added to a regenerative detector and two-stage audio frequency amplifier set.

"C" is a standard neutralizing capacity.

The three-coil inductance unit is of advanced design. It has been found that much greater amplification could be had if the capacity coupling between the primary and secondary of tranformers could be eliminated or reduced.

To that end, a special inductance, called a "regenoformer", was designed. It has a rotor (which may be made by winding 30 turns of No. 24 D.C.C. wire on a 2¼-inch to 2½-inch tube. A hard rubber tube will be best) at one end of the secondary. This secondary may be made in the conventional manner by winding about 50 turns of No. 24 D.C.C. wire on a three-inch tube. At the opposite end of the secondary is the primary. It fits just inside the secondary, at the filament end, and is only two turns wide. In order to transfer sufficient energy from primary to secondary, more inductance is required, so a deep groove, two turns wide, is cut in the insulating disc in which the primary is now wound. For experimentation, try about 15 turns of No. 24 D.C.C. wire as the primary. It may be necessary to change this to as many as 20 turns, or even 25 turns, depending upon the care used in construction.

Resistance "R" may be a Bradleyohm or a Variohm variable between 10,000 and 100,000 ohms.

A filament control jack is used to cut off the filament current of the audio frequency amplifier tubes, when only the detector is being used for reception.

LONG WAVE RECEIVER

(72) Mrs. Lowell Price, Pelham Bay, N. Y., asks:

Q. 1. Please furnish me with a diagram which will enable me to construct a set capable of receiving the programs broadcast by certain French, Swedish, German, Italian, Spanish, Swiss, Dutch, Danish, Belgian and, I understand, some South American stations, on long wave-lengths.

A. 1. The long wave broadcast programs of stations in these and other countries may be tuned to with a set constructed in accordance with the diagram shown in Fig. 72.

The wave-length range is dependent upon the values of inductance and capacity used. Variable condensers of .001 mf. capacity are more to be desired when tuning to the longer wave-lengths than those of lesser capacity. Otherwise, it would cause the unnecessary inconvenience of frequent inductance coil change.

The coil values shown will cover a wave-length range of approximately 1,000 to 3,000 meters. Simplification of control results by the use of only two honeycomb coils. The correct honeycomb coil value for various wave-length ranges may be determined from the table given in the "I Want to Know" department of the January, 1925, issue of RADIO NEWS, page 1229. When changing to a different wave-length range, it will be necessary to replace both coils.

Plate resistors "PR" have a value approximating 70,000 ohms. The exact resistance, which is not critical, is readily determined by test. The value is governed mainly by the "B" battery voltage (which should be high, 135 to 150 volts) and tubes used (practically any make of amplifier tubes will be satisfactory, with the proper resistor values).

Good tubes, preferably balanced, are essential.

The grid resistors, or "gridleaks" as we know them (marked "GL"), may all be of the same size (about 2 megohms).

Blocking condensers "BC" are all of .0005 mf. capacity. The detector grid condenser value is .00025 mf. capacity, as usual.

The two L-200 honeycomb coils shown are placed in variable inductance relation; this is indicated by the arrow-head lines placed to show coupling.

Two variable condensers are shown in the aerial-grid circuits. If only one is used, either the aerial circuit or the grid cir-

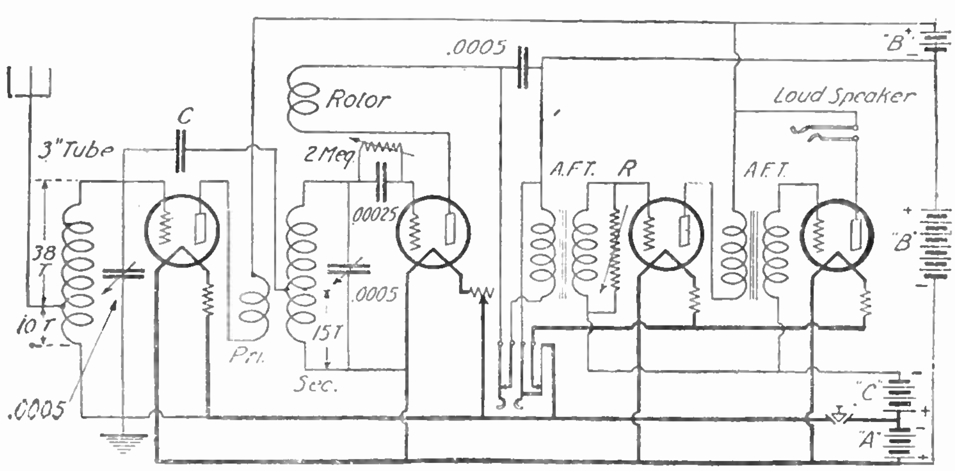


Fig. 71. Radio frequency amplification added to a regenerative receiver. This is possible only through extremely careful design and construction. This circuit shows how to do it. There are other features to this circuit, the Browning-Drake, as well.

cuit will be out of tune on all but one wave-length—the natural period of the aerial system or of the grid circuit.

Hand capacity will be evident from the aerial series condenser, unless the usual precautions are taken.

Investigators have termed a particular form of static prevalent at the lower frequencies (high wave-lengths) as "long wave" static. A "static leak" (SL) of about 50,000 ohms is shown as a method for reducing, somewhat, static effects. This leak is of particular value as a means of causing a slow discharge to ground of static electricity (particularly the kind known as "snow" static, often observable during snowfall) which would otherwise accumulate on the aerial, due to the direct current insulation afforded by the antenna series condenser; fitfully discharging to ground, this stored-up electricity would cause loud, annoying clicks in the headphones.

Variable condenser rotors are indicated by the arrow-head.

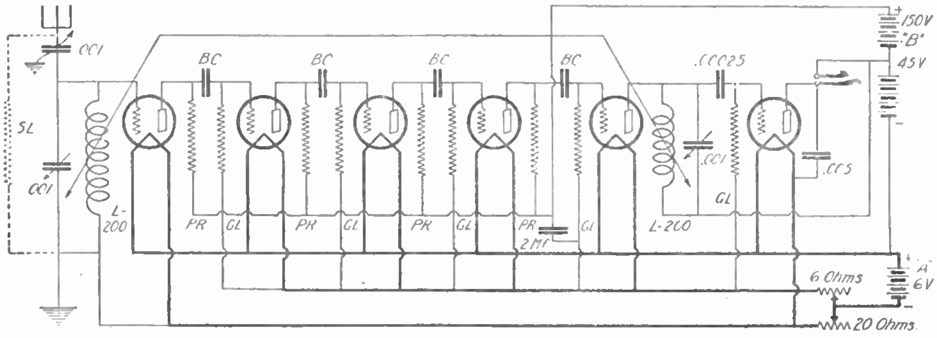


Fig. 72. This efficient receiver is not difficult to tune. It is easy to construct. This is an "all-wave" receiver. One need only change coils, to cover practically all wave-lengths in use today.

FRESHMAN CIRCUIT

(73) Mr. Antonio Costello, Rome, Italy, asks:

Q. 1. What is the wiring diagram, and what are the constants, for a standard set of the radio frequency type, such as the Freshman, incorporating two stages of tuned radio frequency amplification, tube detector, and two stages of audio frequency amplification? I understand no neutralizing methods or potentiometers are required.

A. 1. We are showing this circuit in Fig. 73.

All three variable condensers must be of the same make and capacity rating. Capacities of about .0005 mf. will be about right.

The tuned radio frequency transformers may have to be changed slightly in order to make all the variable condensers balance.

If one desires to make their own radio frequency transformers, the number of turns indicated may be wound on a form about three inches in diameter. The primary may be wound directly over the secondary, at the filament end, with only slight spacing between the two windings. No. 24 D.C.C. wire will be quite satisfactory.

The grid return lead of the second radio frequency amplifying tube is shown in dotted lines. It may be very difficult to prevent strong oscillation of this tube, unless this connection is made to "A" plus. If connection is made to "A" minus and the set oscillates strongly, it would be best to reduce the number of turns in the primary coil in the plate circuit of the first or second tube, still retaining the negative grid return connection. This is generally better practice than that of making an amplifier grid positive by connecting to the positive post of the "A" battery.

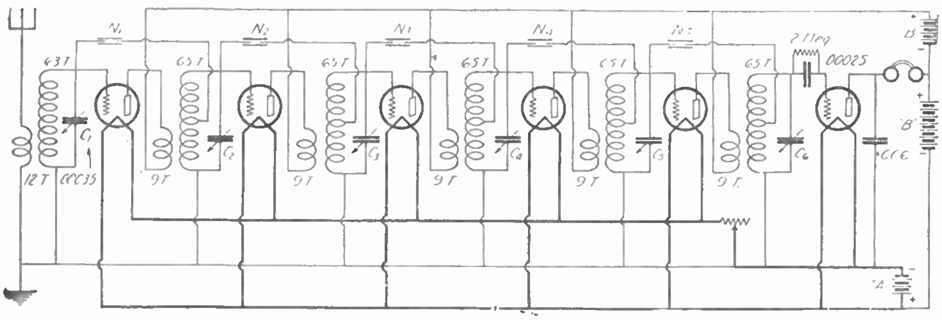


Fig. 74. This is an experimental Neutrodyne diagram. A detector rheostat, not shown, is required in the positive lead of this tube. Reception reports should be addressed to the "I-Want-To-Know" department.

Any tubes may be used in this set, depending upon the sockets and rheostats used. If low-capacity tubes are used, it will be possible to almost triple the number of turns in the plate circuit winding of each tube, without the set going into oscillation. This increase in the number of turns will result in greater sensitivity.

If the "C" battery is not desired, at first, the binding posts for same are connected together with a piece of wire.

Q. 2. Is it true that many of the better broadcast stations use a control system that makes it possible for the station operator to increase the volume of either the high or low notes being broadcast, at will?

A. 2. It is true that programs are balanced in this manner.

Q. 3. What is the softening point of hard rubber?

A. 3. About 150 degrees, Fahrenheit.

FIVE-STAGE NEUTRODYNE

(74) Mr. Jerome Fennimore, Basking Ridge, N. J., asks:

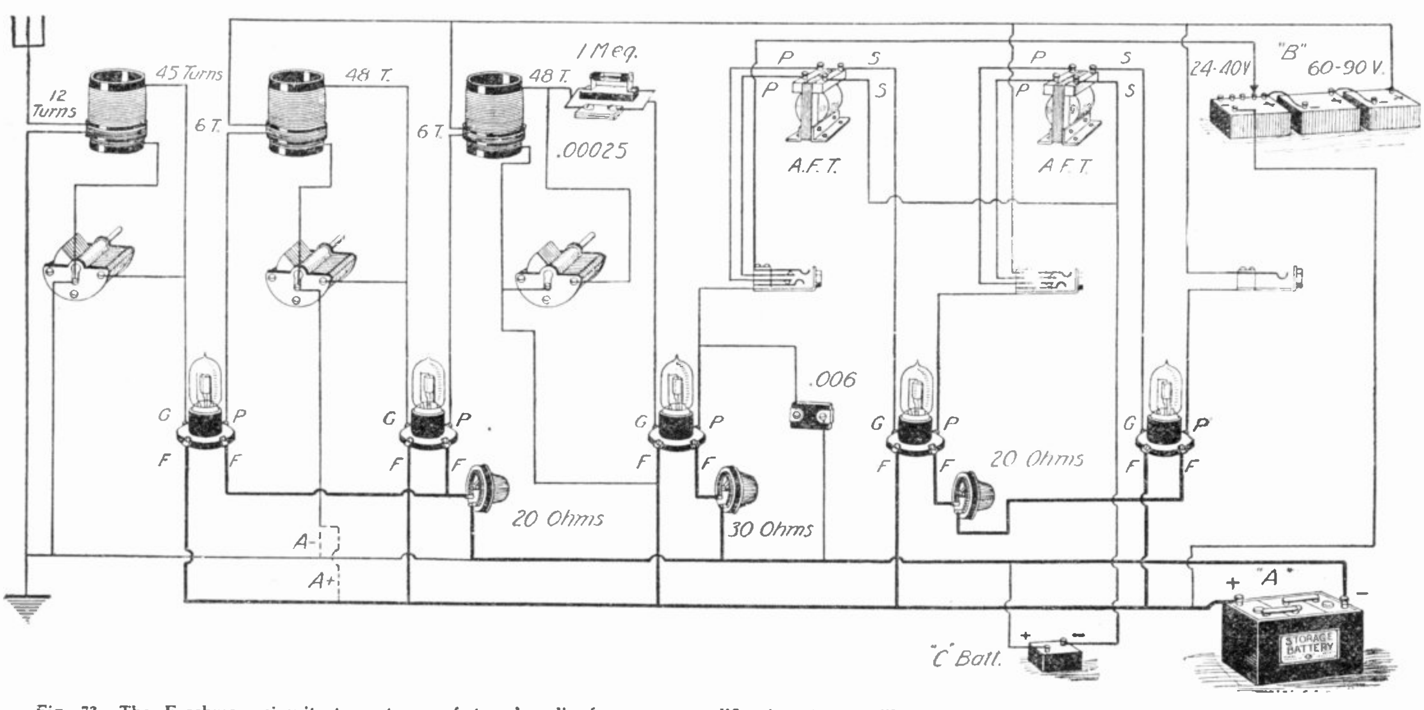


Fig. 73. The Freshman circuit, two stages of tuned radio frequency amplification (non-oscillating), detector and two stages of audio frequency amplification. Twenty-three variable condensers may be used. Once logged, a station will always be received at the same three points on the dials.

Q. 1. What is the tube tester diagram using an oscillating circuit?

A. 1. This is standard. It will be found in Fig. 74B.

The inductance may be made by winding 50 turns of No. 22 D.C.C. wire on a tube about 1¼ inches in diameter. There is a tap on the middle of this collodion coated coil.

A Weston thermo-galvanometer ("G") model 425, is used, having a range of 0 to 115 milliamperes.

The D.C. ammeter ("A") is a Weston model 301, 0 to 1 amp. range, instrument. The D.C. voltmeter ("V") is also a model

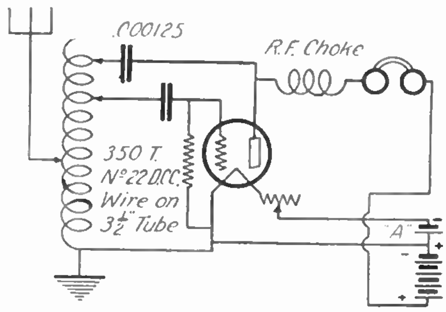


Fig. 74A. Weagant circuit applied to a three-slide tuner. When oscillating a loud click is heard as the sliders are moved.

301 Weston with a range of 0 to 7 volts.

The voltages shown must be used.

Tubes having 0.06, 0.025 and 1.0 amp. filaments at the respective voltages of four and one-half, six and six volts, may be tested. Different tubes known to operate satisfactorily should be put in the tester and the readings noted. An average reading may thus be determined, by which unknown tubes may be checked.

Q. 2. I would like very much to have you publish a picture diagram showing how to use a three-slide tuner in a regenerative circuit.

A. 2. We are showing you an effective way of using your tuner in a regenerative circuit.

The circuit diagram in Fig. 74A shows the Weagant system of producing regeneration oscillation.

The radio frequency choke may be made by winding about 250 turns of No. 36 B. & S. gauge S.C.C. wire on a tube about two inches in diameter.

Q. 3. Since it is possible to make a satisfactory Neutrodyne having three dials, why would it not be possible to make one having five or six dials?

A. 3. It is possible, but not easily done. If care is taken in the construction of the set, it would be interesting to construct one along the lines of the Neutrodyne circuit illustrated on the preceding page.

Probably the best way to go at this unit is to first make up the set with only the usual two stages of neutralized radio frequency. Then, one-by-one, build additional stages, carefully neutralizing and balancing each successive one. As soon as a stage is balanced, the aerial and ground are removed and that coil to which the aerial and ground were connected now becomes the plate circuit primary winding for the next stage.

All neutroformers and condensers should be of the one make and type selected. N-1, etc., are the usual neutralizing capacities. C-1, etc., are the usual tuning variable condensers, all of the same capacity.

The combination shown is one of extreme sensitivity and selectivity. Audio frequency amplification may be added in the usual manner, if desired. One stage, using a transformer of about 3:1 ratio, is sufficient.

It may be quite difficult to neutralize some of the stages unless the neutroformers are mounted in such a way as to be rotable through an arc of perhaps five degrees to the right or left of the calculated angle.

This set will not function if the parts are crowded.

The neutroformer windings are on tubes 2¾ inches in diameter. No. 26 S.S.C. wire is used. The neutrodon taps are taken 15 turns from the grid end of the secondary.

To prevent oscillation, it may be necessary to use only four to six turns in the radio frequency tube plate primaries.

ROBERTS "KNOCKOUT" REFLEX SET

(75) Mr. Rodney Ware, Jr., Wadsworth, Ohio, asks:

Q. 1. Please show and describe the Roberts circuit using a "C" battery and one of the forms of neutralization. Are any changes required when using the No. 285 General Radio audio frequency transformers?

A. 1. We are showing this circuit below in Fig. 75. In addition to the variable detector leak "R", which may be a Bradleyleak, one more leak of the same range will be required across each of the secondaries of the audio frequency transformers when using the No. 285 transformer mentioned above. The fixed condenser values indicated cannot be considered as exact. It may be necessary to use larger or smaller values than those shown. This is particularly true of the .002 mf. fixed condenser. Also, the .0001 mf. fixed condensers shown in shunt (parallel) to the primary and secondary of the audio frequency transformer in the grid circuit of the first tube should be varied in value to determine the best capacity.

If the small neutralizing condenser "N.C." should accidentally short circuit,

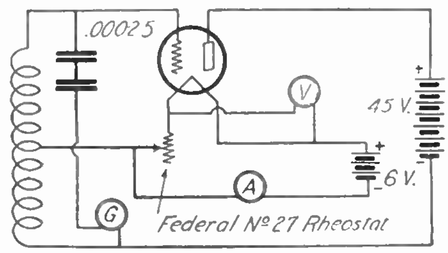


Fig. 74B. A simple tube testing circuit. Meter "G" only registers oscillating currents.

it would cause the total "B" potential to be applied to the tube filaments, thus burning out all the tubes. To prevent this, we are showing a "stunt" in the form of a large fixed condenser which may be of about .001 mf. capacity. This has practically no effect on the functioning of the neutralizing condenser and it serves as an added protection to the tubes. If this fixed condenser is not available, the circuit is indicated by the dotted line.

The aerial inductance "L" may consist of about 55 turns of No. 20 D.C.C. wire, tapped in the center and wound on a three-inch tube or on a spiderweb form.

Once adjusted, the aerial condenser need not be changed unless the aerial is changed.

The most difficult parts of the set are the windings comprising unit N-1. This unit is now being manufactured with spiderweb coils. There are two ways of making this four-part unit. One is to wind the coils in cylindrical shape and the other is to wind the wire on spiderweb forms. S and F denote the start and finish of a two-wire coil made by winding two wires, side by side, at one time. The wire used should not be larger than No. 26 D.C.C. It is advisable to have one wire colored so that there will be no mistakes

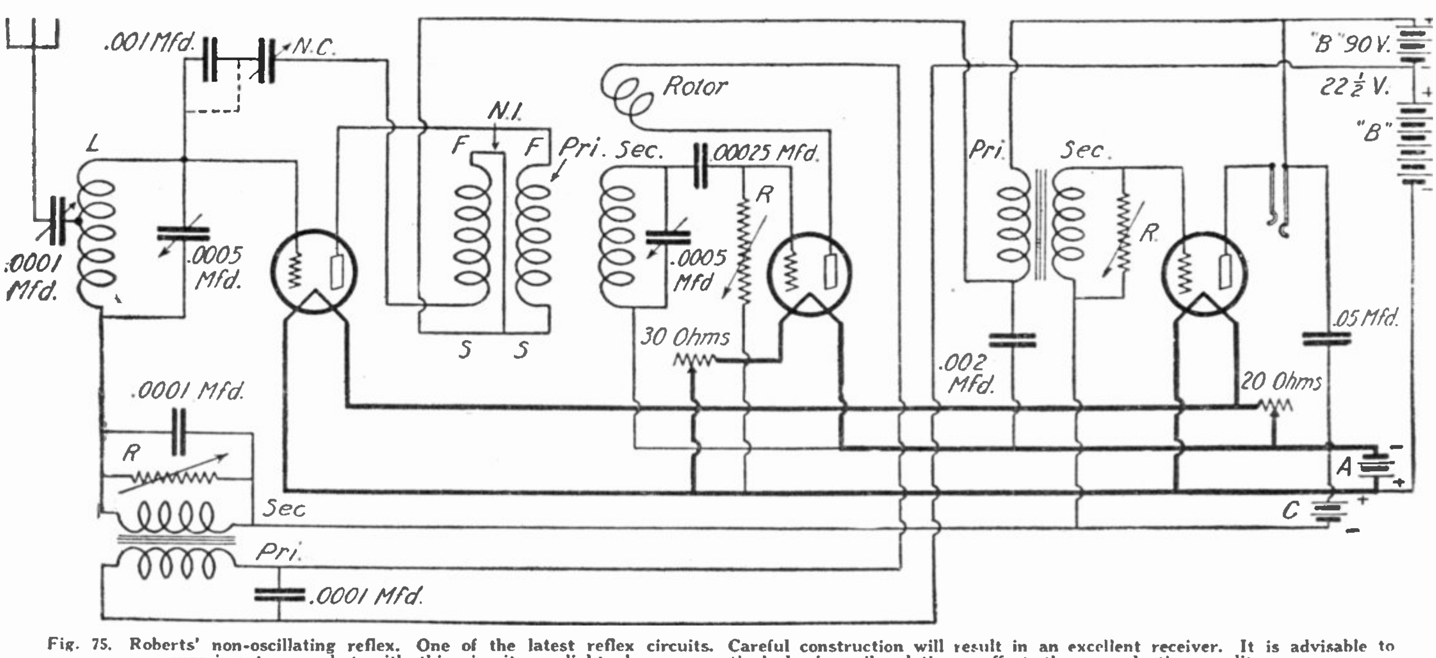


Fig. 75. Roberts' non-oscillating reflex. One of the latest reflex circuits. Careful construction will result in an excellent receiver. It is advisable to experiment somewhat with this circuit as slight changes, particularly in coil relations, affect the reproduction quality.

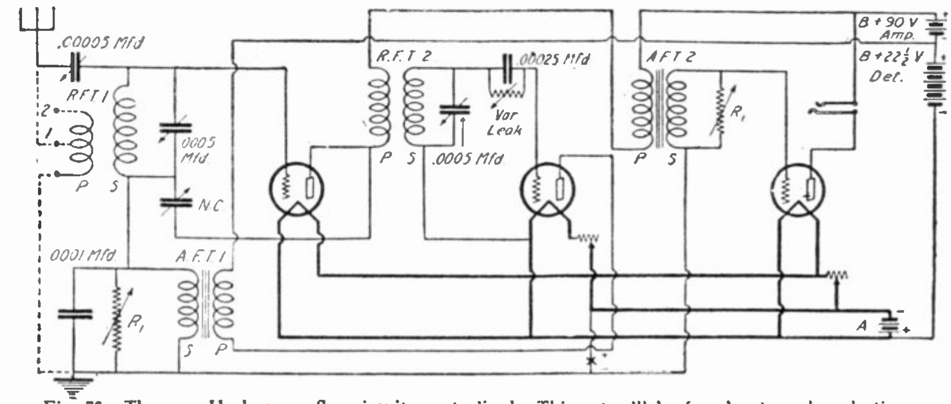


Fig. 76. The new Harkness reflex circuit, neutralized. This set will be found extremely selective if apparatus of good quality is used. Any type of tube may be used if sockets and rheostats are changed accordingly.

when making connections. It has been found that the radio frequency tube may be neutralized much easier if these two wires are first twisted. Twenty turns of this twisted wire are wound on a spiderweb form or a three-inch tube. This leaves four connecting ends, two at the start ("S" and "S") and two at the finish ("F" and "F"). The finish of one coil ("F") and the start of the other coil ("S") are connected together. On a second spiderweb form, placed about one-half inch from the first, are wound about 45 turns of No. 22 D.C.C. wire. If the three-inch tube is being used, the same number of turns may be wound, starting one-quarter inch from the starting end of the 20-turn coil. At the finishing end of the 20-turn coil is placed the rotating tickler ("rotor"). This may be of about 22 turns. If spiderweb forms are being used, the tickler may be of about the same number of turns placed on one of these forms and variably coupled to the secondary.

The variable condenser rotor plates are indicated by the arrowheads.

Use from 90 to 125 volts "B" battery and a "C" potential of 4 to 6 volts.

This circuit is sensitive, selective and very loud. The quality of reproduction depends greatly upon the inductive relations of the various coils, as will be evidenced by a little experimentation with the circuit. Aerial length seems to have very little effect on this receiver, in the matter of selectivity.

The quality of reproduction will be improved somewhat by connecting the detector variable grid leak to "A" minus instead of to "A" plus, although the sensitivity is not then quite as great.

The aerial coil must not be in inductive relation to the balance of the coils in the set.

If the secondary coil can be arranged to have a variable inductive relation to the double-wire plate coil, the coupling point for best operation may be easily found.

See the May, 1925, issue of RADIO NEWS, containing these constructional details of the Roberts set.

Q. 2. Although the tubes in my set seem to operate well in other sets they do not seem to function in the present receiver. According to hydrometer test the "A" battery is fully charged. The tubes do not light up very brightly. In lieu of other wire, I have been using a two-conductor phone cord "A" battery lead. Can you offer any possible reasons for my results?

A. 2. The inoperation of your receiver is probably due to the phone cord you are using as an "A" battery connection. Use No. 18 wire, or larger, for your "A" battery leads. The phone cord is made with what is called "tinsel cord" and has a very high resistance.

Q. 3. When employing fixed radio frequency transformers in a set having two stages of radio frequency amplification, will it make any difference if low internal capacity tubes (such as the UV-199 or the C-399) and low capacity sockets are substituted for the regular storage battery type of tube?

A. 3. Yes. If a potentiometer is being used, its moving arm may now be advanced much further toward "A" negative. If a potentiometer is not being used, it may be of advantage to connect a very small capacity, such as that of a neutrodon, from the grid to the plate of one or more radio frequency tubes. Also, try connecting such a condenser from the plate of the detector to the grid or plate of the first radio frequency tube. In this instance it may be advisable to use the small type of neutralizing condenser that can be controlled from the panel.

LATEST HARKNESS REFLEX CIRCUIT

(76) Mr. Stanley R. Hart, Philadelphia, Pa., asks:

Q. 1. Please show the latest Harkness reflex circuit.

A. 1. The latest Harkness reflex is being shown in Fig. 76.

Radio frequency transformers R.F.T.2 may be made by winding about 50 turns of No. 24 D.C.C. wire on a three-inch tube. One end of this secondary coil connects to the grid. The other end connects to "A" plus. About one-quarter inch from this end of the secondary is wound the primary, which may consist of about 15 turns of the same size wire.

In the earlier Harkness receivers the tuned radio frequency transformer marked R.F.T.1 consisted of two coils which we have designated "P" and "S." In the newer circuit it has been found possible to eliminate the 15 turn primary, the aerial being connected directly to the grid end of the 50 turn secondary (wound with No. 24 D.C.C. wire on a three-inch tube), through a very small variable condenser instead of to the 10 turn tap or the end of the primary. The capacity of this condenser is higher than the maximum capacity of the average condenser of the "neutrodon" type. It is of such small size that changes in its capacity change the wave-length very little, but an excellent control of selectivity is afforded by its use. This method of inducing antenna current to the control grid of an amplifier tube will probably come into more general use.

The neutralizing condenser marked N.C. may be of the usual "neutrodon" type.

Resistances R-1, which may be variable grid leaks, will probably be required if the General Radio No. 285 audio frequency transformers are used. The .0001 mf. fixed by-pass condenser may not be required with these transformers if the metal shell is connected to "A" minus.

Before the neutralizing condenser is adjusted a loud howl should be heard when both tuning condensers tune their respective circuits to the same wave-length.

The variable condenser rotor plates are

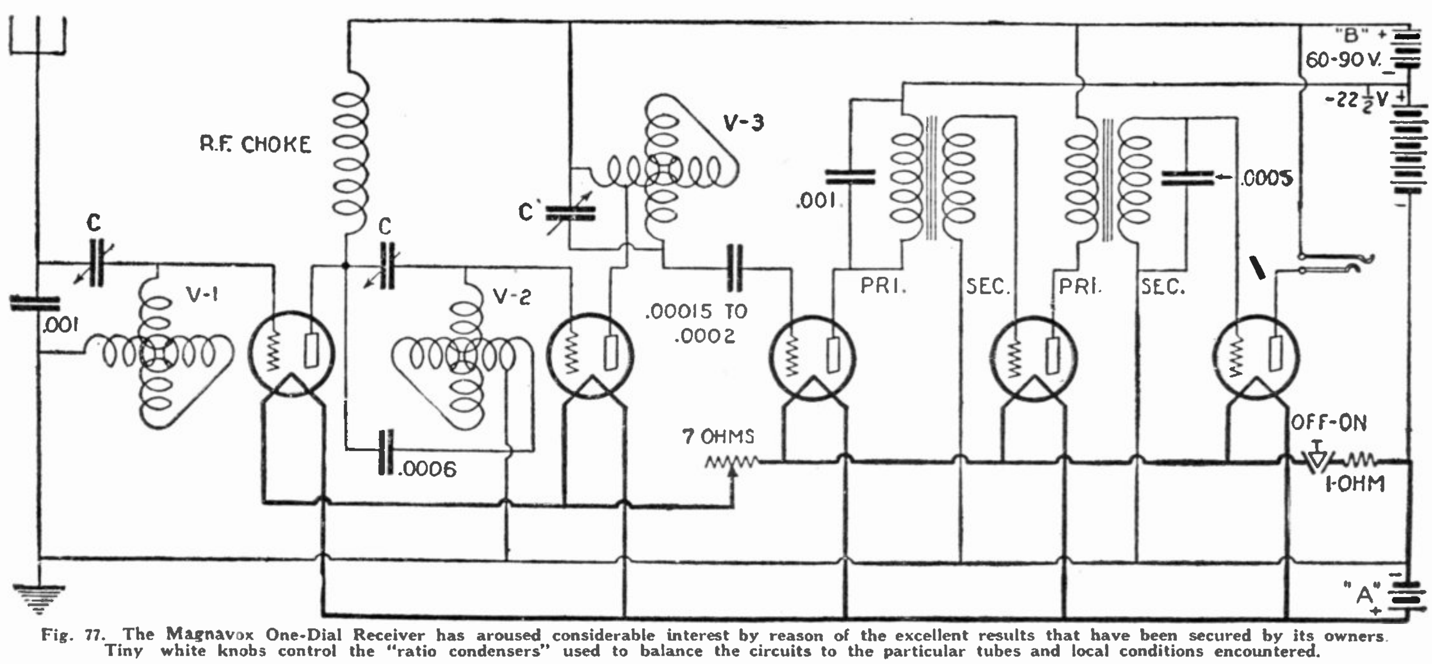


Fig. 77. The Magnavox One-Dial Receiver has aroused considerable interest by reason of the excellent results that have been secured by its owners. Tiny white knobs control the "ratio condensers" used to balance the circuits to the particular tubes and local conditions encountered.

indicated by the arrowheads.

If a three to six and one-half volt "C" battery is placed at "X," it will be possible to use as high as 135 volts in the amplifier "B" battery.

Q. 2. Why are the amateurs permitted to send "CQ" in code a dozen or more times, at a wave-length of 80 meters, when the Government has requested that these letters be sent only a few times?

A. 2. This regulation was intended to apply to spark transmission, not C.W. (continuous wave-) transmission with inductively coupled antenna systems. Due to the extremely sharp tuning at such short wave-lengths, it is necessary that the receiving set be adjusted very slowly. For this reason the amateurs have been permitted to repeat this general call many times before signing the letters assigned to the sending station. This gives the receiver a chance to properly tune in the calling station, an operation requiring much more time on the short wave-lengths than at the longer wave-lengths or when the continuous waves are interrupted. Such interrupted or modulated signals are more readily tuned in, but this type of transmission is not permitted on the wave-length band you refer to.

MAGNAVOX ONE-DIAL SET

(77) Mr. George A. Bell, Bethany, Mo., asks:

Q. 1. What is the circuit of the Magnavox one-dial receiver type TRF-5?

A. 1. The circuit of this and the type TRF-50 receiver is shown in Fig. 77.

Condensers "C" are variable between .00001 and .00015 mf. These are called "ratio" condensers. They are controlled by the three white porcelain knobs. When a distant station is being received, these three ratio condensers are varied until maximum signal strength is reached, and need not again be adjusted unless the set is moved or the tubes are changed.

When balancing the tuned circuits, it is advisable to make the adjustments while a low wave-length station is operating. If the variable ratio condensers are adjusted for a high wave-length station, there is a possibility of circuit oscillation when receiving stations at the shorter wave-lengths.

The radio frequency choke may consist of 300 turns of No. 30 D.C. wire, wound on a 2-inch tube.

It will be noticed that no detector grid leak is used in the manufactured set. The experimenter may wish to use the customary grid leak from the detector grid to "A" plus. A variable one will be satisfactory.

Audio frequency transformers having a ratio of about 3:1 will probably be found best.

Variometer V-2 may be tapped at about 8 to 15 turns from one end of the stator winding, as shown, the exact number of turns being determined by experiment. Variometer V-3 may be tapped 5 to 10 turns from one end of the stator winding. The three variometers are mechanically arranged to be controlled by a single dial.

The 7-ohm rheostat is marked "Volume Control," and used in the following manner: With "Volume Control" at maximum, a whistling note is heard on tuning in a station. Turning "Volume Control" towards minimum, thus reducing the filament current of the first two radio frequency amplifier tubes, will now eliminate the whistle.

PICTURE DIAGRAM

(78) Mr. John W. Smith, New York City, says:

Q. 1. Please show the picture diagram of a reflex receiver having only one tube.

A. 1. We are showing the circuit above in Fig. 78.

The crystal detector is shown connected to a center tap on the second radio frequency transformer secondary. The object of this is to increase selectivity. The dotted line indicates how one side of the radio frequency transformer secondary may be connected to "A" minus. This connection sometimes improves reception considerably, strong capacity effect being noted until this connection is made.

All coils are wound in the same direction, with any convenient size of wire. Three-inch tubes may be used. If larger tubes are used, less turns are required; if smaller, more turns. Although the spacing between the 12 (and 15) turn primary and the 50-turn secondary looks large, the spacing of a single turn of wire will probably be found quite sufficient. A greater spacing will considerably sharpen the tuning but also decrease the volume. This reduction is most noticeable when receiving signals from distant stations. Enamel, cotton or silk may be used as wire insulation, the latter two being preferable.

The potentiometer controls amplification (regeneration).

Any good audio frequency transformer may be used. Those of high ratio are not desirable in regular sets, but in reflex receivers high ratio transformers seem to be desirable, rather than otherwise. The UV-712 transformer (of which there are two types) was originally designed for high amplification of spark signals. (That is, one type was.) In regular broadcast receivers considerable distortion results when these are used. This circuit may be used with these audio frequency transformers with quite excellent results.

Different tubes and different audio frequency transformers (and different placing of apparatus) require different "by-pass" condenser (that is, the condensers connected to the primary and to the secondary windings of the audio frequency transformers) values. Other values than those shown should be tried and the result noted.

This is an extremely efficient circuit for the reception of local stations. Tone quality is very good. If the radio frequency coils are not crowded together, selectivity should be quite sufficient for all ordinary needs.

Although an adjustable crystal detector is shown, one of the fixed variety may be used. A dozen different minerals should be tried. At least two different "detector stands" should be tried.

The size of the "A" battery used will depend upon the tube used and the tube selected is a matter of personal like and dislike. A regular "storage battery tube" will give best results. You are fairly safe in buying a tube that will oscillate.

Q. 2. Is a loud speaker any good when made by clamping a pair of head-phones on the horn? Some of the loud speakers of this type require only a single unit.

A. 2. Head-phones are not designed for adequate handling of the strong currents necessary for proper loud speaker operation. There are many "units" obtainable that may be incorporated in some of the various types of horns. These units are entirely satisfactory for loud speakers.

A pair of head-phones designed to be really sensitive to weak signals will rattle greatly if forced to operate for even "moderate" loud speaker volume. Although not recommended, a simple expedient that permits of loud speaker operation with most head-phones (with the exception of the Brown and the Baldwin brands) is the raising of the diaphragm from the pole-pieces. It is the touching of the diaphragm against the pole-pieces which causes the rattle. Sometimes merely reversing the diaphragm, so that the inside now becomes the outside, is sufficient to stop the rattle. A thin paper washer, one-eighth inch wide and with an outside diameter equal to the diaphragm diameter, may be used to raise the diaphragm slightly from the pole-pieces, a sufficient number of washers being used to prevent the rattling.

Another thing. Some head-phones are wound with wire much finer than that used in other makes of receivers. The wire is large enough for ordinary signal strength, but is insufficient when taxed by the output of a 2-stage audio frequency amplifier. The result is a burn-out which renders the phones useless until repaired.

Q. 3. Where is it possible to purchase a book or construction blueprints for making an inexpensive, one-tube regenerative set?

A. 3. Our Book Department will be glad to furnish "How to Build a Low-Loss Receiver" (which is a packet containing blueprints and all details for making a one-tube regenerative receiver), or "How to Make a One-Tube Regenerative Set." The latter is a 64-page booklet. Prices will be supplied upon application.

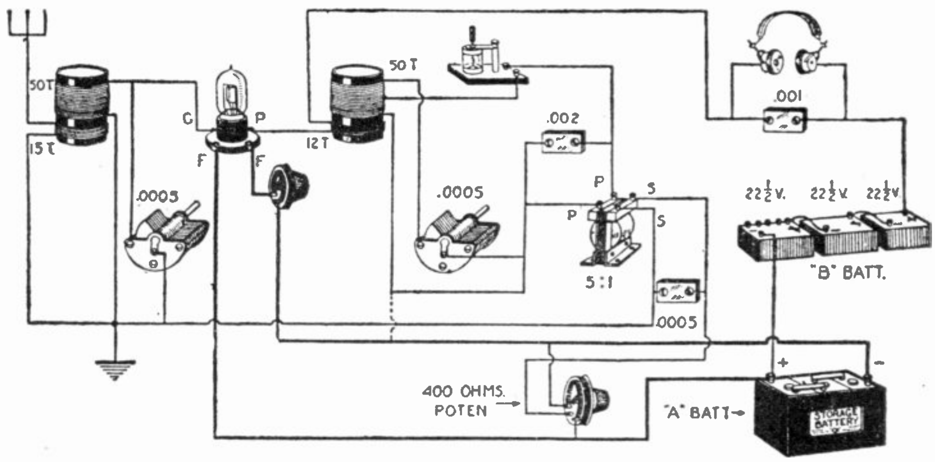


Fig. 78. This month we are showing an efficient 1-tube reflex circuit. Good quality and range are promised to constructors who build this set with care. An adjustable detector may be used, but fixed ones are now obtainable.

INTERFLEX HINTS

Q. 3. Kindly tell me what precautions to observe in building an efficient Interflex set.

A. 3. We have listed below the points we have found of greatest importance in connection with the Interflex receivers.

1. It has been found that the All-American type R-201A and Acme type R-2 radio frequency transformers give exceptionally good results in the Interflex sets.

2. Try reversing the radio frequency transformer primary connections. Also, try reversing secondary connections.

3. A carborundum crystal is particularly good. Other kinds of crystals having rectifying properties can be tried, but they are not likely to give as good results.

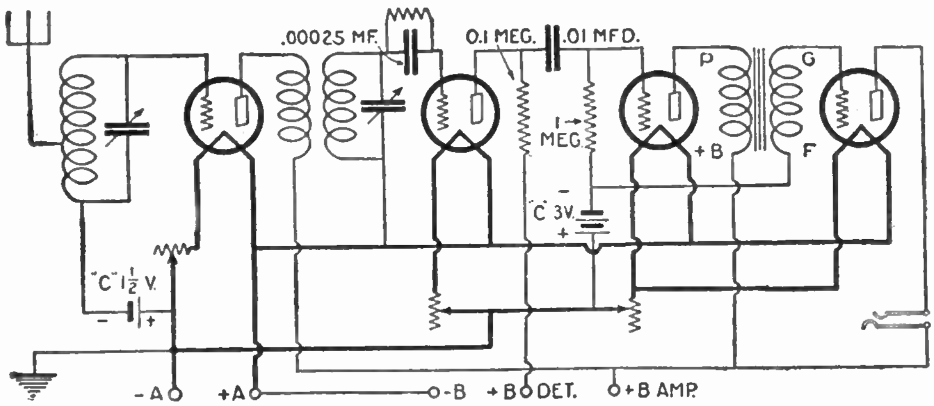


Fig. 79. The Sleeper RX-1 Receiving Circuit. Inexpensive and simple to build, one wonders at the results obtained in regard to both sensitivity and quality, for the time and money spent. The stage of resistance-coupled amplification before the ordinary transformer-coupled stage, accounts for the set's unusual quality of reproduction.

4. Different carborundum crystals should be tried and reversing the connections sometimes makes a difference.

5. An aerial length of 65 feet, including lead-in, is excellent.

6. In the 4-tube circuit, the radio frequency, or first tube may have a plate potential of about 45 to 60 volts; the second tube, the one having its grid connected to the crystal detector (and therefore called the post-crystal tube) may have a plate potential of 22½ to 45 volts, for best results. The voltage for this (post-crystal) tube remains the same if the stage of radio frequency preceding it is not used.

7. When adding an audio frequency amplifier, a small condenser across the primary or secondary of the first audio frequency transformer may improve the operation.

8. Changing tubes around often results in a surprising improvement in tone, volume and selectivity.

9. The following Interflex articles have been published:

"The Interflex" (1 dial, Radio News, September, 1925.

"The Balanced Interflex" (1 dial), Radio News, October, 1925.

"The Interflex Receiver" (1 dial), *Radio Review* October, 1925. *N. Y. Telegram*, August 29, 1925.

10. Note the effect of connecting a small variable condenser (about 5-plate size) from the post-crystal tube grid to "A" minus.

11. Fixed detectors are usually more rugged and are generally more satisfactory than adjustable ones.

12. Tune very slowly.

SLEEPER RX-1 RECEIVER

(79) Mr. A. S. Emerson, Burlington, Vt., asks:

Q. 1. I have heard a good deal of the new Sleeper RX-1 Model Receiver. Can you confirm any of the reports as regards its sensitivity and over-all efficiency as a receiver? Also, can you furnish me with constructional details, providing this type of receiver is simple to build?

A. 1. The receiver you mention has aroused a great deal of discussion and interest here in New York City, especially in the radio sections of our various local newspapers. It is very simple and quiet-operating, these two characteristics making it an ideal receiver for the home. The circuit that is used in this receiver is of the conventional type, no "tricks" being incorporated; thus permitting the average builder with very little radio knowledge to build this set, without having to make any peculiar or intricate adjustment.

Another feature in its favor is that it is very inexpensive to build, the parts necessary being few, although necessarily of a high quality. The quality of reproduction obtained from this receiver is excellent, due to the stage of resistance-coupled amplification that follows the detector tube. This is a better scheme than the average system of resistance-coupled amplification, which usually follows a stage or two of transformer-coupled, because distortion from the output of the detector circuit is immediately corrected; whereas, when transformer-coupled amplification follows the detector output, the distortion is enhanced.

The parts necessary for this circuit are as follows:

- 2 .005-mf. variable condensers, preferably of low-loss straight-line frequency type;
- 2 Coils, wound on a 3-inch tube, and consisting of 45 turns of No. 22 D.S.C.; one having placed within it a primary winding of 8 turns, on a 2¾-inch tube (The other coil has a tap at the 35th turn);
- 1 .00025-mf. grid condenser;
- 1 Two-megohm grid leak;
- 1 .01-mf. condenser;
- 1 One-megohm grid leak;
- 4 Sockets;
- 1 25-ohm resistance;
- 1 4:1 transformer;
- 2 15-ohm rheostats;
- 1 10-ohm rheostat;
- 1 Single-circuit jack;
- Binding posts, etc.

The circuit diagram for this receiver is shown in Fig. 79.

"C" batteries are used in conjunction with this receiver to obtain the proper bias on the radio frequency tube and on the first audio tube. Flexible leads should be used where the "C" battery is connected, in this particular circuit, to one end of the variable condenser in the radio frequency circuit, and to one end of the resistance in the first audio circuit. It is suggested, for best results, to use two 201A or 301A tubes; and two 199, or one 199 for the radio frequency amplifier circuit and one Sodion tube for the detector. Tubes other than the 199 in the R.F., and the Sodion in the detector stage will be found to cause undue oscillation. A special Hi-Mu tube (Daven U-20 or other similar tubes) may be used in the resistance-coupled stage. Do not attempt to use a transformer of a higher ratio than the 4:1 mentioned above, or distortion will result. A resistance is placed in series with the filament circuit of the first R.F.T. to cause a slight voltage drop, and thereby prevent the 199 tube from burning out from excessive filament voltage. The resistance should be in the neighborhood of 25 ohms. The filament adjustment of the Sodion tube is not very critical. It can be set at a certain position and left there permanently. The audio frequency rheostat can be adjusted and left in that position.

There are no extravagant claims made for this receiver. Remember, it is simply a home set, built especially for quality reproduction; and has not too many "gadgets" to adjust, although this receiver is capable of producing as good results as some of the numerous "much touted" ones.

SHORT-WAVE TRANSMISSION

(80) Mr. L. Donald, Sacramento, Calif., asks:

Q. 1. I am contemplating the constructing of a short-wave receiver of the plug-in type, to cover the wave-lengths from 20 to 100 meters. Will you please inform me as to whether there are any broadcasting stations operating on these wave-lengths, and also what wave-lengths are used by amateur transmitting stations?

A. 1. According to our latest available information, there are only four such broadcast stations operating regularly on these short waves. They are KDKA, at East Pittsburgh, Pa., which operates almost nightly on wave-lengths of 63 and 14 meters; Station WGY (2XAD and 2XAF) at Schenectady, N. Y., which transmits on 22.6, 26.2 and 32.8 meters with a rebroadcast of the regular transmission of WGY on 380 meters. Both of these stations come through with tremendous volume on these waves, being considerably louder than on their normal wave-length. WLW, Cincinnati, now broadcasts all its programs on 52.02 meters, and WABC, New York, on 64 meters.

The transmissions of KDKA and WGY have been heard repeatedly in Australia and South Africa, a fact which demonstrates the tremendous carrying power of high frequencies.

The wave-lengths now most used by amateur transmitting stations are the so-called 40- and 80-meter bands. The former to be exact, includes the wave-lengths between 37.5 meters and 42.5 meters; while the higher band, used principally for phone work, includes those from 75 to 85 meters.

THE ULTRADYNE L1 RECEIVER

(81) Mr. J. S. Arlington, Des Moines, Iowa, asks:

Q. 1. I am unable to procure blueprints or the original issue (February, 1924, issue of Radio News in which the Ultradyne circuit is described. The circulation department informed me that no additional copies are available. I, and several of my friends, would like to build this receiver, as we have heard much of its efficiency; in fact, have heard several receivers that incorporate this principle, and I am now determined to build one just like them. Can you please supply me with the necessary data? Undoubtedly you have some copy from which you could obtain the original information. Also, where can I purchase the parts which are most essential?

A. 1. In view of the fact that we have received innumerable requests for Ultradyne data, due to the shortage of back copies in which this information was published, we are herewith reprinting the Ultradyne article. All data are included, for both oscillator and antenna coils and the intermediate transformers; as these parts can no longer be purchased, due to present Super-Heterodyne litigation.

The Ultradyne Receiver By R. E. Lacault

The super-heterodyne receiver is coming more into use among the amateurs and broadcast listeners, on account of its numerous advantages; and it is our intention to describe in this article the construction of a super-heterodyne functioning under a new principle. This improved receiver, which has proved superior to the usual type, is the result of a long series of experiments carried out by the author. The principle of operation of this receiving system has already been explained in many text books and radio magazines; but we shall describe it again in a few words for the benefit of those who do not have such references at hand.

Everyone who has operated an ordinary regenerative receiver has noticed that, when a broadcast station is being received, a whistle is heard in the telephones when regeneration is increased beyond a certain limit. This is caused by the receiver itself, which oscillates and produces, by interference with the carrier-wave of the transmitting station, a beat note of an audible frequency. A beat note has a frequency equal to the difference between the two frequencies which produce it. For instance, if a carrier wave of 1,000 kilocycles is received, a beat note of 1,000 cycles will be heard in the receivers if an alternating current of 999 kilocycles, or 1,001 kilocycles, is made to interfere with the carrier wave.

In the super-heterodyne receiver, this principle is employed; but instead of producing bad notes at an audible frequency, beats of a super-audible frequency, such as 50 or 100 kilocycles are used. By means of a variable condenser the oscillator circuit may be tuned so that such a beat note is produced for any incoming signal. Therefore, no matter what the incoming signal frequency is, the signal which is amplified and detected is always of the same frequency. This is a great advantage, because it is easier to design a radio frequency amplifier to function on one frequency only, than one which amplifies in the same proportion a broad band of frequencies.

In most short-wave radio-frequency amplifiers using untuned transformers, the amplification varies for each frequency. It is generally found that greater amplification is obtained at two points while comparatively smaller amplification is had over the remainder of the frequency range covered by the transformer. If tuned radio-frequency transformers are employed, the tuning becomes very complicated, owing to the numerous controls; and it is difficult to tune in a station unless the entire amplifier is calibrated. The radio-frequency amplifier used in the super-heterodyne receiver is designed to amplify at maximum intensity at one frenquency only; thus increasing the selectivity, since only signal frequencies which are interfered with by means of the oscillator can pass through the amplifier.

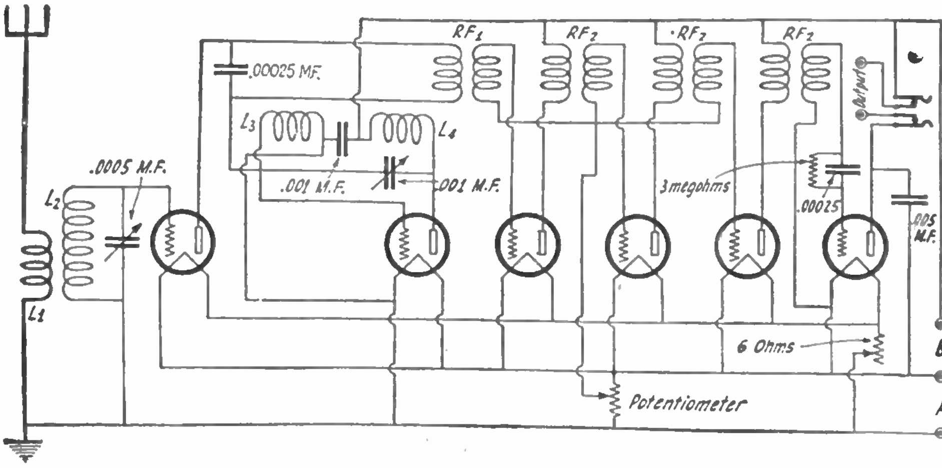


Fig. 81. This is the complete circuit diagram of the Ultradyne L-1 receiver, which incorporates the "modulation system." As explained in the text, one or two stages of audio frequency amplification should be added so that loud speaker results can be obtained on distant stations.

The Modulation System

In the ordinary type of super-heterodyne, the first tube employed as a frequency changer is connected as a detector with a grid-condenser and grid-leak. This detector rectifies the incoming signal after it has been heterodyned, and the variation caused in the plate circuit is amplified through a long wave radio-frequency amplifier. In the system to be described a new principle is made use of. This, which has been called the modulation system, causes the incoming signal to modulate the oscillations produced locally, in the same way that the speech modulates the output of the oscillator tubes in a radio-telephone transmitter. This system, which is a departure from the conventional detector arrangement is not only more simple, but produces a greater signal strength, which is more noticeable on weak signals.

Fig. 81A shows the principle of operation of the circuit. The first tube, which is called the modulator, is connected across the oscillating circuit of the oscillator; the plate-filament space acting as a resistance, the value of which is varied by the incoming signals impressed upon the grid. In this arrangement no "B" battery is necessary, for the plate of the modulator tube is supplied by high-frequency current from the oscillating circuit. To receive continuous waves, this arrangement is very efficient, and it has been applied very successfully to the super-heterodyne receiver described in the article.

To give an idea of the sensitiveness of this receiving arrangement we mention the results obtained with it in New York City, the set being installed on the fourth floor of an apartment house situated in a good location. Using only the secondary coil, composed of 72 turns of wire wound on a tube 3 inches in diameter, stations in Cincinnati, Detroit, Atlanta, Chicago and other cities are heard practically every night with good audibility. No audio-frequency amplification is used, and no loop, aerial or ground is connected to the receiver. With one or two stages of audio frequency the loud speaker may be oper-

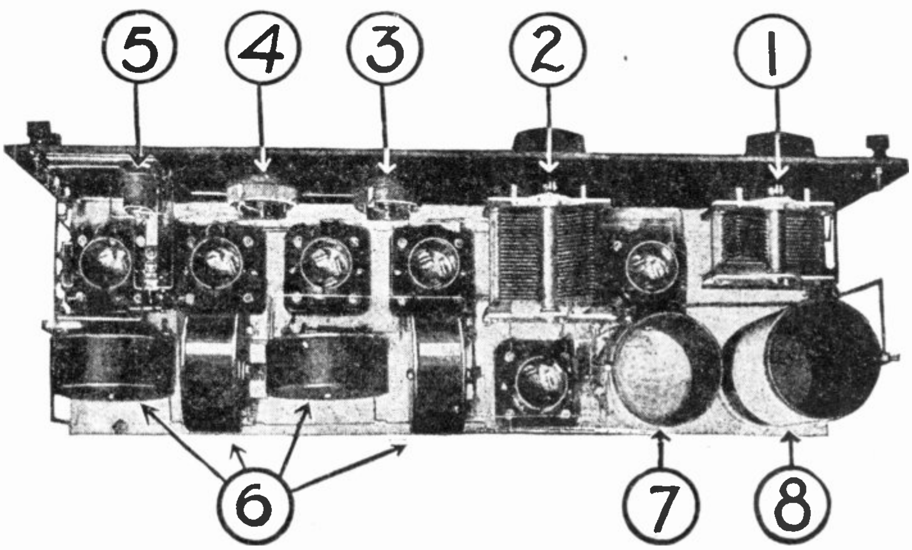


Fig. 81C. Illustration of the Ultradyne L-1 receiver showing panel and parts layout. Note that the intermediate frequency transformers are mounted at right angles at each other to prevent interstage coupling. A slightly larger panel is required, if audio frequency amplification is to be added to the receiver.

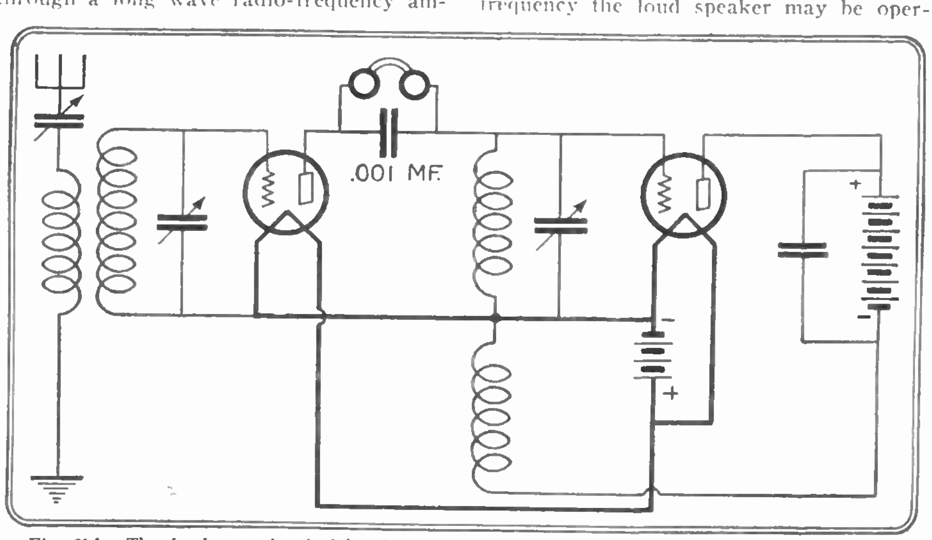


Fig. 81A. The fundamental principle of the Ultradyne receiver, showing the first detector and oscillator circuit employing the efficient modulation system. This method is a radical departure from the conventional, and results in a receiver of remarkable efficiency.

ated and, of course, the music and speech are audible throughout the apartment.

Hook-up and Parts

Fig. 81 is a complete diagram of connections of the receiver. The entire outfit may be mounted in a cabinet 7x24 inches, and is composed of the following parts:

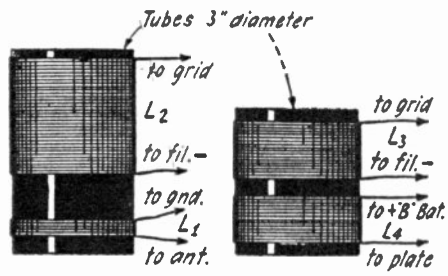
1 Panel 7x24 inches,
1 Cabinet 7x24 inches,
1 Variable Condenser .001-mf., with vernier,
1 Variable Condenser, .0005-mf., with or without vernier,
1 Potentiometer,
1 Rheostat, 6-ohm,
1 Double-Circuit Jack,
1 Battery Switch,
7 Binding Posts,
6 Sockets,
4 Radio-Frequency transformers,
1 Grid Condenser, .00025-mf.,
1 Fixed Condenser, .005-mf.,
1 Grid-Leak with mountings,
1 Fixed Condenser, .00025-mf.,
1 Fixed Condenser, .0025-mf.,
1 Tube of bakelite, hard rubber or formica, 3 inches in diameter and 6 inches long,
1 Tube of the same material, same diameter, 3¾ inches long,
Bus-bar for connections, screws, baseboard 7x23 inches, wire, etc.

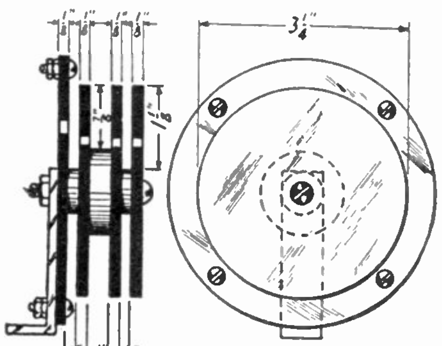
The constructional details of the tuning inductance and of the oscillator coil are given in Fig. 81B. L1, which is the untuned primary, consists of eight turns of No. 20 D.C.C. wire, wound half an inch from the end of the tubing. L2 which constitutes the secondary, is wound with 72 turns of the same wire, and 1½ inches away from the primary on the same tubing. The oscillator coil is composed of two sections wound in the same direction, as shown in Fig. 81B. The first section L3, connected between the grid and the filament of the oscillator tube, is composed of 24 turns of No. 20 D.C.C. wire; while the second section, L4, connected between the plate and "B" battery, is wound with 32 turns of the same wire. These coils should be carefully wound and given a light coat of special varnish, which may be obtained from firms manufacturing insulating materials. If no such varnish is obtainable, a light coat of varnish made of acetone, in which celluloid is dissolved, will do very nicely. No shellac should be used on the coils.

It is advisable to fasten the ends of the wire, in each coil, to small screws with nuts fixed on the tubing, as this permits a good connection to be made between the connecting wires and the inductance. The coils may be fastened to the baseboard supporting them by means of small brackets made of brass strips bent at right-angles as shown in Fig. 81B. The ends of the wire in each coil should be soldered to the screws fastened to the tubing, in order to insure perfect contact. Once the set is wired, a drop of solder should also be applied to the joint of the bus-bar wire and the screw.

R. F. Transformers

The radio-frequency transformers may be of any suitable type designed for long wave reception. Those used in the receiver illustrated are of a special design; and may be easily constructed of hard wood or insulating material, such as hard rubber or bakelite. Fig. 81B shows how these transformers are constructed. They may be turned out of a solid piece, or made up of discs of the proper thickness and diameter. The end disk, which is of greater diameter than the others, supports four screws or binding posts, to which are fastened the ends of the primary and secondary windings; and a bracket, made of a strip of brass fastened under the screw holding the unit, permits its mounting on the baseboard. The primary should be wound first and should consist of 500 turns of No. 28 double silk covered wire in the center slot which is ¼-inch wide. The secondary is wound in two sections with No. 30 double silk covered wire; 550 turns should be wound in each slot on each side of the primary. The two sections may be wound without breaking the wire by passing it over the primary from one section to the other. To maintain the ends of the wires in place, a drop of sealing wax may be applied on the last turn of both windings. Once the transformers are





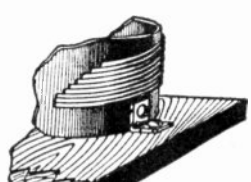


Fig. 81B. Constructional data for antenna and oscillator coils and intermediate frequency transformers. Refer to text for number of turns, etc.

wound, the screws used as binding posts are fixed on the large disc and the ends of the wire are soldered to them.

The beginning of the primary and secondary windings should go to the positive pole of the "B" battery and center arm of the potentiometer respectively; while the outside ends of the windings are connected to the plates and grids of the amplifying tubes. In order to reduce the action of one transformer upon the other, they should be mounted so that their axes are at right-angles to each other. It should be noted that the primary of the first transformer is wound with only 300 turns, so that its natural frequency is brought up to that of the other transformers when the .00025-mf. by-pass condenser is connected across it.

Picture No. 81C shows the arrangement of parts on the baseboard supporting the outfit. In order to simplify the wiring of the receiver, it would be advisable to proceed as follows: after the various pieces of apparatus mounted on the panel are fixed, all the wires which are against the panel may be placed and soldered. The sockets, inductances, and transformers are then wired separately and the panel fixed to the base. The only connections which remain to be made are those joining the condensers, rheostat, potentiometer and binding posts.

Before mounting the various parts on the panel and baseboard, it is a good precaution to screw tightly all the screws and bolts of the sockets, rheostats and other apparatus, which are very difficult to reach with tools, once they are fixed on the panel or board. We strongly recommend that any amateur attempting to build such a receiver, use instruments of good quality, as this is an important factor in the results obtained with a super-heterodyne receiver of this type. The connections should be made with bus-bar wire bent at right-angles, or else with No. 16 copper wire, which is cheaper and very efficient for connections.

Aerial and Ground

If a loop aerial is used, the tuning inductance composed of L1 and L2 is not necessary, since the loop is connected across the first condenser in place of the inductance L2. However, it is preferable to use a short antenna; as the signal strength is greatly increased with this type of collector. If no antenna can be installed outdoors, a single wire, stretched around a room at a distance of about a foot from the walls and ceiling by means of insulators, will be preferable to a loop. The ground connection may be taken on the radiator system, the water pipe, or any other grounded metal-work. If none is available, a counterpoise may be made with a length of lamp cord wound spiral-fashion under the carpet or rug.

The tuning of the super-heterodyne receiver is extremely simple, and in a short time anyone should be able to bring in distant stations, provided the tuning and oscillator condensers are turned very slowly. As the tuning is very sharp, a vernier is necessary on the oscillator condenser, but it may be dispensed with on the tuning condenser, which is not so critical in adjustment. The receiver may be calibrated if the same loop or tuning circuit is used at all times; and if desired a silver dial may be employed on the tuning condenser, thus permitting the inscription of the station call letters to be put directly on it.

To tune the receiver, the tuning condenser should be moved two degrees at a time, and the oscillator condenser turned over the whole scale range for each setting of the tuning condenser. Some station should be heard at one place or another along the scale; if whistles are heard, the potentiometer controlling the radio frequency amplifier should be turned until the whistles stop. The station may then be brought in loudly and clearly. The potentiometer may then be adjusted at the most critical point, where amplification is maximum; and need not be readjusted unless very weak signals are tuned in. The rheostat acts as a vernier for the potentiometer, and sometimes may prove quite useful in bringing to good audibility a distant station. It will be found that signals are heard at two different adjustments of the oscillator condenser; it is best to try the setting which gives loudest signals. After a few hours spent in operating this receiver, it will be quite easy to tune in stations, for at a certain point a slight rushing noise is heard, indicating that a carrier wave is tuned in.

From 45 to 90 volts of "B" battery may be used on this receiver. If an audio frequency amplifier is added to operate the loud speaker, it is advisable to use a separate "B" battery on the audio frequency tubes, although the same filament battery may be used. It is recommended to use 201-A or 301-A tubes for the modulator and radio frequency amplifier. A different tube may be used as a detector, although very good results may be obtained with one of the above-mentioned tubes, if the proper grid-leak resistance is used. For the oscillator we would recommend a 216-A, or E tube (VT-2), although any other tube which operates well as an oscillator may be employed. It is a good idea to try the tubes in different positions, for very often some tubes function better in some stages than in others.

NEW YORK EVENING JOURNAL CIRCUITS

(82) Mr. R. Contini, Brooklyn, N. Y., asks:

Q. 1. Can you furnish me with the circuit diagram of the Journal's new One-Knob set, and all other data necessary for the proper construction of this receiver, as I am unable to obtain the radio section of the New York Journal in which this receiver was published? Please do not give the schematic circuit diagram, as I am unable, as yet, to understand radio symbols. A diagram of the picture type, that is, showing a picture of the various instruments used and the wiring connected to the various instruments in the proper order, will be greatly appreciated. Also, may the coils be purchased? I would rather buy them than attempt to construct them (due to lack of radio experience), unless absolutely necessary.

A. 1. We are herewith showing a set diagram of the new Journal One-Knob receiver in Fig. 82A. Also, due to the enormous popularity of this and other circuits published by the New York Evening Journal, and the numerous requests received for this and the other circuits, we are publishing the entire group, including all the data necessary for the construction of each. The circuits are named as follows:

Journal One-Knob Circuit, Journal Selective Filter Tuner, and the Journal One-Tube One-Knob Set. (The last will appear in next month's issue.)

The following is the list of parts necessary for the construction of the Journal One-Knob set (5 tubes):

1 Panel 7x21x3-16 inches,
1 Baseboard, 10x19 inches. This size is necessary because of the triple-gang condenser, room for which must be provided.
1 Single-Circuit Jack,
1 Battery Switch,
1 Triple or three-gang Condenser of three .00035-mf. units, all of which are rotated by a single shaft,
1 Grid Leak, 2-megohm,
1 Grid Condenser, .00025-mf.,
9 Binding posts, etc.

The coils are wound with a half-pound of No. 22 D.C.C. copper wire on bakelite tubes three inches in diameter. The first tube, the aerial coupler, is 3 inches long; the other two each 3½ inches long. Three rotor coils are 2¾ inches in diameter and ¾-inch long. We know of no commercial manufacturer who is producing these coils. It is possible to obtain coils somewhat similar in construction and rewind to make them coincide.

Adjustments

The following is a description, taken from the New York Journal, of the proper method of adjusting the receiver.

"The process of balancing the Journal's new one-knob set is done somewhat in this manner: tune in a long wave station around 500 meters, more or less, for a preliminary test to determine if the condenser sections need to be balanced. Take a ruler without a metal edge or a wooden stick, not a pencil, and turn the rotor of one coil and then another, beginning with the aerial, one way or another to hear which position gives the loudest signal.

"When this is found turn the condenser to another station lower in the wave-scale, and make another adjustment of the coil rotors. If a gain in signal strength is observed it indicates that the condenser sections are not balanced; and if no gain occurs it shows that the sections need no further attention.

"If the condenser sections are balanced properly, they will show an equal reduction in capacity as the shaft is turned toward the lower wave-scale; and when this is so the coils will be tuned alike on the high and low waves. If one section of the triple condenser reduces in unequal amount, one coil will be out of tune, which will be shown when the rotor, being turned, will increase the volume at any point.

To Change Capacity

"Each section of the condenser is provided with a means of increasing or decreasing the capacity, to compensate for any differences that exist between one section of the condenser and another. To balance the condenser, tune in a long-wave station again, and move the compensating plate on each section, using a stick to avoid hand-capacity effects, until the best setting is obtained, indicated by the greatest volume.

"The long wave stations are best for balancing because adjustments of the set at these points are not subject to regenerative effects that occur in the lower bands. If balancing is attempted in these low channels, the results will be false because of the increased volume produced by regeneration when the balance is upset. Here is one case where the strongest impulse is obtained when the set is unbalanced, a fact which will be recognized when one makes the test. For this reason, the preliminary balances of both coils and condenser sections should be made on waves above 450 meters. After they are obtained, further refinements may be made on the shorter wave settings.

"If you suspect that one section is badly out of tune with another, it can be tested by a simple process. Wind a ten-turn aerial coil, with leads long enough to be connected to the aerial and ground and placed in different positions in the set. Place this aerial coil about three inches from the detector secondary and, with the two radio frequency tubes turned off, observe the setting of the dial when tuning the detector alone. Note this setting, and move the coil to the second radio frequency secondary, and turn on the second tube, removing the first from the socket and observing this setting. By comparing the settings you can instantly tell which section is unbalanced, and compensate accordingly. This is never necessary if the coils and condensers are made accurately.

"It will be found that the two vertical-coil rotors will be in about the same position when balanced. The aerial coil position depends on the length of the aerial. A change in the position of any rotor or compensator affects the entire set.

The Filter Tuner

"This is a one-tube set, and can be used with one or two tubes of audio frequency amplification. The signal from the aerial passes through an untuned primary coil and is filtered from other signals by two intermediate, or linking coils, before it reaches the secondary. Two features of the Filter Tuner, giving it a unique place in radio, are the arrangements for reducing the resistance of the linking circuit and for controlling the current used for the purpose.

"Increased selectivity without loss of volume is accomplished by including one of the linking coils in the plate circuit. The wiring, as shown in Fig. 82B, is sim-

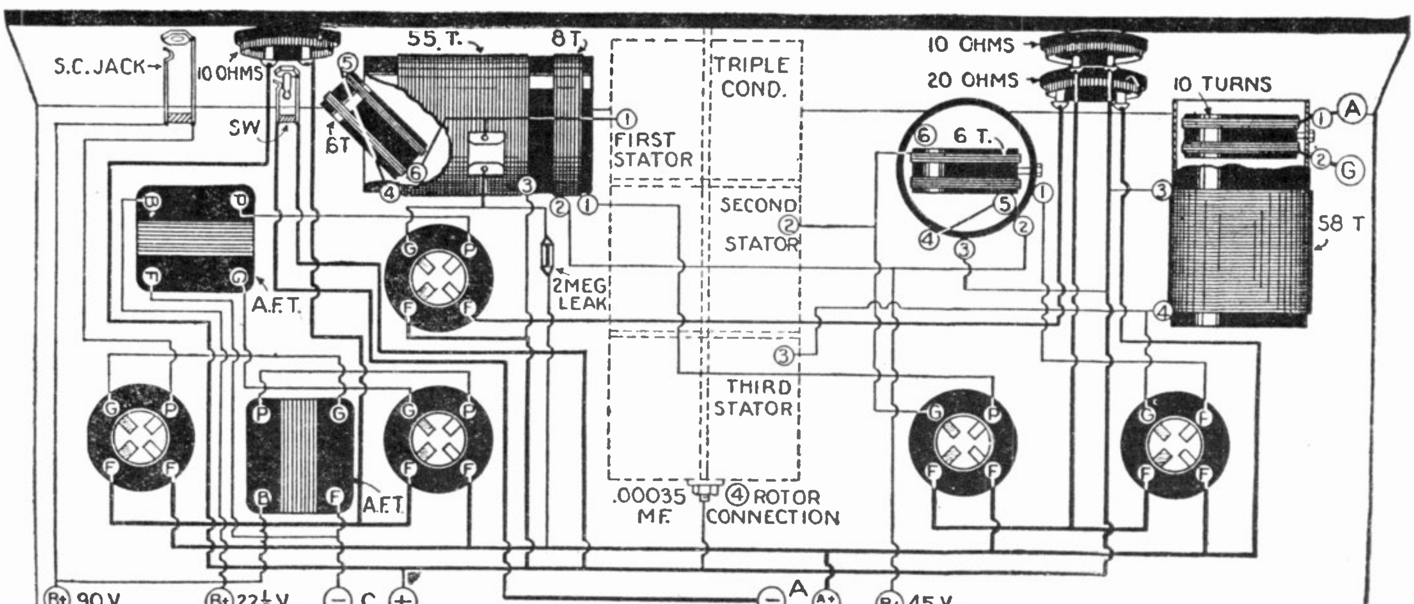


Fig. 82A. The Journal One-Knob, five-tube, receiver consisting of two stages of radio frequency amplification and regenerative detector, resulting in an extremely efficient and selective receiver, although only one dial is employed for tuning. Any type of tubes may be employed in this receiver, although for best results it is advisable that storage-battery type, 201-A or 301-A tubes be used throughout.

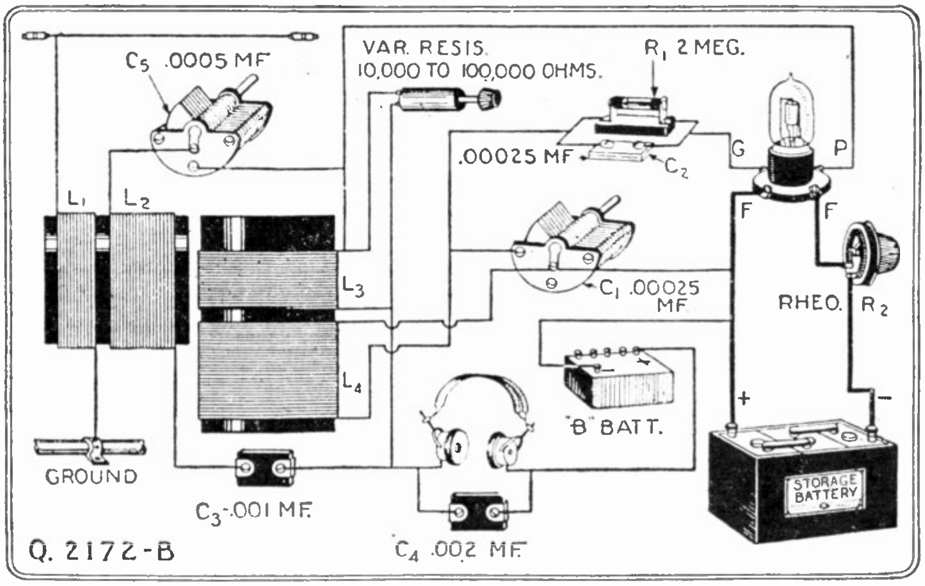


Fig. 82B. The Journal One-Knob Filter Tuner, is an efficient one-tube receiver which is very popular with New York fans. A consistent DX-getter, and yet easily operated. Either the dry-cell or storage-battery type tube may be employed, with practically equal efficiency.

ple, and the set is appreciated by the person who likes to build a receiver at home. Regardless of the theoretical complexity of the circuit, it can be made and operated by the novice.

"Standard parts are used, which may be obtained at the cost of an ordinary one-tube set. The coils are wound on two bakelite or cardboard tubes, three inches in diameter. The tube for the primary and first filter coil is four inches long; and that for the second filter coil and secondary winding is six inches long. No. 20 D.C.C. copper wire is used on the four coils.

"Both filter coils, L2 and L3, have forty turns each, while the primary L1 has twenty-five, and the secondary L4 sixty turns. As shown in the arrangement of the parts, the tubes are mounted at right-angles, to eliminate inductive transfer of energy from the primary to the secondary direct. This excludes all but the desired station.

"The variable-resistance unit controls the strength of the magnetic field produced by the second filter coil L3 which, in turn, affects the entire filter circuit. This controls regeneration and volume. The grid-leak, R1, and condenser, C2, may be 2-megohm and .00025-mf., respectively. The "B" battery should not exceed 67 volts on the detector."

The set can be built into a 7x12-inch panel and cabinet. The filter variable condenser C5 should be mounted on the left of the panel and the secondary condenser C1 on the right. The filament rheostat R2 and filter resistance can be mounted vertically in line between these condensers, with the latter on top. The six-inch tube should be mounted vertically with the primary and the first filter coil in position behind the filter condenser. The terminals of the coils should be brought through holes bored in the tube with a 1-16-inch drill, and their position should be near their terminal connections.

By using a 7x10-inch hard-rubber panel for a baseboard, mounting it to the main panel with brass angles, a first-class job can be made of the wiring, which may be concealed beneath the panel. On the front of the panel are mounted the aerial and ground binding posts; and on the base-panel are mounted the "A" and "B" battery binding posts.

The operator will develop his own system of tuning the set, but in general he will find that the two variable condensers tune with about the same settings, and that stations are picked up best by advancing the filter condenser slightly more than the secondary condenser. Clearing up distant stations is done by turning the filter condenser slightly behind the position of the secondary condenser. A point of adjustment is found on the filter resistance where signals over a given wave-band may be received without further adjustment of that unit. With this set a long aerial can be used to advantage, as none of the interfering problems common to other one-tube sets are encountered.

JOURNAL'S ONE-KNOB ONE-TUBE SET

(83) We quote the description and constructional information on the One-Knob One-Tube set; illustrated by a schematic diagram of this simple receiver.

"This set has proven itself to be one of the most remarkable developments of radio, and for ease of operation, maximum strength of broadcast music as well as the reception of long distance stations, it is hard to beat. The cost of a set of this kind is relatively small and it will give results equal, if not superior, to many sets selling for several hundred dollars. Its chief feature lies in the fact that it has only one control, which is for wavelength only, the regeneration being fixed at the best point.

"The two coils of wire, shown at the left of the Fig. 83, are both wound on the same cardboard tube, which is three inches in diameter. The upper coil is called the primary and consists of 20 turns of No. 22 S.C.C. wire; and the secondary, on the same cardboard tube, one-quarter of an inch away, consists of 50 turns of the same size wire. Make absolutely certain that both coils run in the same direction, otherwise the set will not work. The only thing that is at all critical about this set is the wiring from the secondary coil to the rest of the circuit. If the set does not seem to work right at first, simply remove the wires where they are connected to this secondary coil and reverse them. It is also highly advisable not to use too much "B" battery, because it will make the tube oscillate too easily. Separate "B" batteries should be used if audio frequency amplifiers are added. Radio frequency amplification will not work with a set of this kind.

"No taps of any kind should be used with this set, the .0005-mf. vernier condenser across the secondary coil giving sufficient tuning; and it will be found that the set tunes extremely sharp, no trouble being experienced in bringing in long-distance stations while the locals are sending. Of course, if you are located close to a broadcasting station, you may not be able to tune him out; but generally speaking the other stations may be brought in through the locals without the least trouble.

"In order to make this, or any other set, work properly it is essential that the plans and specifications be followed just as closely as possible. Do not try to use a larger condenser in place of the one shown, because the set will probably be a failure if this is done.

"In order to overcome any hand-capacity effect that may be present, it is advisable to glue a piece of tinfoil on the inside of the panel in the place where the condenser is put. Make absolutely certain that none of this tinfoil touches the metal of the condenser at any place. One side of this is connected to the ground binding post. This will act as a shield and will positively eliminate all capacity effects. A vernier rheostat may also be of assistance with a critical detector tube. Never place the variable condenser inside

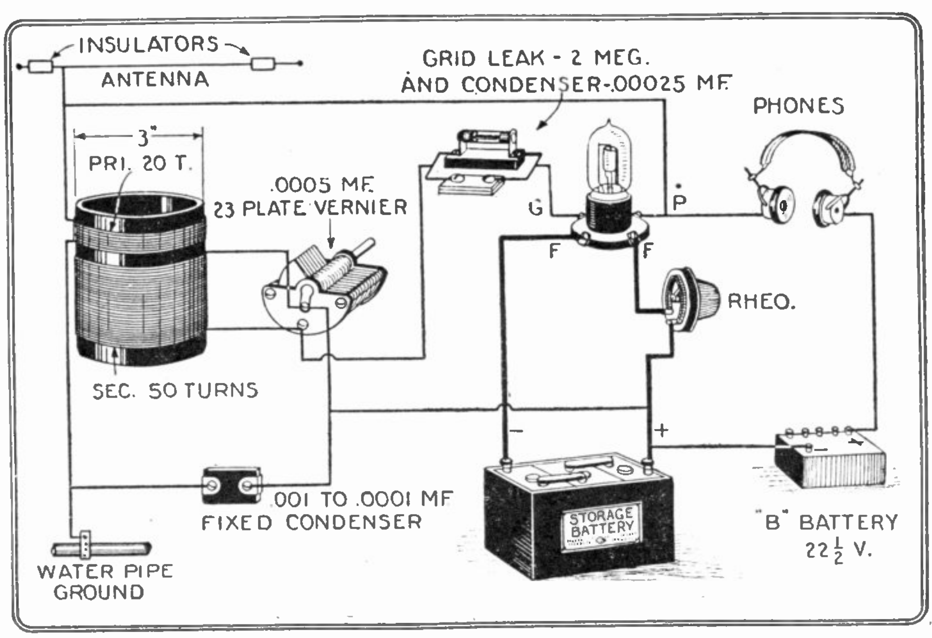


Fig. 83. The Journal One-Knob One-Tube set. An unusually efficient receiver employing regeneration, with only one dial to tune. Extraordinary results have been reported from this set.

of the inductance coil. This is extremely bad practice."

PRIZE WINNING SET

(84) Mr. M. L. Newmann, Brooklyn, N. Y., asks as follows:

Q. 1. Dr. C. H. Hullinger of Clinton, Iowa, won the International Broadcast Test cup for 1926, for receiving most European and other foreign stations during the recent International Broadcast Test Week. Have you any information available relative to the circuit or type of receiver employed by Dr. Hullinger? Any helpful information that you might be able to give me would be greatly appreciated.

A. 1. The circuit employed by Dr. C. H. Hullinger of Clinton, Iowa, with which he won the International Broadcast Test Cup for 1926, is none other than R. E. Lacault's famous L-2 Ultradyne, in which is included his well known Modulation System. The same circuit brought in European stations consistently in 1925.

Because of the system employed, the tuning is extremely sharp and any station within range may be received without intereference from locals. The tuning is extremely simple on account of the small number of controls required; only the variable condensers have to be adjusted for tuning. These features combined make the Ultradyne the ideal receiver for experimenters who want to receive distant stations.

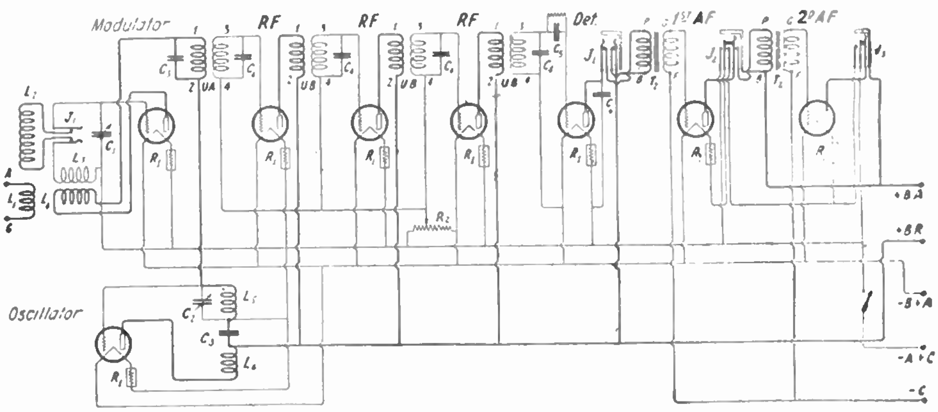
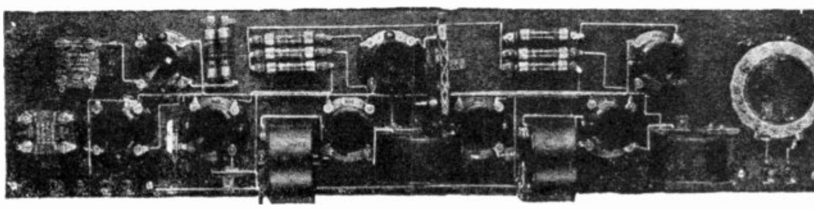


Fig. 84. Wiring diagram of the Ultradyne L-2. L1 has 7 turns, L2 36 turns, L3 20 turns, L5 36 turns, L6 22 turns.



View of the interior of the Ultradyne L-2 receiver. The layout, with its fine balance helps to make this set highly efficient.

To give an idea of the sensitiveness of the Ultradyne we may mention the fact that in New York City, using only a coil three inches in diameter, wound with 60 turns of No. 20 wire, instead of a loop, broadcast stations in Chicago, Detroit, Cleveland, Cincinnati, Atlanta and even Cuba are heard with good audibility practically every night. The reception is accomplished on the detector alone, or with one stage of audio-frequency amplification. With two stages, a loud speaker may be operated with good volume.

In order to help all others interested to assemble this efficient type of Super-Heterodyne receiver, embodying the Ultradyne circuit, the following data are given. No. 84 is the diagram of connections of the complete receiver with two stages of audio-frequency amplification. Jacks are shown, which allow the use of the detector alone, or with one or two stages of audio-frequency amplification to operate a loud speaker or to receive extremely weak signals. By means of a double-circuit jack a loop aerial may be substituted for the tuning circuit; this is an interesting feature which allows instantaneous comparison of efficiency between an aerial and a loop, when receiving from a certain station; for when the loop is plugged in all the connections are changed automatically.

List of Ultradyne Parts

The following is a complete list of parts required for experimenters to construct a Model L-2 Ultradyne Receiver:

One cabinet, 7x30 inches, with baseboard and panel;
Two variable condensers, .0005-mf.;
Two vernier dials;
One tuning coil;
One oscillator coil;
One ultraformer, type "A";
One ultraformer, type "B";
Three ultraformers, type "B";
One double-circuit and one single-circuit
Two bakelite binding-post mountings;
One grid condenser, .005-mf., with grid-leak mounting;
Bus bar wire, No. 14 copper tinned;
One low-loss 180° coupler, with shield;
One dial for coupler;
Eight vacuum tube sockets;
One potentiometer;
Eight automatic filament adjusters;
Two double-circuit jacks;
One double-circuit and one single-circuit filament control jacks;
One filament switch;
Two audio-frequency transformers;
One grid leak;
Seven binding posts;
Two bakelite binding-post mounting strips;
One grid condenser, .0005-mf., with grid-leak mounting;
Five fixed condensers, .00025-mf.;
Two fixed condensers, .001 and .005-mf.;
Bus bar wire, No. 14 copper tinned, with assortment of screws and nuts.

Ultraformers

The radio-frequency transformers used in the Ultradyne receiver, are of a different design from those generally employed in such receivers. They are so constructed that they amplify at one wave-length only. The band of frequencies amplified by these Ultraformers is just wide enough to avoid distortion of radio telephone signals; but these are, nevertheless, sharp enough in tuning to provide the necessary selectivity. The first Ultraformer, connected between the plate of the modulator tube and the grid of the oscillator tube, is of a slightly different construction, the primary being shunted by a small fixed condenser to tune it to exactly the proper frequency. It is important that the capacity of this fixed condenser be exactly .00025-mf., as otherwise the frequency of the input circuit will be different and the amplifier will not operate as efficiently as it should.

The basket-weave coils can be replaced by tubular coils, using tubes 3½ inches in diameter. The primary of the antenna coupler consists of 7 turns of No. 22 D.C.C. wire, and the secondary of 36 turns of the same size wire. The oscillator coupler has a grid coil of 36 turns of No. 22 D.C.C. wire and plate coil has 22 turns.

The sensitizer coupler has a rotor coil of 20 turns and a stator coil of 26 turns, both No. 26 S.S.C. wire.

For exact constructional data of the transformers and coils, see the "I Want to Know" columns of the May, 1926, issue of RADIO NEWS, in which all the necessary details were published. The ultraformers may be of the same type as are employed in the L1 model, described in that article.

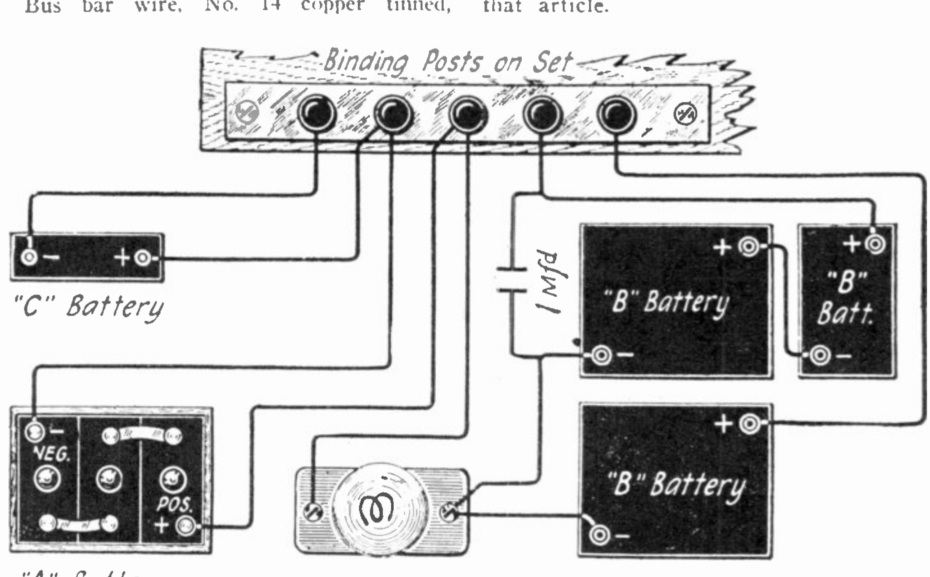


Fig. 84A. Method of connecting batteries to the Ultradyne L-2 receiver. A special test lamp is used to detect a possible short circuit in the receiver, and prevent burning out tubes.

Assembling and Wiring

The construction of a Super-Heterodyne receiver is no more complicated than that of any other radio receiver, and such sets as the Ultradyne are in fact easy to construct. Any experimenter, even though he has but little experience with tools, may build an Ultradyne with good chances of success if the instructions given hereafter are carefully followed, and if apparatus of suitable quality is employed.

After procuring all the apparatus necessary for the construction of the receiver, it should be carefully examined to see if all is in proper condition to be used. It is a good precaution, before fixing the sockets, to make sure that the screws acting as terminals are tight. The potentiometer should also be looked over before mounting. The coils, sockets, and the Ultraformers are mounted on the baseboard and should be arranged as shown in the illustration and diagrams.

When connecting the variable condensers, care should be taken to connect the movable plates to the negative filament lead, as shown in the wiring diagram. This is important if capacity effect from the body of the operator is to be avoided when tuning.

In order to facilitate the work it is advisable to wire the panel and the base separately, and then connect the various circuits after the panel is fixed against the edge of the base. It is easy to wire both the panel and base by following carefully the wiring diagram.

The wiring of the receiver, should be done very carefully and slowly, as results depend greatly upon the position of the wires in the set. Each connection fastened under a screw or nut should be made by bending the end of the wire or bus bar with a pair of round-nosed pliers, or soldering it to lugs fastened under the screws on the instrument.

The wire or bus bar should be bent at right angles.

Note that the shield between the panel and feed-back coupler is connected to the negative lead of the "A" battery.

When wiring the eight-tube receiver, which is equipped with two stages of audio-frequency amplification, one should be careful not to run the wires, connecting the audio-frequency transformers to the jacks, too close together, as this might cause a feed-back, and make the amplifier howl. It is also important, when wiring the audio- and radio-frequency amplifiers, to keep the connections from the secondary windings to the grid terminals on the sockets reasonably short, in order to insure higher efficiency.

Antenna

Almost any type of antenna may be employed with an Ultradyne receiver and if the special coupler shown in the illustration is used, no extra control is necessary for the tuning of the antenna circuit. The antenna may be of the outdoor or indoor type, and consist of a single wire about 100 feet long, well insulated, and supported as far away as possible from walls, trees or structures. A good indoor antenna may consist of a single wire stretched around the room about 6 to 12 inches away from the walls and ceiling and supported in the corners of the room by means of small insulators. The end of the wire is connected to the receiver and constitutes the lead-in.

Very good results may also be obtained by using a loop or coil antenna wound on a frame. If the frame is constructed so that the loop is three feet square, eight turns of No. 18 wire or lamp cord spaced one-half inch apart and supported by strips of insulating material, are suitable to cover the broadcast wave-lengths. If the frame is only two feet square, ten turns will be required, also spaced one-half inch apart. Smaller sized loops may be employed with Ultradyne receivers, and some very suitable loops of this type are now obtainable on the market. A folding loop is quite practical when used with an Ultradyne receiver, as the complete outfit becomes portable and may be installed in an automobile or be carried to camp during the summer.

Tuning

Turn the oscillator dial one degree at a time, and for each setting of this dial turn the tuning dial over the whole range slowly. If nothing is heard at any setting, move the oscillator dial one more degree and repeat the process with the tuning dial. At some point one should hear a station, and it will be noticed that a slight hissing noise is heard when the station is transmitting but no one speaking or singing in the microphone. This indicates the presence of a carrier wave, and will help in tuning other stations when the same slight noise is heard. All this tuning should be done with the potentiometer turned so that no whistles are heard. If whistles are present, the potentiometer should be turned toward the positive side until the whistles stop, at which point the amplifier operates at its maximum sensitiveness.

When tuning in distant stations, it may be necessary to readjust the potentiometer slightly. This should be done only after the station is heard faintly but clearly enough to increase the amplification. When tuning in very weak signals from distant stations, the feed-back coupler should be turned slowly until a whistle is heard, and moved back just below this point. A slight readjustment of the two condensers will then bring the signal to the maximum audibility. When tuning in another station, turn the feed-back coupler to zero (coils at right angles) and tune first with the two condensers as explained above, then adjust the coupler as soon as the station is tuned in.

When operating the loud speaker with two stages of audio-frequency amplification, a certain amount of the extra noises which may be present on account of static or other disturbances can be reduced by slightly turning down the potentiometer. When using the telephone receivers, it is only necessary to use the detector or one stage of audio-frenquency amplification.

Vacuum Tubes

Almost any kind of vacuum tube may be used in the Ultradyne receiver; however, we would advise the UV201-A or C301-A throughout.

If desired the low-consumption tubes, such as the UV199 or C299, may be employed throughout in the Ultradyne. WD11 or WD12 tubes are also suitable. Although it is not absolutely necessary, it is advisable to use two separate "B" batteries, one set exclusively for the two stages of audio-frequency amplification. This will reduce noises considerably, and also the tendency to feed-back which is often present in such amplifiers. The same "A" battery may be used for all the tubes, however, without experiencing any trouble. The small UV199 or C299 tubes may be used with adapters in the standard sockets or in special sockets.

If the special sockets are used, care should be taken when wiring the receiver to connect the sockets correctly, as the position of the binding posts is not the same as on standard ones.

Batteries

If standard six-volt tubes are employed in the Ultradyne receiver, a six-volt "A" storage battery should be employed as a filament current supply. The connection of this battery to the receiver is shown in the wiring diagram in which one may notice that the same binding posts are used to connect two batteries. This is to simplify the construction and avoid the use of too many binding posts. Whenever possible, it is advisable to use about 45 volts of "B" battery on the radio-frequency tubes, and 90 volts on the audio-frequency tubes. No tap is taken for the detector as this is only necessary when a "soft tube" or gas-content detector is employed. The use of such a tube is not advisable in superheterodyne receivers, as it requires critical adjustment of the filament and plate current and does not improve the results in such sensitive receiving sets. If greater volume is wanted, the "B" battery voltage on the audio-frequency amplifier may be increased to 100 or 120 volts, provided the "C" battery is increased from 4½ to about 9 volts. The "C" battery need only be a small flashlight battery, of a type now obtainable on the market for use in audio-frequency amplifiers. It is advisable to connect a 1.0-mf. fixed condenser across each "B" battery.

If low-voltage tubes, such as UV199 or C299, are used, the set may easily be carried to camp or in a car; for it is then possible to use dry cells as a filament battery. To supply eight of these tubes, six No. 6 dry cells are necessary, connected in series parallel.

If UV199 or WD11 tubes are used, the proper type of automatic filament resistance should be selected, depending upon the voltage of the "A" battery.

Full information, with profuse illustrations, and layout patterns for the construction of this receiver, is contained in a descriptive booklet titled "How to Build and Operate the Ultradyne Receiver." This is somewhat hard to get (discontinued), although it may be obtained from some distributors who may have a few copies left.

SILVER SIX RECEIVER

(85) Mr. N. R. Evans, South Bend, Ind., asks as follows:

Q. 1. Can you supply me with the constructional data and schematic wiring diagram of the Silver Six receiver about which I have heard much? The set, as I understand it, employs the desirable feature of plug-in coils, thus enabling a variable wave-length range to be covered. This characteristic is something that I have sought for a long time, as I am very much interested in short-wave reception. The honeycomb coil receiver lacks flexibility, that is, it is impossible to add radio-frequency amplification to it without complications.

A. 1. The following is the description of the Silver Six receiver which you desire:

"The 'Silver Six' is a six-tube broadcast receiver of advanced design, using either loop or outdoor antenna for the reception of broadcasting programs on any wave-length. It is of the tuned-radio-frequency type, embodying several features which render it extremely sensitive and selective, that are not found in standard equipment.

"The circuit employed includes two stages of tuned-radio-frequency amplification, a detector, and three stages of resistance-coupled audio amplification.

"The radio-frequency amplifier uses a new type of inductance, plugging into special sockets, which permits the interchanging of coils for various wave-length ranges. The R.F. transformers are of special design, so built that while their losses are extremely low, any tendency toward undesirable oscillation is very slight, and where present, easily controlled. The antenna coupler is provided with a small adjustable rotor winding, which allows the receiver to be adjusted to suit any particular antenna conditions for each wave-length band it is desired to cover.

"The 'gain control' system employed, inaugurates a new departure in R.F. amplifier design, for it permits perfect control of oscillation and volume without in any way distorting the operating characteristics or selectivity of the circuits, as done by methods heretofore employed, such as grid bias, potentiometers, etc.

"Straight-line-frequency condensers insure maximum selectivity and ease of tuning, since stations will be found separated by a given number of kilocycles per dial degree (approximately ten, or one transmission channel, per degree) instead of by wave-length as heretofore.

"The detector tube, contrary to the customary practice, rectifies by virtue of a negative grid potential, causing it to operate upon the 'knee' of its E_g I_p characteristic curve. This insures maximum handling capacity without distortion, as well as lower detector-circuit losses than would be obtained with a grid-condenser-leak combination."

Assembly

The assembly of the receiver is quite simple. All necessary parts to build it are listed below, and can be obtained in kit form:

- Three variable condensers, .00035-mf. S.L.F.;
- Three dials, 4-inch;
- One set of three plug-in inductances and sockets, designed especially for this receiver;
- Six UX-tube sockets;
- One rheostat, 3-ohm;
- One variable resistance, ½-megohm;
- One kit of resistance-couplings, designed for this circuit;
- One filament switch;
- Two jacks, one open-, one closed-circuit;
- Two by-pass condensers, ½-mf.;
- One fixed condenser, .002-mf.;
- One baseboard 7x24, busbar, screws, etc.;
- One wiring cable, colored.

"The cable is included to simplify the wiring; as any ordinary layman with no practical experience can solder the various connections by simply following the color scheme furnished along with the cable which is especially designed for this receiver. Bus-wire connections may be used instead, if so desired.

"With the tubes in place, pull out the filament switch, and rotate the rheostat from left to right until it is almost all the way around—say within one-quarter inch of the full-on position. The tubes should then be lighted fairly brightly. A plug connected to a pair of headphones should be inserted in the jack, and the grid posts of all tube sockets touched with the fingers. Clicks or squeals will be heard if the receiver is functioning properly.

"The volume control should be turned all the way to the right, or clock-wise, and the three dials set at about fifty degrees. If either end dial is varied over a range of two or three degrees, a click will be heard, possibly followed by a squeal or series of squeals, the pitch of which may be varied by rotating the dials slightly. The volume rheostat should be turned so that its arrow points straight to the right, and the small rotor coil in the antenna inductance slowly turned in so that its axis will coincide with that of the stator coil, until rotating the dials near approximately similar settings fails to cause clicks, squeals, etc. If for any reason, setting this rotor entirely in does not eliminate squealing, then this can easily be done by retarding the volume control to the left until it ceases.

"Tuning in local stations will be an easy matter, and is accomplished by setting all dials at five degrees, then at ten degrees, and so on up their scales in three- to five-degree steps. Once a station is heard it can be brought in to maximum volume by adjusting each dial carefully. However, if the volume control is too far to the right, distortion will be bad and the receiver unstable. Therefore, the volume control should always be operated to the left of the point where distortion begins to occur.

"If the receiver is logged, it will be found that all three dials will remain substantially an even number of degrees apart over their entire scales. This may be overcome, and all three made to read alike by loosening two, holding the condenser plates in position, and shifting the dials only on the condenser shafts so that their readings coincide with the third dial's before tightening them again.

Wave-Length Ranges

"The wave-length range of this receiver includes both the amateur and broadcast bands, that is, 50 to 500 or 600 meters. The constructional data for these coils were published in an article titled "An Improved Laboratory Super-Heterodyne Receiver," in the January, 1926, issue of RADIO NEWS. The dimensions specified in that article for the antenna coupler for various wave-length ranges will be entirely satisfactory for the construction of these coils. These coils in their various sizes may also be purchased, if so desired.

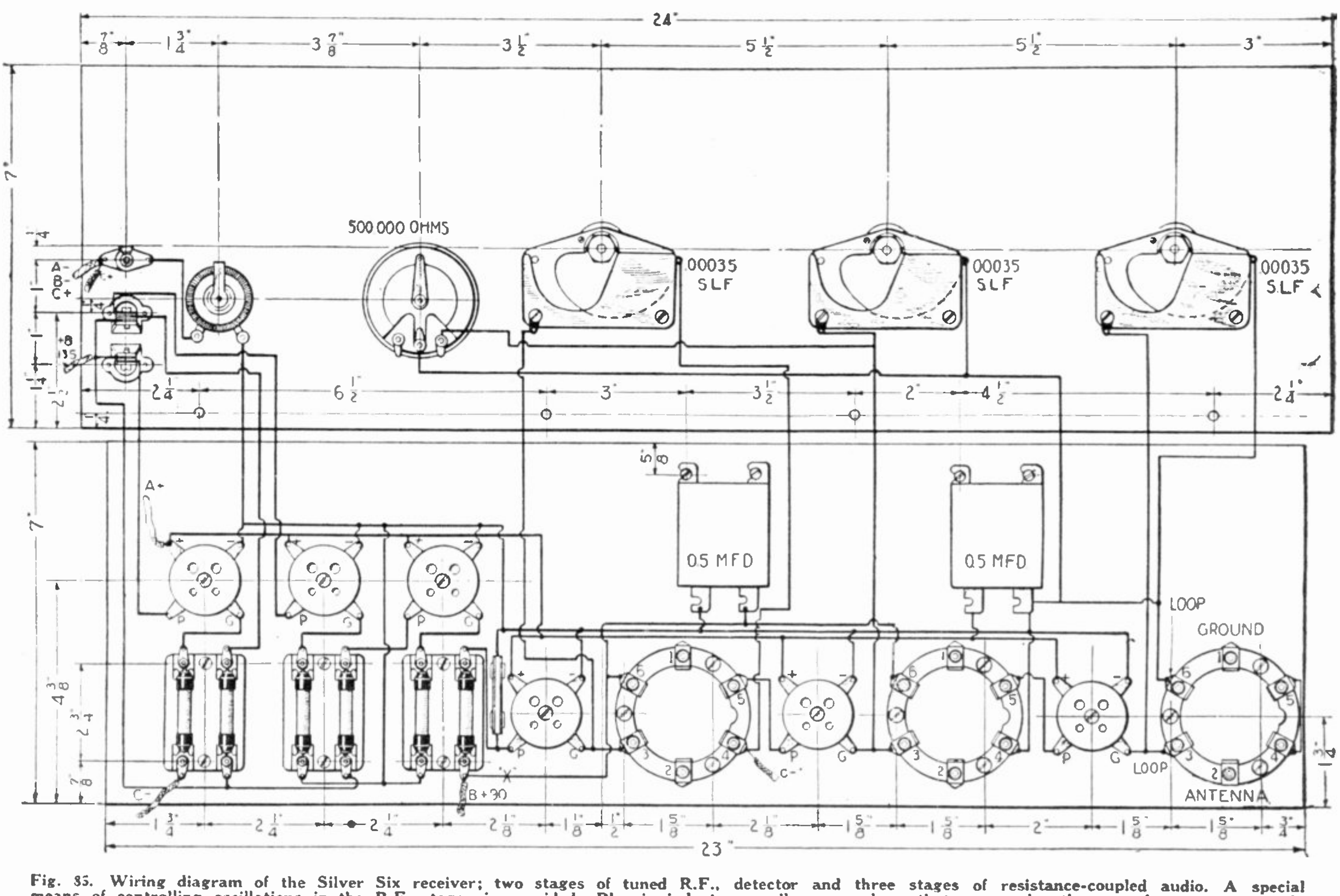


Fig. 85. Wiring diagram of the Silver Six receiver; two stages of tuned R.F., detector and three stages of resistance-coupled audio. A special means of controlling oscillations in the R.F. stages is provided. Plug-in inductance coils are used, so that a wave-length range from approximately 50 to 500 meters may be covered.

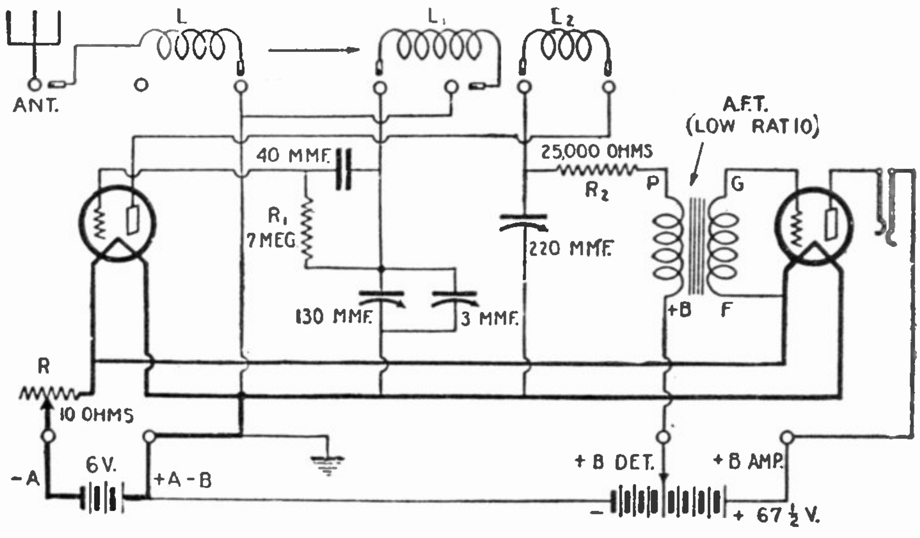


Fig. 86. The Grebe Short-Wave receiver (CR-18), employs plug-in coil inductances, by which a variable wave-length range of from approximately 8:52 to 216 meters may be covered. Constructional data for the receiver are given.

"In some cases, the receiver may be too unstable on the lower ranges. Should this be the case, the remedy is to remove one or two turns from the small (5 to 6) winding of each No. 112 coil covering the troublesome range. In cases when the receiver will not operate on the higher wave-lengths, it may be necessary to add rather than remove turns from the R.F. coils. This is due to variation in tube characteristics.

Dry Cell Tubes

"It is perfectly feasible to use dry-cell tubes in the 'Six.' They should be of the UX-199 type throughout. No change in the design or wiring of the receiver is necessary for these tubes. The same batteries will be required as for UX-201-A tubes, except the storage battery, in place of which six standard dry cells must be used, connected in series parellel. This means that three cells must first be connected in series—the center post of one to the outside post of the next, and so to the third. The other three cells are similarly connected. This will then give two groups of three cells in series. The unconnected center posts of each series should be joined and led to the "+A" lead. The unconnected outside posts of the cells on the other ends of the groups then connect together and go to the "—A" lead. Using UX-199 tubes, the rheostat should be barely turned on—not further than when its arrow points straight to the left. Dry-cell tubes will give about 10 per cent. less volume than storage-battery tubes.

"The last audio tube, or right hand one, may well be a power tube for maximum volume. For use with UV-201-A's, its type number would be UX-112 or UX-171; for UX-199's the proper type is UX-120. With either style it will be necessary to turn the rheostat slightly further on than when standard tubes are used, and to supply the proper "C" battery voltage."

GREBE SHORT-WAVE RECEIVER

(86) Mr. B. P. Deverest, Ottawa, Can., asks as follows:

Q. 1. I am informed that A. H. Grebe has developed a new short-wave receiver, "CR-18" I think. Can you furnish me with any constructional information concerning same, as I am very much interested in short-wave sets?

A. 1. All the available information on the Grebe CR-18 short-wave receiver, is obtained from their booklet "Instruction and Operating Manual." All the necessary data which we think you might need, contained in that booklet, are herewith reprinted.

Short-Wave Receiver Design

"In designing a receiver for short-wave reception, many problems are encountered which are not met with when dealing with the higher wave-lengths. Radio frequency amplification does not seem to offer any particular advantages, and more complex circuits using multi-stage amplifiers are either unstable or have too many operating controls to be of any practical use.

"The adjustable-tickler-coil circuit, for example, is inferior at very short wavelengths, because a change in regeneration produces so great a change in wave-length that the transmitting station cannot be received with any degree of certainty. On the other hand, the capacity feed-back coupling method generally used results in stray-capacity effect so great that tuning is destroyed and the receiver becomes difficult to operate. While a few receivers have been designed, using the above mentioned circuits, generally the wave-length range of such sets is small and they can only be used to cover a limited band.

"In order to receive continous-wave stations to the best advantage, the circuit should be such that the point of oscillation is practically constant over the entire tuning range. For reception of broadcasting on the high frequencies, however, the regeneration control should operate in such a manner that the change from oscillating to non-oscillating condition is gradual rather than sudden.

"The CR-18 receiver has been designed with all these points in mind, and a study of the circuit will reveal that variable electro-magnetic coupling between the antenna and secondary circuit is employed, contrary to the usual practice of using a small coupling condenser. This coupling coil permits a greater transfer of energy without affecting the wave-length calibration, and affords greater selectivity, reduces interference and induction noise and makes possible the use of harmonic tuning when using a large antenna.

Interchangeable Coils

"In order that tuning shall not be too critical the receiver is provided with five different coils which cover wave-length ranges, as shown above. The winding indicated as "L" may be approximately 8 turns. Coupling is varied by changing its position or proximity to the other windings.

"These coils are fitted with plugs and are mounted outside of the cabinet, in order to reduce all losses and permit the coils to be interchanged without delay or difficulty. (No. 16 or 18 DCC wire will be satisfactory for winding these coils). Although each coil covers only a small wave-length range, the frequency-range is very large; and for this reason the beat-frequency control, consisting of a small variable air condenser, is incorporated in the receiver. This condenser permits one to discriminate between stations separated by only a fraction of a kilocycle and makes it possible to hold a station which is swinging or changing its frequency.

"In place of a choke-coil in the plate circuit, the CR-18 employs a resistance. This resistance eliminates non-oscillating points in the tuning range which frequently occur when a choke-coil is used. Cushion sockets are used to eliminate all vibration and microphonic disturbances which seriously affect the operation of a short-wave receiver.

Coil No.	Wave-Length range-Meters	L1 turns	Space	L2 turns	Frequency range Mega-cycles
1	8.5- 18	1	1	2	16.6 -35
2	15.8- 31	3	1	2	9.7 -19
3	29 - 62	8	1	4	4.85-10.3
4	56 -112	18	2	6	2.68- 5.35
5	107 -216	49	1	18	1.38- 2.8

Operating Instructions

"The CR-18 is designed to operate with 201-A, 5-volt, ¼-ampere, X-type-base vacuum tubes. It is some times advisable to reverse the tubes in order to obtain the most desirable results. A storage battery should be used for filament supply.

"At least 90 volts of 'B' battery is necessary. A clip should be provided on the detector lead, so that variation of detector plate-voltage may be easily secured, as certain coils require more voltage than others.

"The antenna should consist of a single wire, approximately 75 or 100 feet in length including the lead-in, and should be well insulated. Good results may be obtained with an antenna as short as 25 feet, or even an indoor antenna may be resorted to. Connection to the ground should be made securely by means of a ground clamp fastened to a water pipe or radiator system. Care should be exercised in making all connections, as loose connections are more detrimental on short waves than on the higher wave-lengths.

"Set the wave-length dial on '0,' and starting at '0' on the regeneration dial slowly increase the reading to 35 or as far as necessary to cause indications of oscillation to be heard in the telephones. This point is usually 40 but will be subject to slight variations. When the point on the regeneration dial at which oscillations occur has been determined, move the dial 5 points higher. The receiver should now be in an oscillating condition over the entire wave-length range covered by the wave-length dial. A simple test to determine whether the receiver is oscillating or not is to touch the left-hand screw on the secondary coil; if a click is heard in the telephones the receiver is oscillating.

"Insert the antenna coupling coil and connect the antenna to the binding post provided. Adjust the antenna coil so that there is a separation of two inches between the top of this coil and the top of the secondary. Note again whether oscillations take place; if they have stopped, increase the regeneration dial 10 degrees and if this is not sufficient to cause oscillations, further separate the antenna coil from the secondary coil. Starting at '0', move the wave-length dial to 100; and if points are found where the receiver stops oscillating, it indicates that the antenna circuit or a harmonic of it is in tune with the secondary circuit.

"If in later experience it is found that these non-oscillating points fall directly in the most generally used wave-length ranges, the points may be shifted by either at 75 meters; fifth at 60 meters, etc. If the antenna coil is close to the secondary coil, the receiver will stop oscillating at these wave-lengths. However, if oscillations are again restored by any of the previously-mentioned methods, stronger signals will be obtained at these points than on other wave-lengths in the tuning range. It is therefore, possible to adjust any antenna so that some harmonic falls on approximately the wave-lengths one desires to receive. The advantage of this method is that a long antenna may be used, which naturally will have better pick-up qualities.

"It is important for the operator to realize at the outset that the frequency band included in a single wave-length dial division is sufficient to accommodate as many as fifteen stations; and while

Q. 1. Can you furnish me with the schematic wiring diagram of the Radiola 28 receiver? Accidentally a few connections have become loose and I would like to obtain a wiring diagram, so that I can trace the connections and find the proper places for the loose connections.

A. 1. The schematic wiring diagram of the Radiola 28 receiver is shown in Fig. 87. Those who may desire to construct a super-heterodyne receiver employing this circuit and peculiar characteristics, will be interested to know that any 60-kc. type of intermediate-frequency transformer can be satisfactorily employed. The UV-1714 transformer (5,000 meters) will serve excellently in conjunction with the oscillator coupler illustrated in answer to 87. The loop circuit is tuned by a .0005-mf. variable condenser, preferably

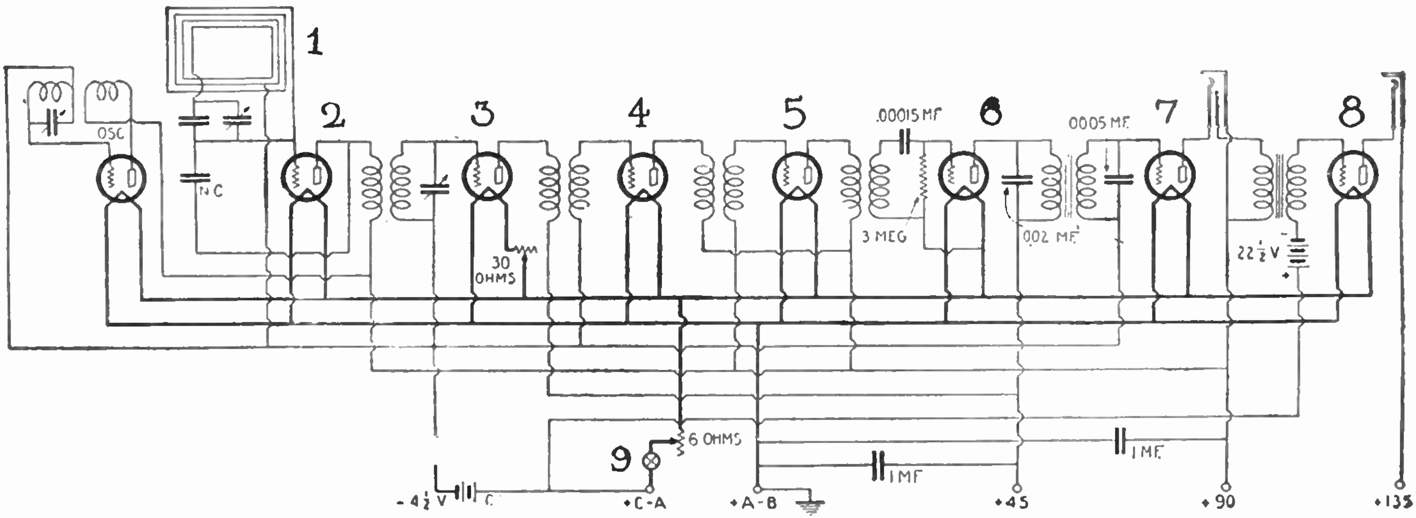


Fig. 87. The circuit diagram of the Radiola 28 receiver (superheterodyne type). Superheterodyne parts designed to operate with an intermediate-frequency amplifier of the 5,000-meter type (60 kc.) may be employed satisfactorily with this particular circuit.

lengthening or shortening the aerial. It will be impossible under certain conditions to eliminate all these points, regardless of the treatment of the antenna; but when these points appear, moving the antenna coil further away from the secondary coil will again permit oscillation to be maintained. Moving the regeneration dial to a higher point will also accomplish this, but it is preferable to utilize the antenna coupling coil for this purpose.

Use of Antenna Condenser

"With further reference to the occurrence of non-oscillating points on the wave-length dial, some may prefer to use a third method of shifting or eliminating such points. It may be accomplished by connecting a small variable condenser with a capacity of .00035- or .0005-mf. between the aerial and the antenna binding post on the receiver. By tuning this external condenser, a point will be found where the receiver stops oscillating; and by adjusting the condenser, above or below this point, stable operation will again be restored.

"It is important for the operator to appreciate fully the advantages that may be gained by harmonic tuning. This can be accomplished by using a small variable condenser connected in series with the antenna and the coupling coil. The effects are most noted on wave-lengths in which the fundamental period of the antenna is some multiple of the received wave-length.

"For example, if the length of the antenna is such that, when it is connected to the antenna coupling coil, it has a natural period of 300 meters, the following harmonics would occur; second harmonic at 150 meters; third at 100 meters; fourth

very fine tuning can be secured with the tangent wheel, many of the stations will be passed over unless use is made of the beat-frequency control. The tuning values of the main wave-length condenser and the beat-frequency control are so proportioned that, whereas approximately fifteen stations will be found in one degree of the wave-length dial (one notch of the tangent wheel) each station may be separated by approximately one notch of the beat-frequency control wheel. With this in mind, the operator will soon become familiar with the tuning capabilities of this receiver.

Reception of Code

"When receiving C.W. or I.C.W. code signals, the regeneration dial should be reduced to the lowest reading possible, where oscillations are just maintained. This will result in weak signals being received with greater intensity. In other words, the weaker the signal, the weaker the oscillations in the receiver should be for maximum intensity in the telephones. However, where signals are easily readable, stronger oscillations may be used and are helpful in reducing noises and low-frequency interference.

"In order to receive broadcasting or speech it is necessary to keep the receiver in a non-oscillating condition. Maximum strength of reception will be obtained when the regeneration dial is set just below the oscillating point. A final critical adjustment can be made by using the filament rheostat."

RADIOLA 28 RECEIVER

(87) Mr. L. J. Kanter, Cleveland, Ohio, asks as follows:

of the straight-line-frequency type. The oscillator condenser is of the same capacity. A UX-120 power tube is employed in the last stage, for which increased "B" and "C" voltages must be used. The small neutralizing condenser, indicated as NC on the diagram, is an ordinary small midget balancing condenser, consisting of 5 or 7 small plates (total, including stator and rotor plates). The original model was specially designed to operate with dry-cell tubes.

BEST'S 5-TUBE SUPERHETERODYNE SET

(88) Mr. H. T. Borden, Portland, Maine, asks as follows:

Q. 1. I am advised that G. M. Best has designed a new superheterodyne receiver, a 5-tube affair. Have you any constructional data on this receiver? Would appreciate any schematic diagram and any additional information.

A. 1. The Best 5-tube superhetrodyne receiver was originally featured in the April, 1926, issue of "Radio" magazine. The following are parts of the description of this receiver from the article, written by G. M. Best, which appeared in the publication mentioned.

"The salient features of the circuit are selectivity, superb quality of output, excellent volume with cone loud speaker, by the use of a power tube, economy in battery consumption, as only five tubes are required, and ease of assembly by the use of two carborundum crystal detectors for the frequency changer and the detector, commonly called the first and second detectors. It has long been known that crystals could be used in these positions in a superheterodyne; but the objections were that the crystal was not easily adjusted, had a low internal resistance which destroyed selectivity, and was not sufficiently sensitive.

"The new carborundum detector, however, has none of these disadvantages, as it has a permanent adjustment under pressure which prevents instability; has a high internal resistance, so that the detector will have little or no damping effect on the tuned transformer or antenna tuner; and is remarkably sensitive. The carborundum detector, in order to produce maximum results, requires a small battery to control the detector resistance and sensitivity. A new unit is now available which consists of a small flash-light dry cell, a potentiometer, by-pass condenser and carborundum detector, arranged for convenient panel mounting and adjustment.

"Working with two of these detectors as a basis, a five-tube super-heterodyne was developed, which had the sensitivity of a seven-tube circuit, with greater selectivity and less battery drain than conventional five-tube tuned R.F. receivers. (By reference to the schematic wiring diagram in Fig. 88, the general arrangement of the circuit can be understood.)

Avoiding Radiation

"While the set can be operated with a loop antenna, many readers object to the loop for various reasons, and prefer to use an outdoor antenna. Realizing that the indiscriminate use of the set with the antenna without due regard to the radiation of the receiver when improperly operated, would cause a great amount of harm to neighboring receivers, an antenna system was selected, which, when properly adjusted, will cause a minimum amount of radiation of the oscillator output. The antenna circuit consists of a series air condenser, loading coil, and coupling coil. If the loading coil is the proper size, the antenna system will tune through the broadcast band without difficulty. The coupling coil is arranged so that very loose coupling can be obtained, and a center tapped secondary is used to obtain greater selectivity.

"The antenna condenser is mounted on the left end of the panel, and the secondary tuning condenser, which is similar in size to the antenna condenser, is in the center of the panel.

"The frequency-changer circuit is connected to the secondary of the antenna tuner, and consists of a pick-up coil placed in the field of the oscillator, a carborundum detector unit, and the primary of the first intermediate-frequency transformer. The oscillator is of the conventional pattern, and is tuned by another variable condenser of .0005-mf. capacity in series with a protective .006-mf. fixed condenser; the latter preventing tube burn-outs in case the air condenser develops a short circuit.

"The intermedaite-frequency amplifier consists of two stages, with storage-battery tubes.

"Parts necessary for the construction of this receiver are as follows:

- 3 Variable condensers, .0005-mf.;
- 1 Antenna load coil;
- 1 Antenna coupler;
- 1 Oscillator coupler;
- 2 Intermediate-frequency transformers;
- 1 Filter transformer;
- 2 Audio-frequency transformers;
- 2 Carborundum crystal-detector units;
- 4 Automatic filament resistances, ¼-amp. size;
- 1 Automatic filament resistance, ½-amp. size;
- 1 Filament switch;
- 2 Fixed condenser, 1-mf.;
- 1 Mica condenser, .006-mf.;
- 1 Mica condenser, .002-mf.;
- 1 Filter tuning condenser;
- 1 Grid leak, ½-megohm with mounting;
- 1 Tube-protective resistance unit—500-ohm;
- 2 4½-volt "C" batteries;
- 5 X-type sockets;
- 1 Single-circuit jack;
- 1 Variable resistor, 50,000-ohm;
- 1 Binding post strip—7 posts;
- 1 Panel, 10x20x3/16 in.;
- 1 Bakelite or formica shelf, 5x18¾x¼ in.;
- 2 Brackets for shelf;
- Insulated and bare wire, 3 doz. ½-in. 6/32 r.h. brass machine screws, and four 1-in. flat-head brass 6/32 machine screws for fastening brackets to panel.

Coil Data

"The antenna coil may be made by winding 125 turns of No. 26 silk-covered wire on a 2¾-in. bakelite tube 3 in. long. The antenna tuning coil comprises a stator and rotor. The stator coil consists of 70 turns of No. 26 S.C. wire, wound on a 2¼-in. tube, 2½-in. long; a tap is taken off at the 35th turn, for connection to the ground circuit. The rotor, or antenna coupling coil, is wound on a 1½-in. tube, and consists of 10 turns of No. 26 S.C. wire. If the set is not sufficiently selective, it may be necessary to reduce the number of turns of wire on the rotor.

"The oscillator-coupler is identical in dimensions with the antenna coupling coil, except that when using the "A" tube as an oscillator, 5 turns in the pick-up coil will be ample; and it may be possible to reduce the turns to 3 or 4, where sufficient energy is obtained from the oscillator. In this connection, the "A" tube delivers more energy as an oscillator than a type 99 tube under similar conditions; and it is a good idea to reduce the oscillator output by placing an additional filament resistance cartridge in series with the filament of the oscillator, which will serve to reduce the filament current of the tube. A variable filament rheostat at this point would give greater flexibility, but it has been found that two 6-volt automatic filament control units in series will reduce the oscillator output to just the right amount. If the type 99 tube is used, the normal filament current of 60 milliamperes should be employed."

HERALD-TRIBUNE FIVE-TUBE SET

(89) Mr. N. R. Porter, Miami Beach, Fla., asks:

Q. 1. The New York *Herald-Tribune* published some time last summer an unusually selective five-tube radio receiver which impressed me very much. I am desirous of constructing this set, but have lost the description of this receiver. Have you the information available, or do you keep files of other radio publications?

A. 1. The article to which we think you refer, is entitled "A Select Five-Tube Radio Receiver," and was published in the *Herald-Tribune's* Radio Section. The receiver is unusually selective and, we believe, will prove interesting to circuit seekers. We are, therefore, reprinting practically the entire description including all the necessary constructional details.

"There is nothing particularly new in this circuit, which is the old Weagant, with a few variations. The set originally was designed for local reception only, but one local did not come in very well, so a stage of audio-frequency amplification was added. A location in the center of Manhattan was selected for a test. In this particular spot the locals have a habit of overpowering each other at times. Sev-

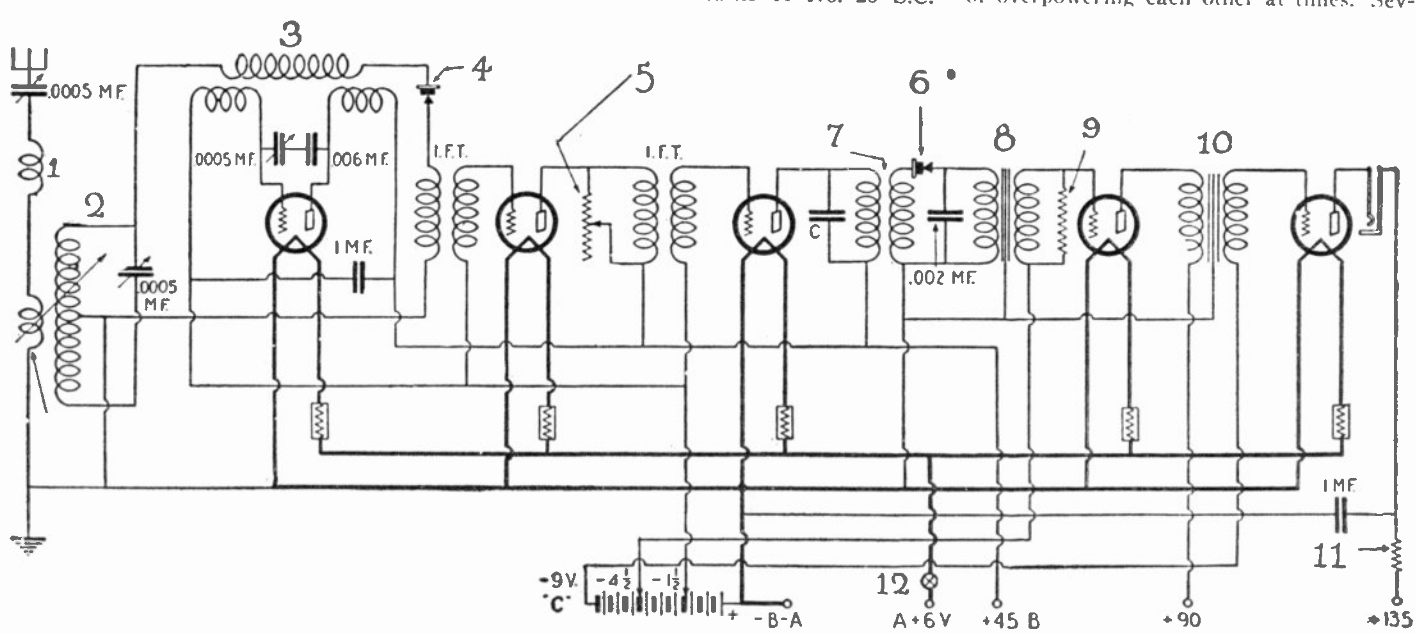


Fig. 88. Best's 5-tube super. An innovation in supers, in that three tubes are eliminated by means of two crystal detectors. Although the sensitivity of the original receiver decreases somewhat, the set is unusually efficient and will satisfy particular constructors, especially as regards DX, volume, and clarity.

eral other sets had been tried out previously, sets which had been boosted as being ultra-selective, but which usually had brought in two stations at a time. The result of the test with the Weagant circuit was very satisfactory, all the locals being easily separated and the selectivity being close enough without any cutting of side bands. The volume was ample and the quality equal to any set the author has heard. The set is compact, the panel being 7x21 inches, and the baseboard 12x20 inches. The length of the panel is only 21 inches, making it shorter than the average for a set using this circuit, which is about 26 inches. The arrangement of

"To obtain a variable capacity of .0002-mf. maximum for the regenerator, a larger condenser can be used by removing a number of the rotor plates. In this case, a .00035-mf. condenser was used, after removing four rotor plates, which brought the capacity down to what was estimated at approximately .0002-mf.

"The inductance forms can be fastened directly to the baseboard with a wood screw, or elevated a half inch or so on S-shaped strips of brass.

"The set should ordinarily tune from 200 to 526 meters smoothly and with equal volume. However, several sets that were built were found a little tricky on wave-

on a little shelf in the corner of the cabinet on the audio side of the set. When the 171 power tube is used, the choke-condenser output circuit must be employed.

Parts Required

1 Cabinet, 21 in. long and 12 in. deep;
1 Baseboard, 7 in. x 20 in. wood. Brass strip, ½ x 1/16;
1 Panel, 7 x 21 x 3/16 in.;
2 Variable Condensers, .0005-mf.;
1 Variable Condenser, .0002-mf.;
5 201-A Tubes;
2 Rheostats;
2 Sockets;
3 Sockets, gang, bakelite;

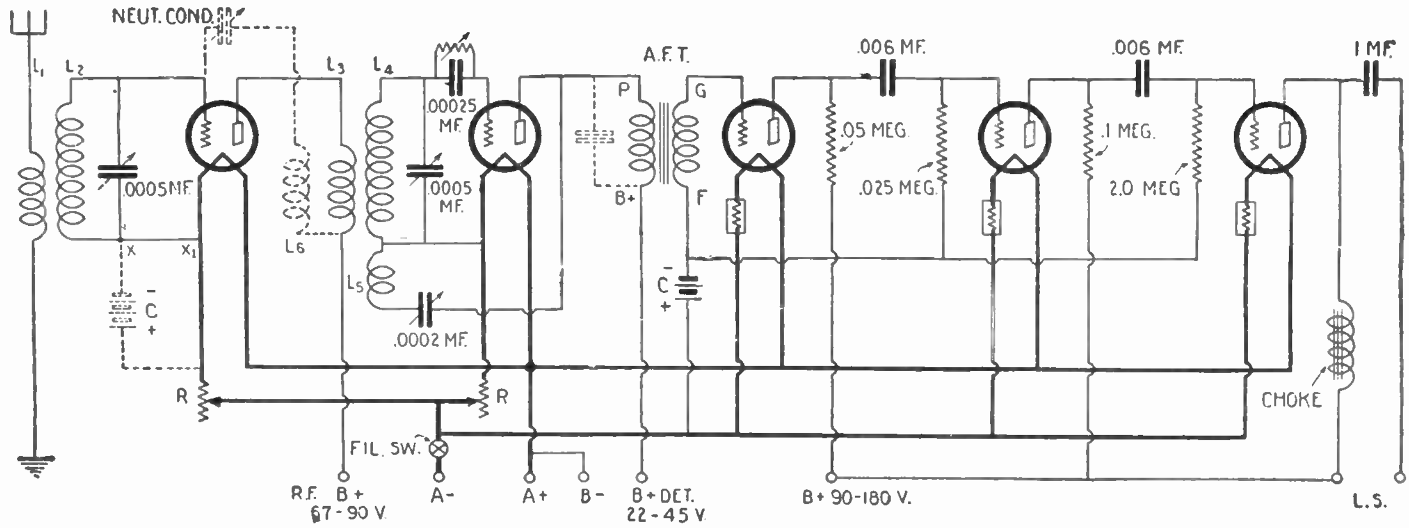


Fig. 89. A composite 5-tube set, whose peculiar features are a combination to make up a set that will be noted for its performance. It consists of a neutralized tuned RF stage, a modified Hartley type of detector, one stage of transformer-coupled audio-frequency amplification, and two stages of resistance-coupled audio-frequency amplification.

parts also is quite different, the result being a shortening and more direct running of leads and a more efficient placing of parts.

"The coils are of the ribbed type of hard-rubber tubing, recommended for its high electrical efficiency. There are twelve ribs running length-wise of the tube, spaced equally around the circumference. The turns of wire, touching only the tops of the ribs, leave a space under the coils and provide practically an air core. The antenna coil was wound on a 3-inch tube, 3 inches long, with No. 22 D.C.C. wire, fifteen turns for the primary coil (L1), and forty-six turns for the secondary (L-2). The number of turns for this coil may vary, depending upon the length and type of aerial used. The aerial used with this set was about seventy-five feet in length. If a shorter aerial is used, fifty to fifty-four turns may be required. The spacing between the primary and secondary is not critical; from one-eighth inch to one-quarter inch works equally well.

Construction of Coils

"The R.F. coil form is 3 inches in diameter, and 6 inches long, as it performs a three-fold duty—that of supporting the R.F. primary, the R.F. secondary and the regenerative coil. The R.F. primary coil (L3) is composed of twenty turns of No. 22 D.C.C., the R.F. secondary coil (L4) of forty-six turns of No. 22 D.C.C., and the regenerative coil (L5) of twelve turns of No. 30 D.C.C. The spacing between the R.F. primary and the R.F. secondary must be two inches; or slightly more may prove even better. This may seem to be a great distance to separate the two coils, but the coupling seems more than ample. The selectivity of this circuit is, no doubt, due to the extremely loose coupling of the primary and secondary. The regenerative coil (L5) is spaced about one-eighth inch from the secondary.

lengths under 300 meters—that is, there was a tendency to spill over and difficulty in balancing. This tendency was corrected by making use of the Rice system of neutralization, which consists of an inductance and a neutralizing condenser. These parts are indicated in the diagram to show their location; but need only be used if difficulty is experienced on the low wavelengths. There is, however, only one chance in a hundred of their being required. The coil, L6, is composed of the same number of turns as the R.F. coil, and is wound directly over the R.F. coil, L3, in this manner.

"Solder one end of the wire to the side of the R.F. coil marked "B + 67" and bring the wire diagonally across the R.F. coil and wind in the same direction as the winding on the R.F. coil; then fasten the twentieth turn to the neutralization condenser. The other side of the condenser leads to the grid of the R.F. tube. To operate, tune in one of the lowest stations you can get (where the squeal seems the lowest), and turn the condenser plates in or out, as the case may be, until the squeal just stops. The set should then tune from 200 to 526 without a whistle. The neutralizing condenser may be any suitable type procurable; a midget can be used.

"The tube in the last stage may be a 201-A if the horn type of loud-speaker is used. However, if the builder intends to use a cone speaker, he will require a great output voltage to properly vibrate the cone. The use of a UX-171 power tube is suggested here as a suitable means of providing the necessary power without distorting the signal. A self-adjusting rheostat of one-half ampere capacity must be provided for this type of tube.

"The choke and large condenser shown in the diagram can be used or not as the builder sees fit. The choke can be a standard commercial instrument designed for this purpose. The choke and condenser take up little space, and can be placed

2 Tubular Forms, 3 x 6 in. and 3 x 3 in. for coils;
1 Grid Leak, variable;
1 Grid Condenser, .00025-mf.;
3 Self-adjusting Rheostats and mountings;
1 Audio Transformer;
2 Resistor Couplers;
4 Resistances, .05, .25, .1 and 2.0 megohms;
2 Coupling Condenser, .006-mf.;
12 Binding Posts;
1 Terminal Strip, 1½ x 4 x 3/16 inches;
1 Terminal Strip, 1½ x 8 x 3/16 inches;
3 Dials;
1 Filament Switch;
¼ lb. No. 22 D.C.C. wire;
⅛ lb. No. 30 D.C. wire;
Miscellaneous, such as screws, wire for connections, etc."

KELLOGG R.F.L. RECEIVER

(90) Mr. W. D. Bridge, Scranton, Pa., asks:

Q. 1. I would like to construct the Kellogg R.F.L. receiver, but lack the necessary constructional data, especially the condenser and coil values. Can you furnish me with the desired information, also whether the receiver is designed for power-tube operation, and the correct plate and grid voltages necessary for the power tube, if used?

A. 1. The following is all the constructional information we have available on the Kellogg R.F.L. receiver. Schematic wiring diagram is Fig. 90.

The five tuning condensers are mounted on a common shaft, which is split between each two condensers by means of an insulating bushing. The station indicator is a transparent sheet mounted on a cylindrical metal frame, and placed in the center of the condenser group. The shaft is turned by means of a worm drive between the right-hand pair of air condensers. Back of the condensers are mounted the tube sockets, adjusting condensers and miscellaneous apparatus, while underneath

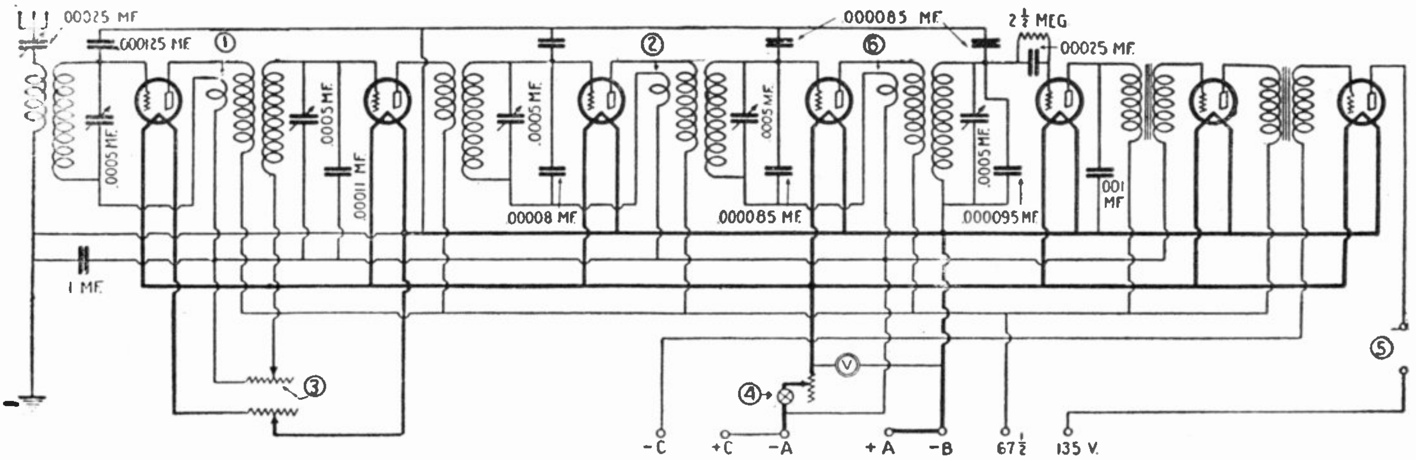


Fig. 90. The schematic wiring diagram of the Kellogg R.F.L. receiver. This set combines many desirable features which are very popular with the broadcast listener; the most important of which are four stages of tuned-radio-frequency amplification before a detector, and two stages of audio-frequency amplification. A power tube is used in the last audio stage, using the voltage shown.

the shelf are the four R.F. transformers, and the antenna tuned circuit, which is the unshielded coil. The filament rheostat and meter panel are mounted to the right of the condenser group, since the filament adjustment is seldom made; and it is not necessary to have the volt-meter on the panel for an operating indicator, as the dial is illuminated. On the left, at the rear, is the antenna series condenser, which is adjusted upon installation of the set to the point of greatest efficiency for that particular antenna system, and is left alone.

Each of the four R.F. transformers is tuned with a .0005-mf. variable condenser, each condenser being shielded by a metal can. The antenna coil secondary condenser is not shielded, being at the extreme left front of the assembly. From the diagram it can be seen that the grid return for three of the tuned circuits is through a one-turn coil, which is coupled loosely with the primary of the next R.F. transformer, and permits efficient neutralization of the amplifier.

Coil Specifications

Each R.F. transformer consists of an 8-turn primary, wound on a 2⅜-inch form, and a 62¼-turn secondary wound on a 2¾-inch form, each coil being of the cylindrical, space-wound type, with No. 20 enameled wire. The balancing coil, in the case of those transformers which are so equipped, is placed close to the primary, and both coils are at the low-potential, or filament end of the secondary. The antenna coil consists of a 45-turn primary, and 51¼-turn secondary, both wound adjacent to each other on a 2¾-inch form, with No. 20 enameled wire. Copper cans enclose each R.F. transformer, and the connecting leads from the transformers to the condensers and tube sockets are brought up through holes in the tops of the cans. This prevents coupling between tuned stages, and is the reason for the sensitivity and selectivity of the set.

Each variable condenser is adjusted for minimum setting by means of set screws with which the rotor plate groups are attached to the shaft; and after all rotor plate groups are adjusted, the individual tuned circuits are brought to resonance by means of small shunt variable mica condensers, which are shown in the diagram in parallel with the variable air condensers. Additional shunt mica condensers are connected directly to the positive filament circuit from the grids of certain of the R.F. amplifiers, in order to stabilize the circuit.

Volume control is obtained by varying the filament current of the first R.F. amplifier tube, and placing a variable high resistance in the grid return of the second R.F. amplifier. The two variables are mounted on the same shaft, and are so adjusted that the set does not oscillate at any time during the operation of the volume-control dial. The positive "A" and negative "B" battery circuits are grounded to the frame and shields, so that the shielding becomes the actual conductor for the A and B current. This reduces the number of wires in the set, and simplifies testing. A voltmeter enables voltage control through a master rheostat, which is in the negative filament lead.

MADISON MOORE SUPERHETERODYNE

(91) Mr. J. S. Cody, Waterbury, Conn., asks as follows:

Q. 1. Have you any information or diagram available on the Madison Moore Superheterodyne receiver? Have heard this super discussed many times at radio fan gatherings, and some of the remarks made me conclude that it must be highly efficient. If you can furnish me with the information, please include the values of the parts employed, and any other information which might be of interest and help to me.

A. 1. The schematic wiring diagram with the values of the parts indicated over their respective symbols is shown in Fig. 91.

Some of the remarkable features of the Madison Moore Superheterodyne are that there is no body capacity or other inductive effects or pick-up; due to the fact that all of the accurately-tuned air-core transformers employed are shielded. All of the metal shields are grounded to the "A—" terminal.

The oscillator is specially designed and connected in an entirely novel manner, the pick-up coil being placed in the plate circuit of the first detector, as the diagram shows. This helps to eliminate noise and other effects of placing the pick-up coil in the grid circuit; and moreover it eliminates the usual superheterodyne annoyance of tuning in a station at two or more points on the dials of the condensers.

Some Special Features

No potentiometer is employed in this superheterodyne circuit, and no "C" battery is used on the I.F. amplification tubes, as in previous circuits where the potentiometer has been eliminated. A potentiometer may be inserted in the circuit for controlling the grid bias on the intermediate-frequency tubes if desired. One source of noise (namely, the grid leak and grid condenser in the first detector circuit) is eliminated by the use of a 4½-volt "C" battery, connected in series with the loop and grid.

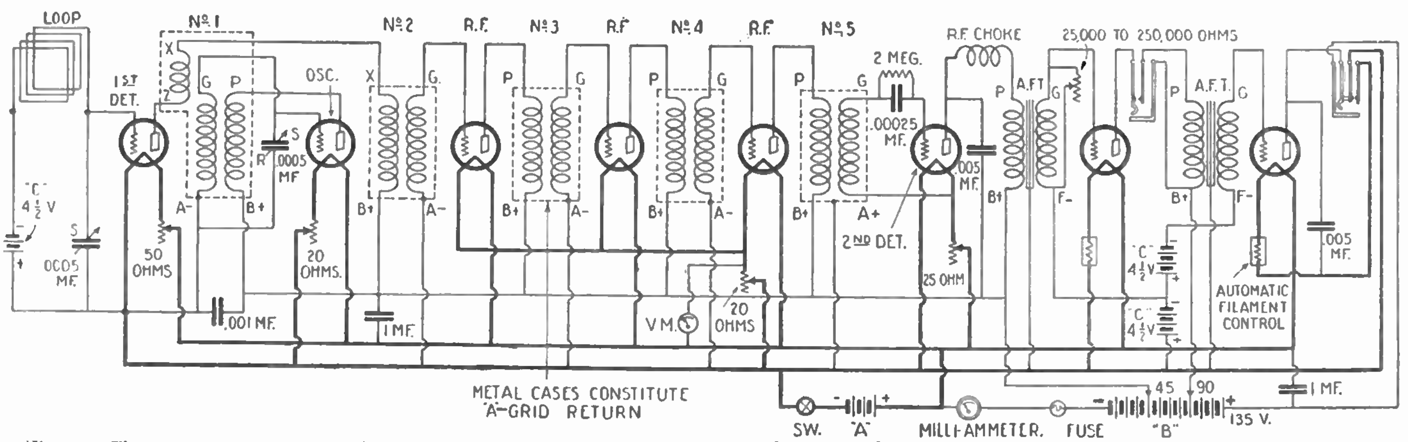


Fig. 91. The Madison Moore Super-heterodyne circuit, one of the most recent along super-heterodyne lines. Special intermediate-frequency transformers are designed for the 199 and 201-A type of tubes, which make possible perfect matching between tubes and transformers, and result in the utmost quality possible to obtain when using either type of tube.

High-resistance rheostats are used on the tubes in order to give accurate and smooth control over a considerable range: the tubes having to burn at only a dim brilliancy, another source of noise is eliminated. It is best to use shockproof sockets for all tubes, or else to mount the sockets on a piece of bakelite, suspended on rubber bands. The metal shields on all the I.F. air-core transformers are grounded to the "A—" terminal; except in the case of the No. 5 unit, which has a wire running from "A—" to the lug on the shield. A radio-frequency choke coil is placed in series with the primary of the first audio transformer. The iron cores or shells of the transformers are grounded to the "A—", as well as the rotor plates of the two principal tuning condensers. It is best to place one of the new protective fuses in series with the "B—" battery line.

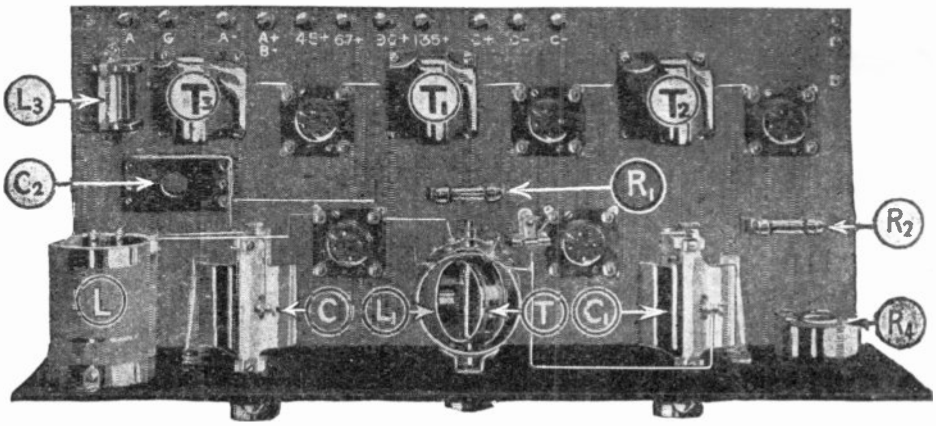


Fig. 93A. Another interior view of the Samson T.C. receiver.

Option of Tubes

If fairly strong signal or voice is desired on the loud-speaker, a UX112 tube can be used in the second audio stage, with a 9-volt "C" battery, as indicated in the diagram. The 4½-volt "C" battery is sufficient for both A.F. tubes if UX201-A tubes are employed throughout. UX199 3-volt tubes can be used in this superheterodyne, its manufacturers supplying specially-designed tuned-air-core transformers for these tubes. The small tubes can be used with the transformers supplied for use on the UX201-A, but results obtained are not satisfactory as with transformers of the proper impedance for the type of tube selected.

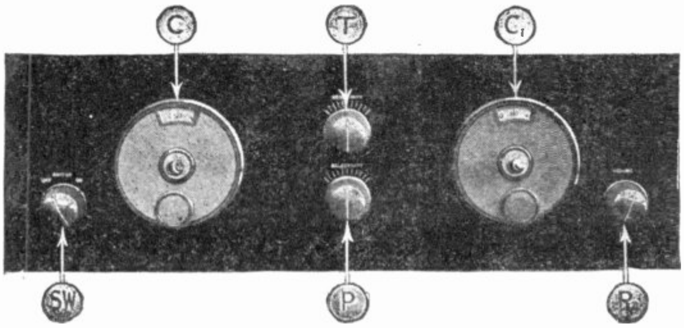


Fig. 93B. The panel view of the Dual T.C. receiver shows a neat and symmetrical appearance. The knob T controls the tickler, shown above; the knob P the primary, which is similarly wound on a rotatable form and may be varied in its relationship to the secondary. This primary knob on this receiver is marked "selectivity."

The volume control, comprising a graphite compression unit giving a range of from 25,000 to 250,000 ohms, is connected across the secondary of the first A.F. transformer, as shown. The voltmeter and milliammeter may be dispensed with if the constructor does not care to purchase them. Only the best grade of rheostats and by-pass condensers should be purchased, as these are two probable sources of noise, especially in superheterodynes. The rheostat used to control the oscillator tube should be of the very highest quality; as variations in the resistance, due to a faulty rheostat, will cause changes in the frequency. In such a case the signal will fade and the set will not be satisfactory. Cheap by-pass condensers are other bad offenders, if they begin to leak. The operator may never suspect that these are the source of the noise, which resembles a steady steaming sound.

The tuned-air-core transformers, of the shielded type utilized in this set, may be placed about 3 inches apart in a row at the rear of the base, with six of the tube sockets, spaced in between them. When using these shielded transformers, there is no danger of picking up noises from house-lighting circuits, etc.; and, unlike other superheterodynes of the unshielded type, it is also impossible for this set to pick up a station unless the loop is actually connected in. Such reception shows that the various intermediate transformers are picking up radio waves; and it can readily be seen that a set which does this is not likely to tune sharply, and also that there is liable to be trouble from picking up more than one station at a time, as well as interference from nearby lighting and power circuits.

In constructing these I.F. units, the transformer condenser is not varied to tune the transformers, in connection with an oscillator and wave meter as is often done; but the number of turns on the secondary is changed until the circuit is balanced to within a fraction of 1% accuracy.

Note that the grid return of the second detector goes to the "filament plus" on the tube socket. Be sure to test all rheostats, and all condensers, including the fixed unit, to see that they are not short-circuited or open-circuited before you install them. It is important to keep the "A" battery always well charged in operating superheterodynes, and a storage "B" battery is desirable.

MODEL C-7 SUPERHETERODYNE

(92) Mr. J. Hathaway, Wiersdale, Florida, asks as follows:

Q. 1. I would like to construct the C-7 type superheterodyne receiver which I am informed, has a high degree of efficiency and is very sensitive to weak signals. Any particulars regarding the construction of this receiver, also a list of parts which I could use in the construction of this set, wherever it is impossible to make the instruments, will be greatly appreciated.

A. 1. The Model C-7 receiver was at one time manufactured by the Norden-Hauck Co., 1617 Chestnut St., Philadelphia, Pa. All information on this receiver published in these columns was kindly furnished by this company. The schematic wiring diagram will be found in Fig. 92.

List of Parts

One cabinet, 40x8x8 inches;
One panel, 40x8x¼ inches;
Eight binding posts;
One heterodyne condenser, .0005-mf.;
One wavelength condenser, .00025-mf.;
Three midget condensers, .000045-mf.;
One oscillator coupler, as per specifications below;
One output transformer, as per specifications;
Two radio-frequency transformers, Type "C" only—E.I.S. special (or 1716's);
Two audio-frequency transformers;
Three "C" batteries, 4½ volts;
Three by-pass condensers, one .005-mf., and two .001-mf.;
One open jack;
One grid leak, 2-megohm; and grid condenser, .00025-mf., with mounting;
Three by-pass condensers, 1.0-mf.;
Seven sockets;
60 ft. each No. 12 bus wire soft drawn tinned copper and No. 12 spaghetti, with necessary screws and nuts.
One filament switch;
Two 4-inch dials, and knobs;
One antenna inductance (see below);
Two master rheostats, one 7-ohm and one 20-ohm;
One fixed condenser, .01-mf.;
One voltmeter, 0-7, 0-140 scale, and one ammeter, 0-3 amps. (optional as extra equipment).

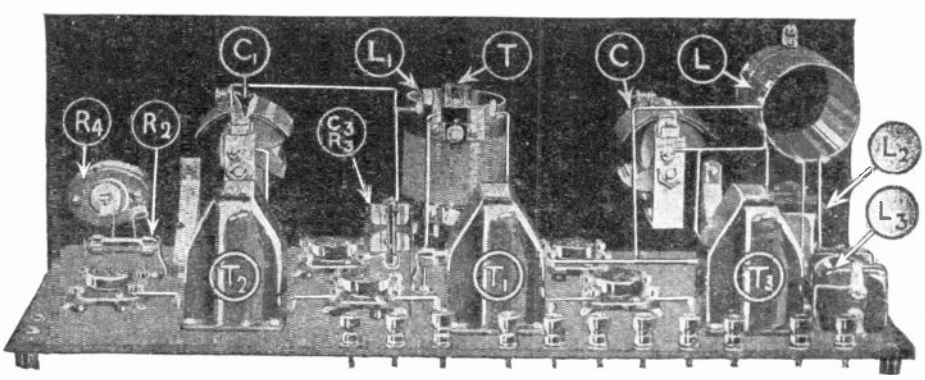


Fig. 93C. A top view of the Samson Dual T.C. receiver. A power tube is employed in the last audio stage to enhance the quality of reproduction obtained. A 500,000-ohm variable resistance to obtain volume control is also incorporated, and is indicated as R-4 in this view.

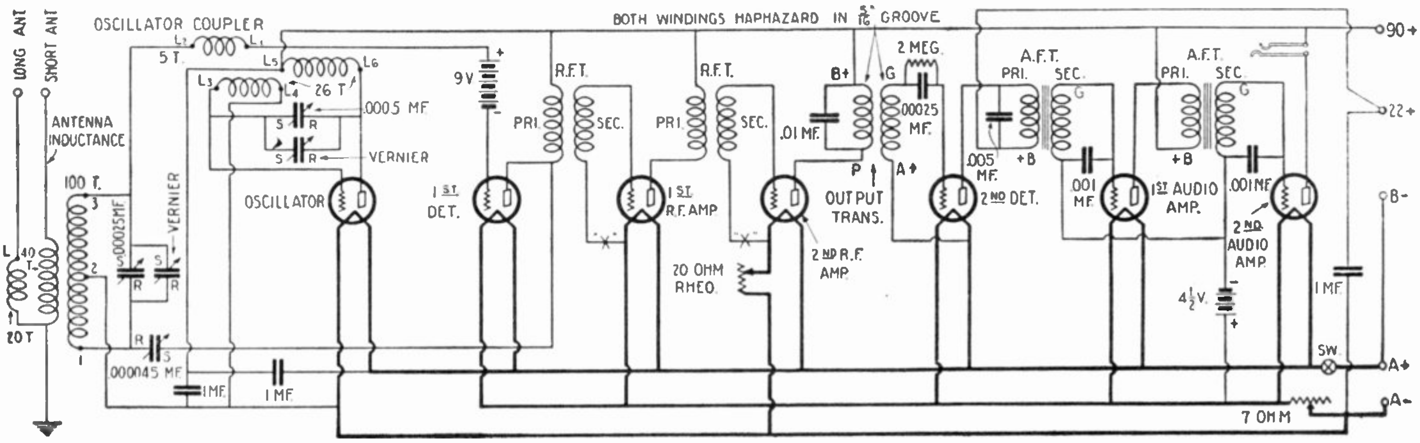


Fig. 92. Complete Schematic wiring diagram of the New Model C-7 Norden Hauck super-heterodyne receiver. Seven tubes are used in a highly efficient circuit.

Coil Specifications

OSCILLATOR COUPLER: form is a 3½-inch tube, 1/8 inch thick, 2⅝ inch long. Start ¼ inch in from edge and wind 26 turns of No. 20 D.C.C. wire, two-layer back winding (L5, L6); start ¼ inch over and wind 26 turns of No. 20 D.C.C. wire, two-layer bank wound in the opposite direction (L3, L4); start ¼ inch over and wind 5 turns of No. 20 D.C.C. wire, two-layer bank winding in the same direction as the first coil. Connect as shown in the schematic wiring diagram. (L1, L2).

OUTPUT TRANSFORMER: form is 2 inches inside, 4 inches outside diameter, with a winding space 5/16 inch wide; the primary is 100 turns of No. 28 D.C.C. wire wound at random; the secondary 300 turns of No. 28 D.C.C. wire, wound in the opposite direction.

ANTENNA INDUCTANCE: primary form, 1¾ inch tube, 1/16 inch thick, 2⅝ inches long. Wind 20 turns of No. 32 D.C.C. wire, in 2-inch winding space, and equally spaced from ends of tube (L). On top of the first coil, and separated from it by a piece of paper, wind 40 turns of No. 32 D.C.C. wire in same direction; Secondary form—2-inch diameter x1/16-inch wall x2⅝-inch long formica tube. Wind 100 turns of 10-strand No. 38 (Litzendraht) with a tap at 50 turns. Wind in opposite direction from the two primary coils and spaced evenly from ends of the tube.

Oscillations and the sensitivity of the receiver may be controlled by the insertion of a 400-ohm potentiometer (in the proper manner) at points marked "X" in the intermediate-frequency stages. One may be used for both stages.

SAMSON DUAL T.C. RECEIVER

(93) Mr. Martin, Jersey City, N. J., asks:

Q. 1. Can you furnish me with the complete schematic wiring diagram of the Samson Dual T.C. receiver and all other details such as coil construction, list of parts, etc? This will be of help to me when constructing this set, and for this information I will be greatly indebted.

A. 1. The Samson Dual T.C. circuit has been previously described in RADIO NEWS; but since then a later factory model has become available. The following are the specifications and description of that particular model. Incidentally, this model when tested in RADIO NEWS Laboratories performed unusually well, giving much more volume than is usually obtained from five-tube receivers. The quality also was excellent and extremely pleasing to the ear. This is undoubtedly due to the special type of audio amplifier incorporated in the receiver, which uses the new Donle system of audio amplification.

The receiver consists of one stage neutralized-R.F., a regenerative detector with variable coupling on the input R.F. transformer (one unit composing three coils, one stage transformer-coupled and two of dual-impedance A.F.)

The following are the list of parts employed in the construction of the set.

2 Variable condensers, .0005-mf. (C and C1);
1 Neutralizing condenser, adjustable (C2);
1 Fixed grid condenser, .0005-mf. (3);
1 Fixed condenser, .001-mf. (4);
1 Fixed condenser, .0001-mf. (C5);
1 Aerial coupler (L);
1 Double-rotor coupler (L1);
2 Radio-frequency chokes, 85-M.H. (L2, L3);
2 Dual impedances (T1, T2);
1 Audio-Frequency transformer, low-ratio (T3);
3 Automatic filament controls, 5-v. ½-amp. (R, R1, R2);
1 Grid leak, 9-meg. (R3);
1 Volume control, 500,000-ohm max. (R4);
5 Sockets, UX type;
1 Battery switch (SW);
2 Tip jacks (L.S.);
2 Vernier dials;
11 Binding posts;
1 Panel, 7x21x3/16-inch;
1 Baseboard, 9x20x¼-inch;
2 Brackets.

The receiver is, from an electrical viewpoint, very carefully designed. For example, in the tuned-R.F. stage neutralization is provided for and made easy by the correct placement of the R.F. choke coil, L2, in the grid-return lead of this stage. In the detector stage there is incorporated regeneration controlled by means of a rotor or "tickler" coil. Any stray R.F. currents are kept out of the audio amplifier by means of another R.F. choke coil, L3. The volume of the receiver is controlled by a variable resistance, R4. This particular

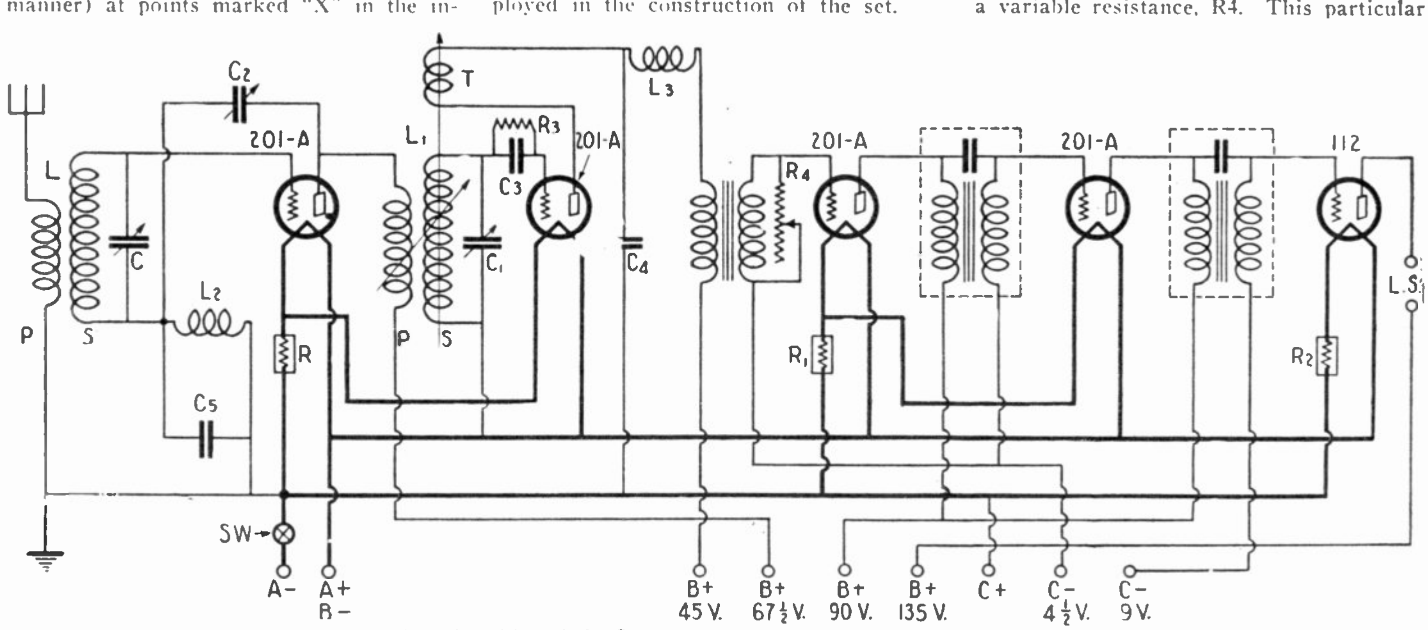


Fig. 93D. The circuit employed followed in the wiring of the Samson Dual T.C. receiver consists of a stage of neutralized R.F. amplification, a regenerative detector, one stage of transformer coupled audio-frequency amplification and two stages of a new, improved type of audio amplifier.

method of volume control is much more effective and efficient than employing filament rheostats and reducing volume by reducing the filament temperature of the tube; since the tonal quality is not in any way altered by the first method. The first A.F. stage is of the conventional transformer-coupled type; the last two of the dual-impedance type, and these stages are largely responsible for the excellent quality obtained. Automatic resistors are employed for filament control, throughout the receiver.

In its adjustment, the only essential control is the small balancing condenser, C2, which should be used only after the shortest wavelength station possible is tuned in. The condenser should then be rotated until all oscillations (or "whistles and squeals," as most laymen describe them) are eliminated. This process should be performed only when the rotor or tickler coil, T, is at right angles to the secondary coil.

The constructional data of the coils employed in this receiver are as follows:

Coil Specifications

Aerial coil, L.: tube 2½ inches in diameter, 3¼ inches long; primary 18 turns of No. 26 D.C.C.; secondary 54 turns of the same-sized wire.

Double-rotor coupler, L1,: tube 2½ inches in diameter, 3½ inches long: primary (lower rotor, P), 40 turns of No. 28 D.C.C.: secondary, S, 54 turns of No. 26 D.C.C.; tickler (upper rotor, T) 16 turns of No. 28 D.C.C. The primary of this unit is wound on a rotor coil, as well as the tickler, in order that coupling between primary and secondary windings may be varied at will; which permits a variation in the selectivity-and-sensitivity factor.

HENRY-LYFORD RECEIVER

(94) Mr. T. J. Dolan, Connersville, Indiana, asks as follows:

Q. 1. I would like to obtain the schematic wiring diagram of the Henry-Lyford receiver, and whatever constructional

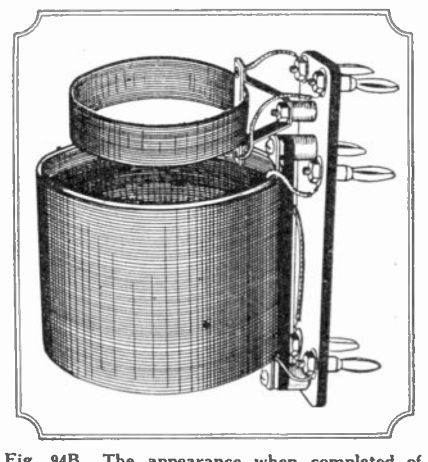


Fig. 94B. The appearance when completed of the coil L1, which is used in the Henry-Lyford receiver. L2 is very similar in construction, except that the third or semi-variable winding at right is omitted.

information you can furnish as regards the various coil units employed in its construction. Please show the adaptation of a power tube in the last audio stage with its proper B and C voltages.

A. 1. The schematic wiring diagram of the Henry-Lyford receiver is shown in Fig. 94. The set comprises one neutralized tuned-R.F. stage, one untuned stage, and a tuned detector stage. Two stages of transformer-coupled A.F. amplification are used, the last stage employing a power tube, and the first stage a variable resistance for controlling the volume. The following are the items necessary for the construction of this receiver:

2 Variable condensers, .00035-mf.;
1 Fixed condenser, .002-mf.;
2 A.F. transformers, low ratio;
1 Midget balancing condenser, 55-mmf. maximum;
3 Automatic filament controls, ½-amp. each;
1 Filament-control jack, single-circuit;

without obtaining the usual regeneration or oscillations heard with regenerative receivers. The three automatic-filament-controls are amply able to regulate the filament temperatures of the various tubes, which feature reduces the number of controls. The 1-mf. condensers are placed in

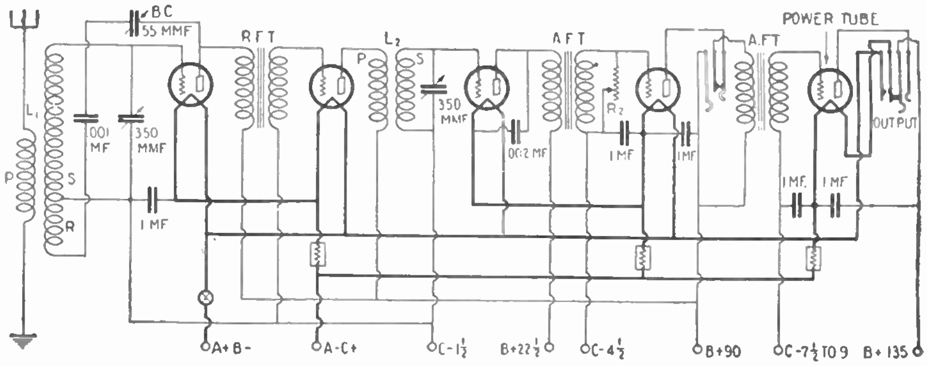


Fig. 94. The circuit diagram employed in the wiring of the Henry-Lyford receiver. A stage of neutralized T.R.F. is used in conjunction with an untuned stage, detector, and two stages of A.F. amplification. A power tube is recommended in the last audio stage.

1 Fixed condenser, .001-mf.;
1 Single jack, closed-circuit;
1 Radio frequency transformer, untuned type, (see below);
1 Variable resistance, 500,000-ohm;
5 Sockets (UX spring-cushion type preferred);
1 Panel, 7 x 20 inches;
1 Baseboard, 7 x 20 inches;
5 By-pass condensers, 1-mf. each;
10 Binding posts;
1 Filament switch.

Construction of the Coils

L is somewhat similar to an ordinary three-circuit tuner, with the exception that the rotor is only semi-variable. Winding R is simply adjusted by hand until maximum efficiency and selectivity is obtained, and also when in the position that permits neutralizing oscillations by means of the small midget variable condenser (BC). The secondary winding, S, is 3 inches in diameter and consists of 60 turns of No. 22 D.C.C. wire, space wound. The wire is imbedded in a celluloid form, which is accomplished by means of acetone, a solvent for celluloid. The primary winding, P, is wound on a 2¾ x ½-inch celluloid form (also imbedded), and consists of 15 turns of No. 24 or 26 D.C.C. wire. R consists of 18 turns of No. 22 D.C.C. wire, on a 2⅛-inch celluloid form. The construction and assembly of this entire unit is shown in Fig. 94B.

Inductance L is practically an ordinary T.R.F. transformer, of the low-loss type. The secondary winding, S, consists of 65 turns of No. 22 D.C.C. wire, space-wound on a 3-inch celluloid form. The primary winding, P, is wound on a 2¾-inch celluloid form, and consists of 15 turns of No. 24 or 26 D.C.C. wire, and is also space-wound. This complete construction and assembly is somewhat similar to that of L except that the third or rotor winding is omitted. Note that these two coils have plug-in mountings, so that coils of other dimensions for various wavebands may be substituted. The untuned-radio-frequency transformer, RFT, should preferably be of the manufactured type, since it is somewhat difficult for the amateur to construct this type of instrument.

Adjustment and Operation

In the adjustment of the receiver, to obtain proper results, all that is necessary is to obtain a combination adjustment of the position of coil R in its relation to winding S and the balancing condenser, which is simply set at various positions until both .00035-mf. variable condensers can be rotated to any desired frequency,

various portions of the receiver, to by-pass any stray R.F. current that may exist in the battery and audio amplifier circuits. A filament-control jack is used in the last or final output stage; so that when using only one stage of audio-frequency amplification, the filament of the fifth tube is automatically disconnected, thus preventing any unnecessary waste of filament current.

For this receiver there are two other sets of plug-in coils which have smaller dimensions, so that with one a wave-length range of from 25 to 135 meters is covered, and with the other 75 to 225-meter reception may be obtained. The coils for which constructional data has been given above cover the entire broadcast range.

If an intermediate volume is desired between the outputs of the first and second stages, the resistance R_2 is increased until the desired volume is obtained. The dial readings for two variable tuning condensers correspond very closely; and the readings may be jotted down with the assurance that should the station be desired again, it will be obtained at their respective positions.

BATTERYLESS GAROD "EA" RECEIVER

(95) Mr. A. Robson, Burlington, Vt., writes:

Q. 1. I would like full particulars regarding the Batteryless Garod Model "EA" Receiver, such as the type of tube employed in each stage, values of the resistances, and a schematic wiring diagram of the receiver and the power unit which supplies both "A" and "B" current. The receiver, by various reports, is said to be remarkably efficient, and though I contemplate getting one I would like to learn something about its internal construction, system employed, etc.

A. 1. The wiring diagram of the Garod "EA" Batteryless Receiver is given in Fig. 95. No additional constructional data or values of the parts in the receiving circuit are available. You will undoubtedly note, however, that the receiving circuit is of the conventional neutrodyne type, the R.F. stages being neutralized in neutrodyne fashion. The particularly noteworthy feature of this receiver is that in all stages, with the exception of the detector, storage-battery type tubes are employed. This permits the attainment of maximum efficiency in each stage, and reduces any possibility of A.C. hum, due to the fact that the heavier filaments in these tubes are more adaptable to A.C. operation than the filaments of tubes of the 199 or dry cell variety.

Also note that, contrary to the practice

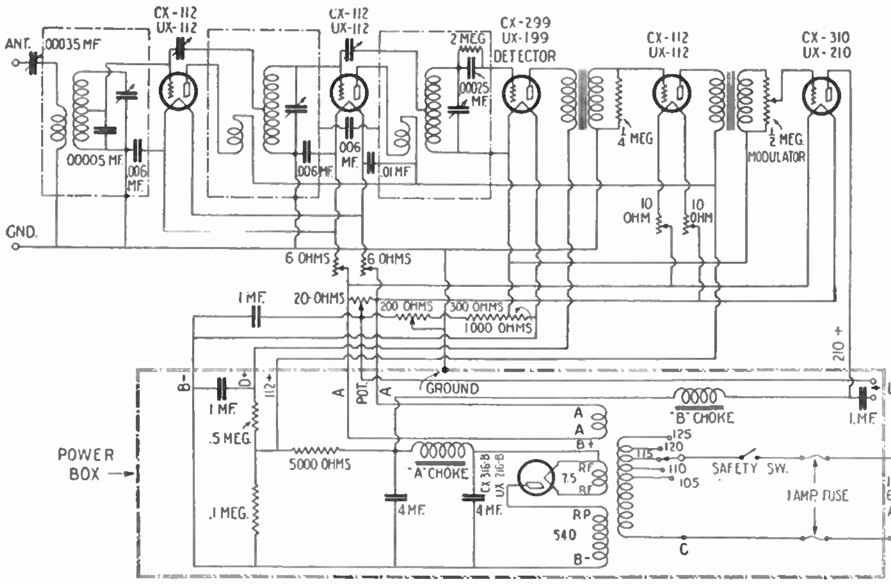


Fig. 95. The Garod E.A. receiver obtains its battery current from the light socket; no trick e charger or storage battery is required. Because of careful design its efficiency is as high as that of any other similar type of receiver. Power tubes are employed in the audio- and radio-frequency stages and a 199 or 299 type of tube in the detector. The filament current for the detector is obtained from the "B" eliminator.

in most batteryless receivers, the filament circuits of the R.F. and A.F. stages are wired in parallel and are supplied with A.C. by a stepdown transformer. The detector tube which is of the 199 or 299 type, obtains its filament current from the "B" unit; this feature is made possible by a resistance which creates the necessary voltage drop. Various balancing resistances for eliminating the A.C. hum are employed throughout the receiver. A 216-B or 316-B rectifying tube is employed in the "B" power unit, which delivers a direct-current output to the receiver. The power unit is entirely shielded and built in separate form to prevent it from inducing an alternating-current flow in the various components within the receiver. Very satisfactory results are obtained from this batteryless receiver.

GREBE SYNCHROPHASE RECEIVER

(96) Mr. D. Jackson, Elizabethtown, Pa., writes:

Q. 1. I recently attempted with the aid of several "radio experts" to repair my Synchrophase receiver, which through violent mishandling when moving, became inoperative. The receiver at the present time does not look quite like the original, due to numerous experiments. However, I seriously contemplate rebuilding it in its original shape, providing you are able to supply me with the necessary information. Most important of all; I need a schematic wiring diagram of the Synchrophase receiver and any other additional information you can supply me which may be of help to me.

A. 1. The information you desire relative to the Synchrophase receiver may be obtained from the manufacturers of this set, who publish an instruction manual in which are contained the wiring diagram of the receiver, hints for adjusting, and correcting troubles, etc.; or else from the distributor of this product in your territory. However, since numerous similar requests have been received by this department, we are publishing a few points of interest relative to the Synchrophase Model MU-1. Information relative to the earlier model will be found in the April 1925, issue of RADIO NEWS. The schematic wiring diagram of the receiver will be found here in Fig. 96.

Your receiver will undoubtedly require balancing after it is repaired and the necessary parts replaced. The following is the process for balancing the receiver described in a bulletin issued by A. H. Grebe & Co., which we feel sure will be of considerable help to you when adjusting the receiver.

"Balancing of the receiver must be done while the instrument is in operation. A practical and efficient balance can best be obtained by employing some form of modulated radio-frequency oscillator. This oscillator should have a range of 200 to 550 meters and should be modulated in such a way as to produce a pure tone. The oscillator serves three major purposes:

"1. The balancing of receivers can be perfected when no broadcast stations are available for testing.

"2. The radio-frequency carrier from the oscillator, beating with the carrier set up by the receiver when oscillating, will cause a whistle or beat note which is a sure indication of the unbalanced condition on that wavelength to which the receiver is tuned.

"3. The modulated note forms a final test of perfection of the balance adjustment, since a receiver may be balanced so as to prevent a beat note or heterodyne whistle, but a modulated note may be distorted or 'fuzzy,' requiring closer adjustment to clear up the modulated tone.

"For these adjustments, the oscillator must be far enough from the receiver to produce only a weak signal, permitting the volume control to be turned up full.

"Where no oscillator is available, a very satisfactory balance can be obtained by employing the signals from a broadcasting station. The method of procedure in this instance is similar to that outlined.

"Since various accessories are often accountable for unbalanced receivers, it is essential that all accessories such as aerial, ground, loud speaker, 'A,' 'B' and 'C' batteries be in perfect condition and properly connected. Perfect vacuum tubes of the particular type recommended, should be in their proper sockets. The Synchrophase should always be balanced while in its cabinet. The most stable balanced condition will result if the instrument is balanced with at least 135 volts applied to the intermediate-amplifier terminal, where 90 volts is ordinarily connected. The 'C' battery voltage should be left as recommended. On 1926 and 1927 model receivers the wave-changing switch should be in 'high range' position. Loosen dial thumb nuts so that all dials may be operated independently. Set 'tone color' on No. 6 setting. Turn volume control to No. 6 setting. Volume control of 1925 model should be on setting No. 6. Filament rheostat should be turned on full.

"Dials should be set as follows:—No. 1 or left-hand dial in 100 degrees. No. 2 (center or master dial) and No. 3 (right-hand dial) on 40 degrees.

"Before proceeding it would be advisable to note the position of the slots of the adjusting screw heads before making the first readjustment; so that, in any event, the original adjustment may be duplicated.

"Start oscillator and set on wavelength to which the receiver is adjusted so note will be heard in the loud speaker.

"With a wooden-handled, hard-rubber or bakelite screwdriver or wrench as described, loosen balancing condenser No. 2, meanwhile rotating No. 2 dial rapidly between thirty and fifty degrees. A click will be heard as the set goes into oscillating condition. Next tighten No. 2 balancing condensers screw until click just disappears, then tighten up about one-quarter turn beyond.

"Set all dials at 40, rotate No. 1 dial rapidly between 30 and 60 degrees, following same procedure on No. 2 balancer. If the click cannot be balanced out readily, a slight further adjustment of No. 2 should clear it up.

"Leaving receiver still set for high range, turn all dials to 20 degrees, reset oscillator on wavelength to which the receiver is now adjusted. No oscillation should be experienced; if such a condition exists turn in slightly more on No. 2

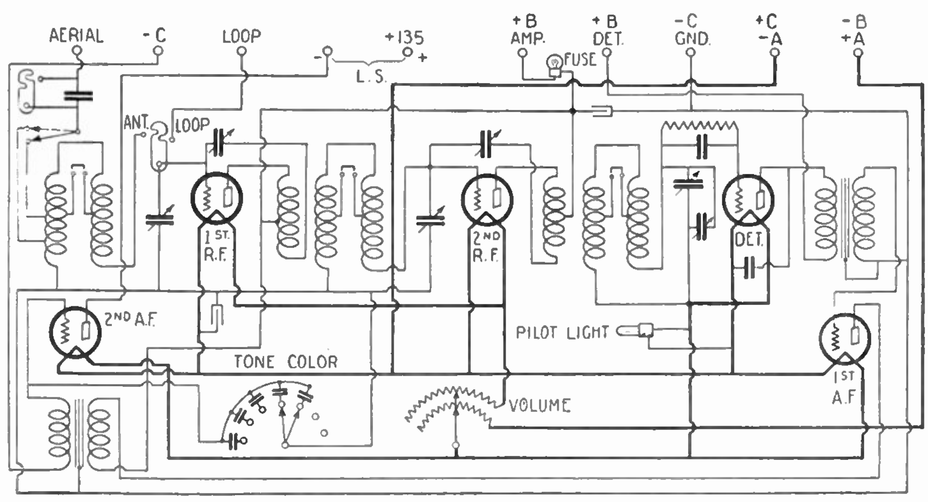


Fig. 96. The efficiency of the Grebe Synchrophase receiver is due entirely to careful design and construction. The use of binocular coils and straight-line-frequency condensers aids considerably in overcoming present-day interference. The employment of a "tone-color" device enhances the quality in the set's reproduction of broadcast programs.

balancer. Continued oscillation would be a likely indication that balancers No. 1 and No. 2 were turned slightly too far in past the click. The first balancing operations already described should be repeated.

"If no oscillation is apparent with dials at 20 degrees, set switch for 'low range' and turn dials to 65 degrees. Reset oscillator as previously described. If slight oscillation occurs, effect readjustments of No. 1 and 2 balancers. If there is tendency to oscillate on the high range, screw in No. 1 balancer slightly further. If set tends to oscillate on the low wavelength, screw in No. 2 balancer slightly further. This procedure should be repeated if not successful with the first attempt.

"After these two balancing condensers are adjusted to their final positions, the third dial readings may be made identical with No. 2, should a marked variation be experienced.

"Tune your oscillator until it is heard between 10 and 20 on the dials. Note the dial readings of condensers 2 and 3. If the third dial reads higher than the second tighten the balancing condenser No. 3 until the readings coincide with those of the second. This adjustment will have little effect on dial settings at high wavelengths.

"The suggestions given below may assist in clearing up further difficulties that may arise.

"While it is advisable to balance the set with a high-plate voltage and full filament brilliance, any receiver which will pick up stations or the oscillator tone without distortion with the volume control at 4 and 90 volts on the 90-volt terminal is satisfactory; since these are the conditions under which the set will operate.

"If the set refuses to balance, and the click does not disappear when adjusting No. 1 balancer, a defective 'B' battery by-pass, below rated capacity, or defective antenna coil, may be the cause. An exceedingly large aerial will make the set critical to balance.

"If no click is heard from the second stage at the beginning of the balancing operation, the filament voltage may be low, or reversed, or the 'B' voltage low. The tube may be poor. A tube that will not oscillate up to the highest wavelengths on the dial when the balancing condensers are released is not active enough to use in balancing. The second binocular coil may be damaged or defective and in need of replacement. The primary may be open (which may be determined by the electrical-circuit test) or part of the primary shorted out, or the litz secondary damaged.

"Unbalancing below 200 meters will probably not be serious and need not be corrected if such correction would endanger the stability on higher waves; since the set is not being used for broadcast reception below 200 under the present regulations.

"If the set oscillates when the screws are released, and responds to the balancing operation as described, but signals are weak, after checking voltages, wave-range switch, etc., look for an open tap on the antenna coil or damaged secondary winding."

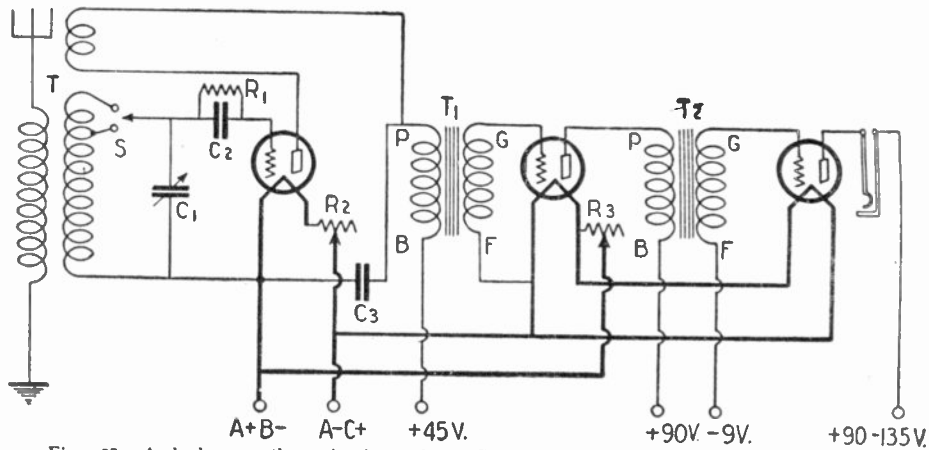


Fig. 97. A dual-range three-circuit receiver. By means of an S. P. D. T. switch it may be changed over instantly to the 150-200 meter band. This will be interesting to many experimenters.

INCREASING RANGE OF THREE-CIRCUIT TUNER

(97) Mr. S. Snyder, Hackensack, N. J., asks:

Q. 1. I have a 3-circuit receiver of the Ambassador type employing a detector and two stages of A.F. amplification. I have read that the Radio Commission considers the possibility of reducing the broadcast wave band to include the wavelengths from 200 down to 150. Would you please inform me of the changes necessary to enable me to receive these wavelengths?

A. 1. From the accompanying diagram, it will be seen that only a few minor changes would be necessary to adapt a receiver of this type to the lower wavelengths.

A S.P.D.T. switch, S, connected as indicated. A tap taken on the secondary of the 3-circuit tuner, at a point 15 turns from the grid end, is connected to one tap of the switch. The end of the secondary which usually goes to the grid condenser is connected to the other tap of the switch. The lead from the grid con-

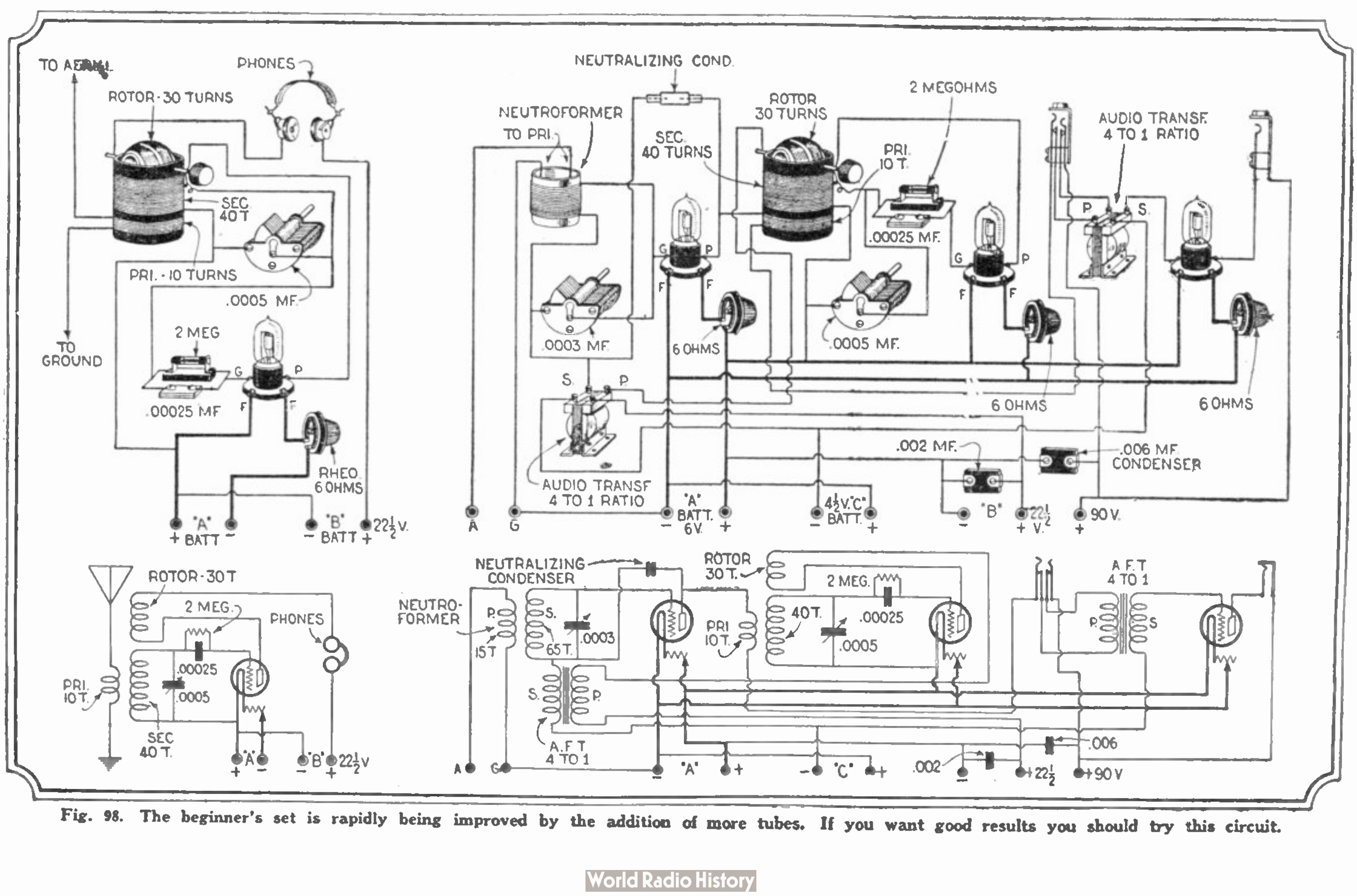


Fig. 98. The beginner's set is rapidly being improved by the addition of more tubes. If you want good results you should try this circuit.

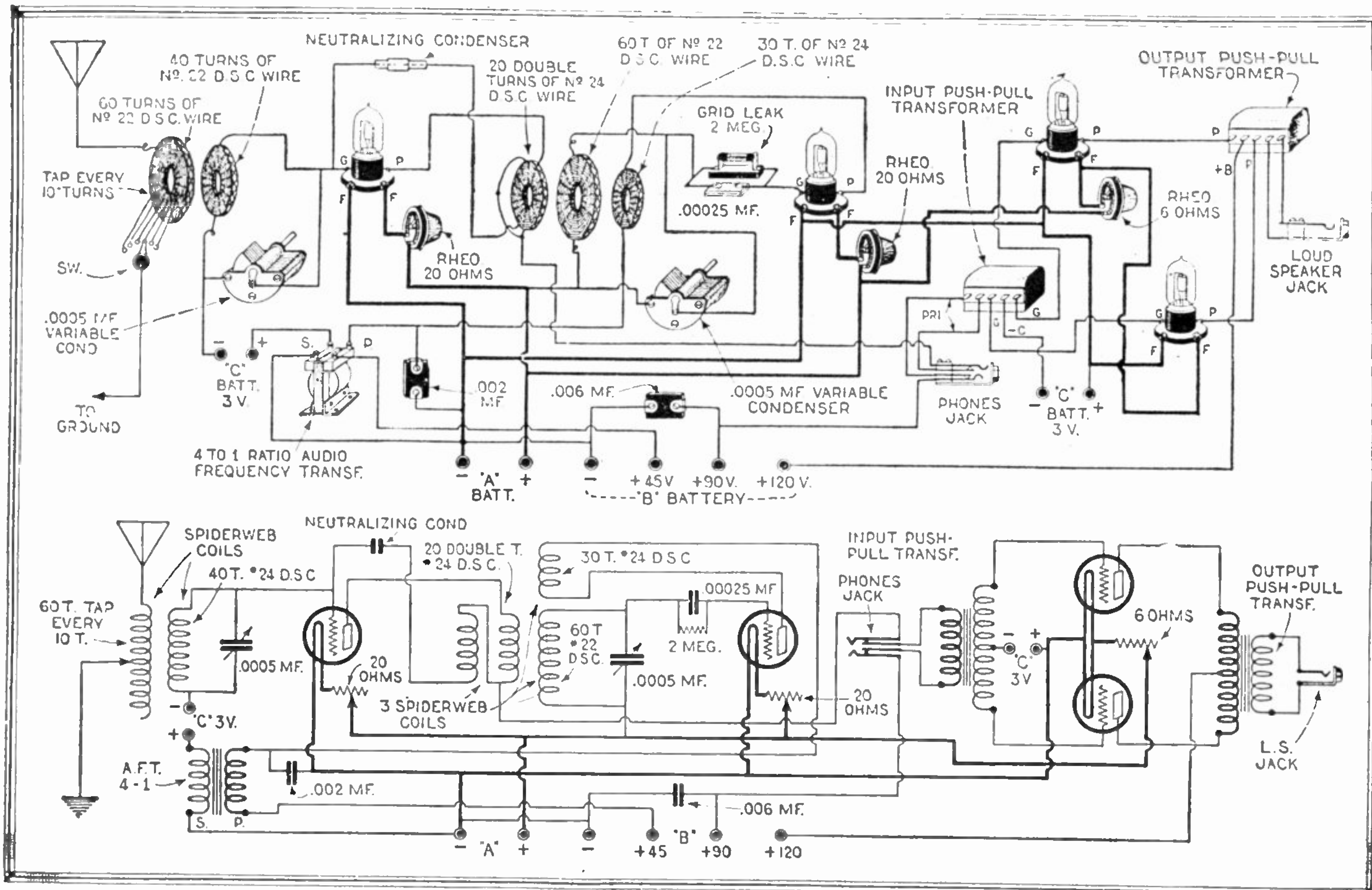


Fig. 99. The addition of a push-pull amplifier to the All Circuit Set will greatly enhance its reproductive qualities. This circuit is an entirely new one which is rapidly meeting with favor by all who have constructed it.

denser and tuning condensers is brought to the movable arm of the switch. It is now a very simple matter to tune to either the high wavelengths or the lower ones by simply using the correct switch tap. It may be necessary to reduce the detector voltage when tuning to the shorter wavelengths, since the tickler coil may be too large and excessive oscillation may occur.

For those desirous of constructing this receiver the following is the list of parts:

- 1 Three-circuit tuner, T;
- 1 Variable condenser, .0005-mf., C1;
- 1 Grid condenser, .00025-mf., C2;
- 1 Grid leak, 2-megohm, R1;
- 1 Fixed condenser, .002-mf., C3;
- 1 Switch, S;
- 1 Rheostat, 20 ohm, R2;
- 1 Rheostat, 15 ohm, R3;
- 2 Audio frequency transformers, ratio 3:1, T1, T2;
- 1 Single circuit jack, J.
- Structural material, sockets, etc.

It is extremely unlikely that the broadcast wavelength band will be extended beyond its present limits (200-550 meters), the Radio Commission having decided that millions of dollars worth of receivers would be made obsolete by the change. A comparatively simple set of the 3-circuit type can be adapted to lower waves without much trouble, but other receivers are not so flexible.

IMPROVEMENTS

(98) Milton Stanley, Syracuse, N. Y., asks:

Q. 1. What is the best circuit to use in rewiring my single tube regenerative set into a three-tube receiver?

A. 1. Instead of merely adding two stages of audio frequency amplification, the circuit in Fig. 198 employing one stage of tuned R. F., regenerative detector, one reflexed and one straight audio frequency stages of amplification will be found to give excellent results.

ALL CIRCUIT SET

(99) Albertus King, Syracuse, Neb., asks:

Q. 1. "Being very much interested in the set described by Miss L. Port in the November issue, I built it and have received some very wonderful results. Will you kindly publish the diagram of the circuit to which is added a push-pull amplifier?"

A. 1. We are pleased to note that you are also getting good results from your "All Circuit Set." We have received a large number of replies from those who have constructed the receiver, praising its good qualities. Diagram No. 99 is, therefore, published with the idea in mind to give those who are somewhat hazy as to its exact construction a more concise explanation of the various details. The addition of the push-pull amplifier does not in any way alter the rest of the circuit. The arrangement consists of a tuned neutralized stage of radio frequency amplification, regenerative detector, reflexed stage of audio frequency and finally the push-pull amplifier which affords excellent clarity and sufficient volume.

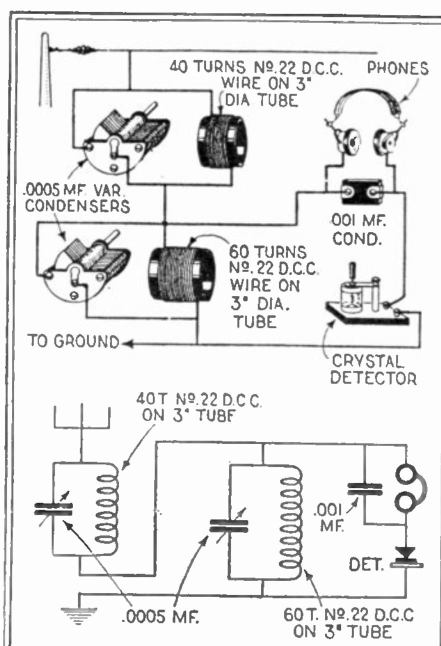


Fig. 101. The above circuit diagram is given for the benefit of the thousands of crystal detector owners who are always looking for a more selective circuit.

Spider-web coils are used throughout merely because they do not take up as much room as the solenoid type of inductance and because their field is more concentrated. Preferably, fibre or bakelite forms about 3½ to 4 inches in diameter and having 17 segments each, should be used. A small brass hinge fastened to one of the spokes allows a variable support. A cam and spring arrangement affords the controlling mechanism which varies the coupling between coils. The neutralizing coil should be fixed in relation to the secondary coil, while the tickler feed-back coil in the detector circuit should be variable in coupling to it.

It is best to use UV-201A or C-301A tubes with this circuit, dry cell tubes giving inferior results. A panel 7 by 21 inches will accommodate the parts very nicely.

TU-RA-FLEX CIRCUIT

(100) Q. 1. Walter Gray, Jr., Hamilton, Ohio, sends us a diagram of a Tu-Ra-Flex radio receiving set and requests us to show how one stage of audio frequency amplification could be added to it.

A. 1. We reproduce this highly efficient circuit herewith for the benefit of all of our readers and show the connections for a third stage of audio frequency amplification. Care should be taken in

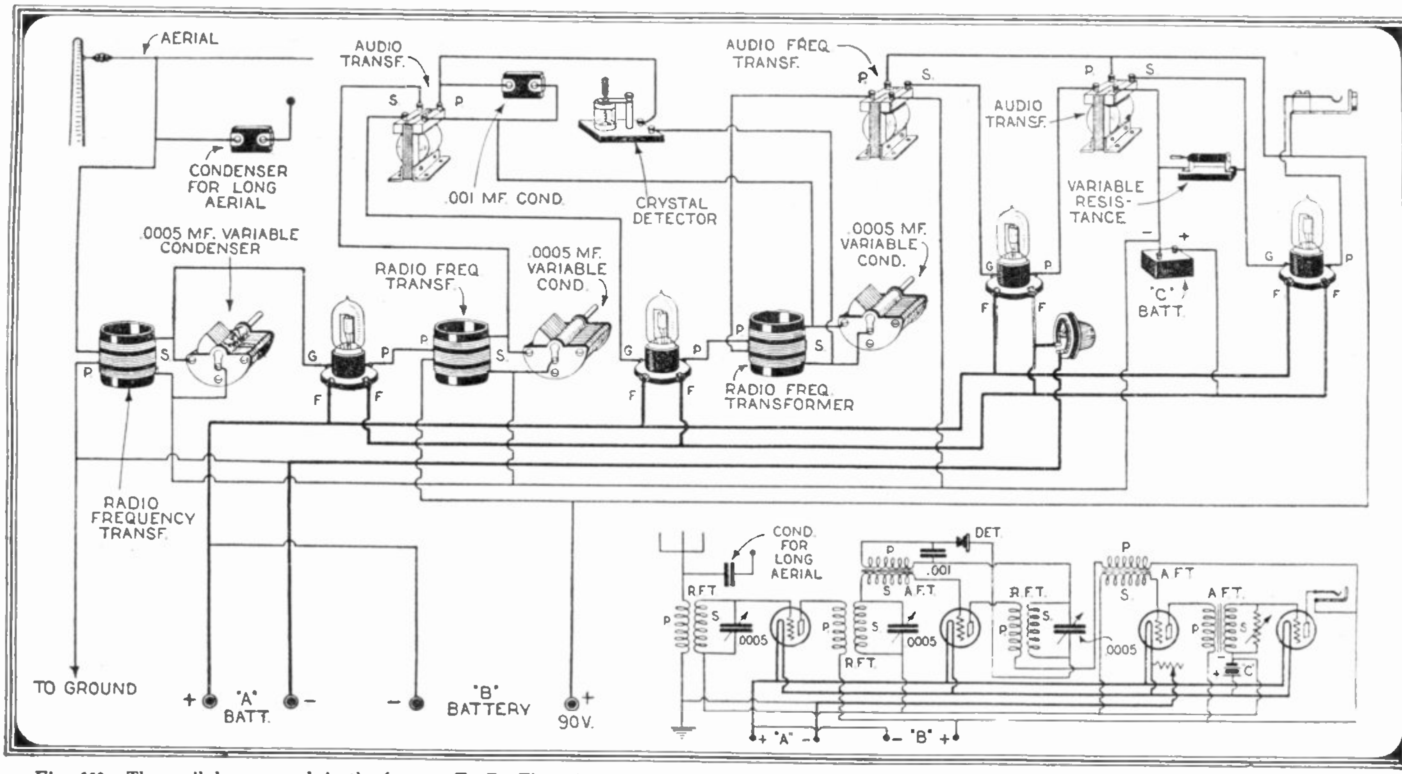


Fig. 100. The well known and justly famous Tu-Ra-Flex circuit is shown in both picture and schematic form above with the addition of a single stage of audio-frequency amplification giving the results of three stages total. The variable resistance shown is of assistance in controlling the circuit.

making this addition because of the fact that unless very good instruments and a low ratio transformer are used, howling in this third stage will result. A variable resistance placed in the third audio frequency transformer circuit as shown may be found of great assistance in controlling this stage.

SELECTIVE CRYSTAL SET

(101) Q. 1. C. Herman, Chicago, Ill., asks for a circuit diagram of a crystal receiving set employing two inductances and two variable condensers which will be quite selective.

A. 1. Probably the best system for you to use is a series wave-trap and a tuning circuit, such as we have shown in the diagram given herewith.

TWO-TUBE REFLEX

(102) Q. 1. D. Vender, Los Angeles, Calif., wants to use honeycomb coils in an efficient type of reflex circuit and asks us to show the connections for a set of this nature.

A. 1. Probably the best circuit for you to use is that reproduced here. If desired, the antenna coil, the plate coil of the first tube and the plate coil of the second tube may all be coupled together, giving a double regeneration effect which, when properly balanced and tuned, will give astonishing results. The circuit which we show is one that is very popular in England and is known as a 2-tube Trinadyne circuit. The choke coil, a honeycomb coil, helps to stabilize the circuit.

NEUTRODYNE VS. TUNED R. F.

(103) Q. 1. Leonard Appel, Washington, D. C., asks us to compare the Neutrodyne type of receiver with the ordinary type of tuned radio frequency set that is not neutralized.

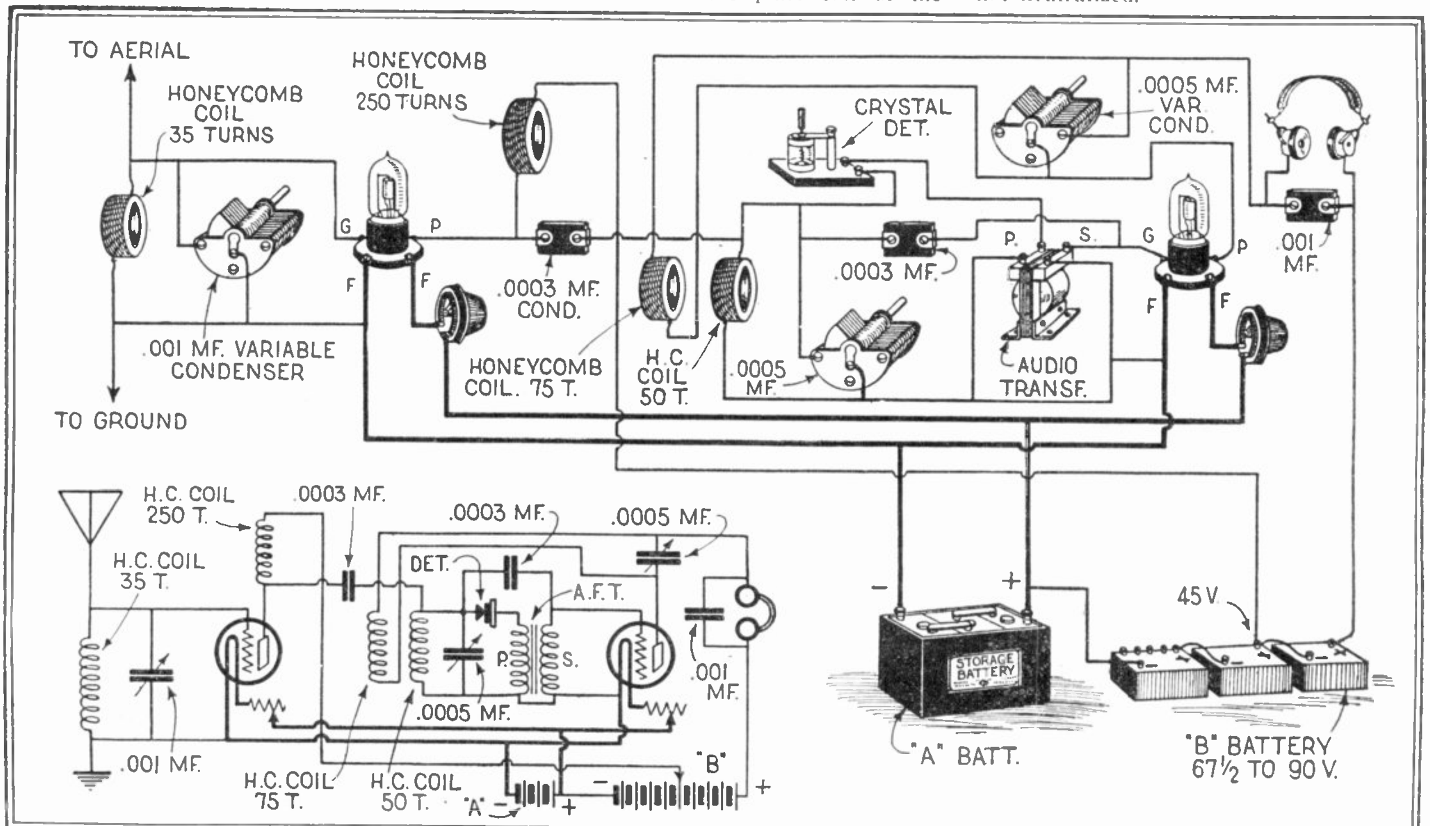


Fig. 102. Many experimenters seem to always be desirous of trying out something new in reflex circuits. Here is one that will keep you busy for some time. It is of English origin and using honeycomb coils throughout, will give good results when properly operated.

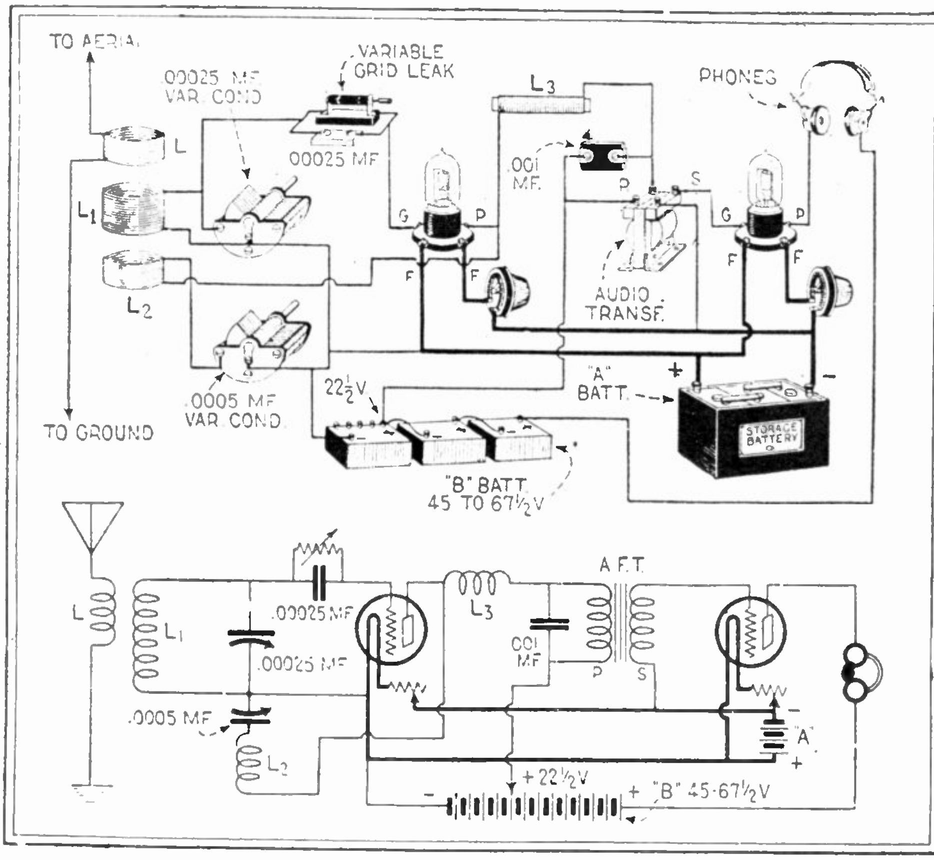


Fig. 107. A short-wave receiver opens new fields for the radio enthusiast. An excellent type for use with headphones is shown above. The data for coils covering the 40 and 80 meter amateur band is given in the text. Follow it carefully in order to obtain the best of results.

A. 1. There are good and bad points to be spoken of in connection with these two types of multi-tube sets. The average Neutrodyne when properly neutralized is very quiet in operation, whereas the average tuned R.F. type unneutralized receiver is noisy and gives vent to the usual squeals and howls that all operators of regenerative sets are familiar with. On the other hand, however, a properly built tuned radio frequency receiver will give much greater volume and usually is better for "DX" reception than a Neutrodyne. The choice between a Neutrodyne and an unneutralized receiver lies in your own desires. If you want a quiet set and do not care for extreme "DX" reception, a Neutrodyne will give excellent results. On the other hand, a tuned radio frequency receiver with the same number of tubes is somewhat cheaper to buy than a Neutrodyne and will as mentioned above give louder signals and more "DX" reception.

REFLEX DETECTOR

(104) Q. 1. Herman Heibner, Pipestone, Minn., asks why a crystal detector is usually used in reflex sets and whether or not he should substitute a vacuum tube detector for the crystal type shown in a diagram which he sent us.

A. 1. Oscillations are easily started when vacuum tubes are used as detectors in reflex sets. It is for that reason that your circuit is shown with a crystal detector. It will not be advisable to change over to a tube detector. The set may become more noisy and erratic in operation.

COUPLING

(105) Q. 1. Frank J. Holly, Jr., Ogdensburg, N. Y., asks: What is the advantage of varying the coupling between the coils in a radio receiving tuner?

A. 1. Coils coupled too closely tune broad and produce high frequency resistance. Coils coupled too loosely do not induce very much current to one another, although the high frequency loses are reduced. It is necessary to strike a happy medium of best coupling. The above is true for ordinary coupled circuits. Where the coupling controls regeneration, it is necessary to vary the coupling in proportion to the amount of current it is desired to feed back from the plate circuits. Here again it is desired to find the point of best feed-back.

NEUTRODYNE

(106) Q. 1. Edward Rumazza, Rochester, N. H., says that he has built a five-tube Neutrodyne receiver and that the adjustment of the neutralizing condensers does not seem to have any appreciable effect on the operation of the set. He asks: Is this usually found to be the case?

A. 1. Neutrodyne sets will sometimes neutralize without requiring the regular neutralizing capacity. That is the situation you have in your set.

SHORT-WAVE RECEIVER

(107) Q. 1. Maxwell Kline, Stamford, Conn., requests a circuit diagram of a short-wave receiver that can use interchangeable coils for tuning over various bands of wave-lengths.

A. 1. In these columns you will find the requested circuit diagram. The coil, L, consisting of three or four turns of wire on a 3½-inch form may be used for practically all waves that this set will cover. The coils L_1 and L_2, however, must be changed for the various bands. In general, L_2 will have half as many turns as L_1. For the 40-meter amateur band use eight turns in L_1 and five in L_2. For 80 meters use 16 turns in L_1 and 10 in L_2. The choke coil L_3 is permanently wired in the circuit and need not be changed. One hundred turns of No. 26 S.C.C. wire on a 1-inch form will be sufficient.

TYPE OF RECEIVER

(108) Q. 1. James H. Fougner, Gilsum, N. H., asks what kind of a receiving set we would advise him to buy.

A. 1. The particular type of receiving set that you will need depends upon whether or not you desire to operate a loud speaker or are content to listen in on headphones. In the latter event, any standard one- or two-tube receiving set would be quite sufficient for your needs. If, however, you wish to use a loud speaker, at least three or possibly four or five tubes should be employed. The circuit you mention in your letter is quite good, but if you wish consistent loud speaker reproduction, we would advise something similar to a Neutrodyne.

Patterns delineating the design and construction of various types of receiving sets can be purchased for a nominal sum. We will be glad to furnish anyone with the name and address of a company supplying them upon receipt of a stamped, addressed envelope.

DETECTOR HOWLS

(109) Q. 1. Ben Crawford, Powers, Ore., has built a four-tube set using one stage of R.F., a regenerative detector and two stages of A.F. He says that the only way the set will operate at all is with the detector tube filament just barely tuned on. Heating the filament further causes the set to howl. Also there is often a scraping sound noticed when the variable condensers are being adjusted. He asks our aid in locating his trouble.

A. 1. First consideration of your problem seems to point toward the wrong value grid leak or grid condenser. Also it is quite possible that your detector tube is not getting the correct plate voltage. Try varying this voltage.

Possibly your variable condenser plates are touching and such can be easily determined by observation. If they are, pry them apart a short distance until they do not scrape. It would seem, however, that aside from the little noise that you get in your set you are getting very good results. Undoubtedly fixing the variable con-

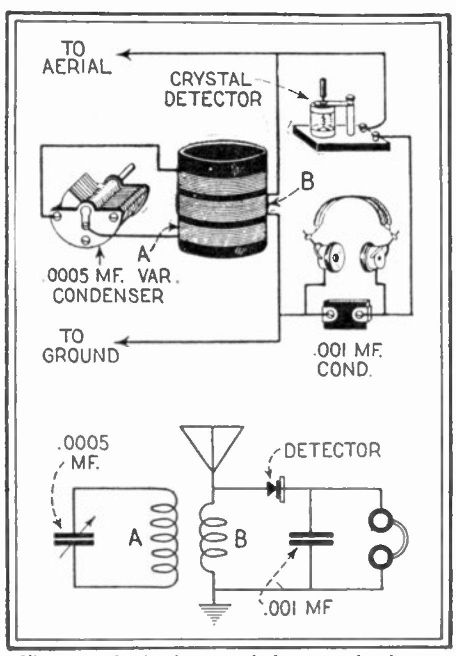


Fig. 110. A simple crystal detector circuit using the absorption method of tuning is shown above.

densers and substituting grid leaks and condensers until you find the right values will clear up your trouble.

CRYSTAL RECEIVER

(110) Q. 1. W. L. Calvert, San Pedro, Calif., asks how to connect up a crystal detector with an absorption type of tuner.

A. 1. The connections are very simple as can be seen in the accompanying diagram. This tuner is quite sharp and the details are as follows: Coil A is 50 turns of No. 22 D.C.C. wire on a 3½-inch form. Coil B is wound on top of coil A and insulated from the latter by a layer of paraffined paper. Coil B consists of 12 turns of No. 22 D.C.C. wire.

A very good kink can be readily perceived from the accompanying sketch. A wave-trap can be converted into a crystal detector circuit by connecting the detector and phones across the antenna and ground terminals of the wave-trap in the same manner as they are connected across coil B in the accompanying diagram. The aerial and ground are also connected to the same posts and the output terminals of the wave-trap are not touched. This, of course, applies to the usual inductively coupled type of trap, wherein two coils similar to A and B in our diagram are employed.

INTERFLEX WITH A.F.

(111) Q. 1. Richard Savage, Hoboken, N. J., has built one of the one-tube regenerative Interflex receivers described in the December, 1925, issue of SCIENCE AND INVENTION and has had such good results with it that he desires to add an additional stage of audio frequency amplification so that "DX" stations can be brought in with greater volume. He asks how this should be hooked up.

A. 1. In these columns we show both schematic and picture diagram of the Interflex receiver with an additional stage of audio frequency amplification. The additional tube should be very easy to add as the connections are not at all complicated. Use a well made A.F. transformer with about a 3 to 1 ratio between the two windings.

REPETITION IN SUPER-HET.

(112) Q. 1. L. G. Benjamin, East Wallingford, Vt., says that he has built up a Super-Heterodyne receiver and finds that he can tune in the same station on two different points on the oscillator dial. It sometimes happens that certain stations can be tuned in on three settings of the dials. The Super-Heterodyne in use is of the Tropadyne type.

A. 1. It is usual to tune a station in at two different points on the oscillator dial. We cannot suggest any method for preventing the receiving of a station at two different settings.

If a station is received three times, the extra reception may be due to one of the Tropaformers being off tune or to one or both of the variable condensers being of rather poor construction and resulting in an irregular capacity. It may also be due to the fact that you hear a harmonic of the wave.

CHANGING SET

(113) Q. 1. W. A. Bazar, Painesville, Ohio, is using a loose coupled type of regenerative receiver and wants to know if we would recommend him to change it to one employing a variometer for tuning.

A. 1. We would not advise you to change the receiving set that you mention to one employing a variometer for tuning. The results would be far from satisfactory, as the circuit would not be very selective and it would radiate more than the one you mention in your letter.

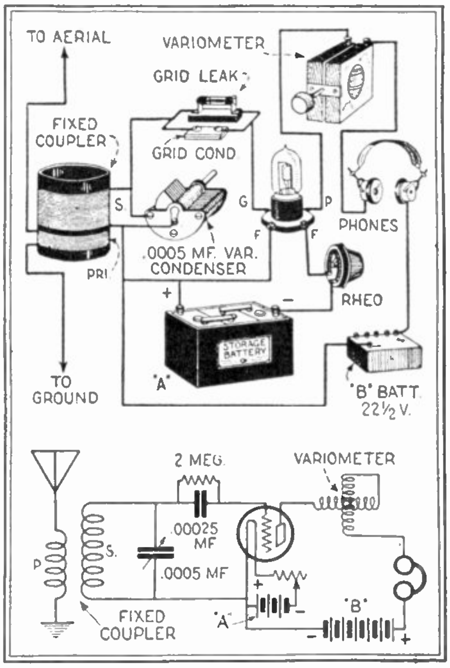


Fig. 114. A very simple yet selective and stable single tube regenerative circuit is shown above. This set is easy to hook up as well as to operate.

SIMPLE RECEIVER

(114) Q. 1. James Moore, Chicago, Ill., wants to know how to hook up a fixed coupler of the same type as used in tuned radio frequency amplifiers with a variable condenser, a variometer and a vacuum tube.

A. 1. This set can be hooked up by following the diagram given in this column. The results will be very good and the set will be quite selective. Simplicity is also a feature inasmuch as only one tuning control and one regeneration control are necessary.

ULTRADYNE QUERIES

(115) Q. 1. J. P. Holloway, Hazelwood, Pittsburgh, Pa., asks in what direction the coils used in an Ultradyne receiver are wound.

A. 1. All coils in the Ultradyne are wound in the same direction.

Q. 2. If I wish to use only a loop, should I use the jack usually shown in the tuner circuit?

A. 2. If you are going to use only the loop, we would advise you to leave out the jack and make connections to binding posts instead. This will eliminate the possibility of inefficiency due to a high loss plug or jack.

BROWNING-DRAKE WITH AMPLIFIER

(116) Q. 1. J. C. Reeves, Milwaukee, Wis., says that he has built the Browning-Drake receiver described in the September, 1925, issue of this magazine and desires to add one stage of transformer-coupled audio-frequency amplification and two stages using resistance coupling. He asks how this can be accomplished, using a jack between the third and fourth tubes and another jack in the plate circuit of the fifth tube.

A. 1. The circuit in Fig. 116 gives all the necessary connections. For the benefit of the rest of our readers, we would advise that specific details on the construction of the tuning coils used in this receiver were given in the December, 1926, issue of RADIO NEWS Magazine.

We have simplified this set to as great an extent as possible by using fixed filament control resistances in the filament circuits of the four amplifier tubes. The

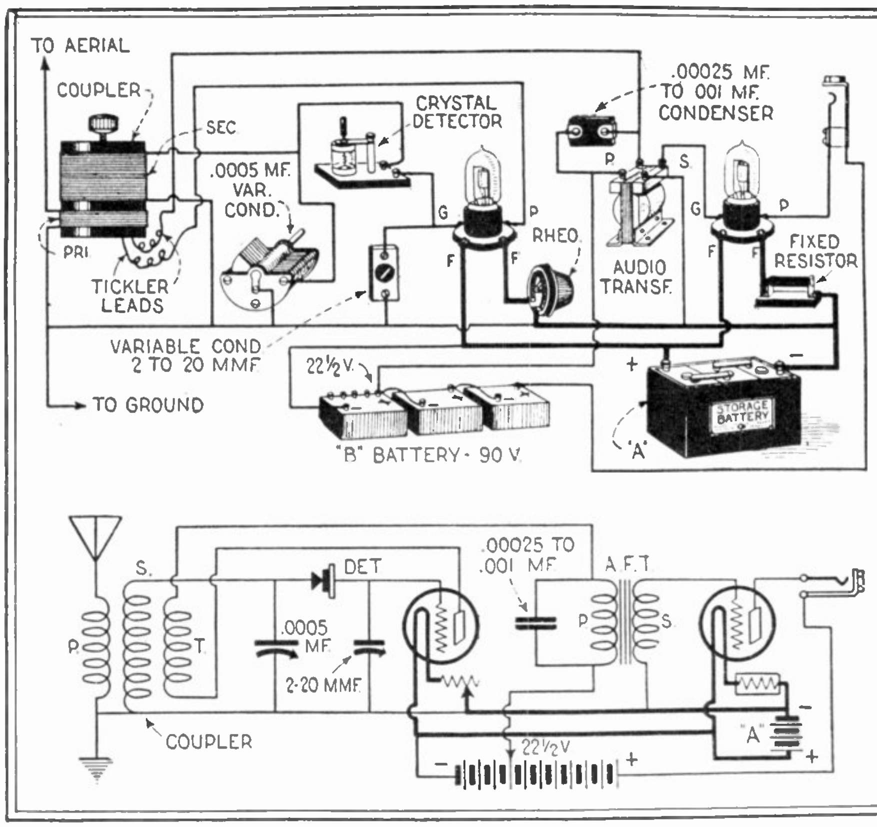


Fig. 111. The Interflex circuit, such as described in the December, 1925, issue of *Radio News* will give loud speaker volume on many stations if equipped with a single stage of audio-frequency amplification. The complete circuit for this work is shown in the diagram above.

only rheostat necessary is that in the detector circuit. An ordinary two-circuit jack is used in the plate circuit of the first audio frequency amplifier and a filament control jack, connected in the filament circuits of the last two tubes is employed in the plate circuit of the fifth tube. In this way, it will not be necessary to turn off the filaments of the fourth and fifth tubes when it is desired to use only the first three.

In the circuit diagram, GC indicates grid blocking condensers, CR coupling resistances and GL amplifier grid leaks. All of these are of the standard types used in resistance coupled amplifiers.

LOW-LOSS WINDING

(117) Q. 1. Stanley Tucker, Brooklyn, N. Y., asks: What, in your opinion, is the most effective type of low-loss winding, particularly for short-wave inductance coils?

A. 1. Undoubtedly a spaced solenoid type of winding holds the honors for this type of work. A comparatively large wire, about No. 14 or No. 16, should be used and the space between turns should be at least equal to the thickness of the wire. This type of winding is far superior to any of the so-called basket-weave or spider-web types, particularly for short-wave work. Its disadvantage on the broadcast waves is its bulk.

FOUR TUBE SET

(118) Q. 1. E. C. Clarke, Jacksonville, Fla., has built the four tube receiver described in the March, 1926, issue of SCIENCE AND INVENTION Magazine and finds two sources of trouble with it. In the first place, the regeneration control does not seem to have much effect on the operation of the set and the second trouble is that a whistle is heard when the loud speaker is plugged into the second stage of audio frequency amplification. He asks if we can help him to remedy these defects.

A. 1. In the first place, we would advise you to look to your regeneration control condenser. Is it of the correct size, and as you vary it from zero toward maximum, do you obtain an increase in signal strength up to a certain point where a click is heard and the music becomes very distorted? If this happens, your regeneration control is operating properly and you will undoubtedly find that your trouble lies in the audio frequency amplifier. By the way, if the regeneration control works over the entire wave band as described, a choke coil in the plate circuit of the detector is not necessary.

The writer had a trouble somewhat similar to the second one which you mention, namely a whistling that at times was very annoying and prevented "DX" reception. It was found that shunting the secondary of the second audio frequency amplifying transformer with a fixed condenser entirely eliminated this whistle and cleared up reception remarkably. We far prefer this system to the usual resistance control of noise. The condenser that the writer uses is of a capacity of .0005 mf. However, the various sizes should be tried until the best results are obtained. This condenser in any case should not be larger than .001 mf.

In case the condenser does not clear up your trouble, make sure that you are not obtaining an audio frequency feedback in your receiver. Possibly the audio transformers are close together or their cores are parallel and if such is the case this will of course take place. In such an event, separate the the transformers or turn them at right-angles to each other. Occasionally grounding the cores or the metal cases or both of the transformers will be of considerable assistance.

One further thought is that the grid leak that you are using may not be of the correct value.

FENWAY SUPER-HET.

(119) Q. 1. Samuel Crosley, Memphis, Tenn., asks: Kindly give a circuit diagram and special coil specifications for the so-called Fenway Super-heterodyne, showing how to connect the switch for changing over from four tubes to nine by eliminating the intermediate frequency amplifiers and the second detector.

A. 1. The Fenway Super-heterodyne, the diagram of which is reproduced in Fig. 119 consists of a single stage of tuned radio frequency amplification, placed ahead of an ordinary eight-tube Super-heterodyne employing a local oscillator, two detectors, three intermediate frequency amplifiers and two audio frequency amplifiers. In the diagram given it will be noted that a cam switch is employed for changing over from a four-tube to a nine-tube set, eliminating the intermediate frequency amplifier and the second detector. With this Super-heterodyne, any standard type of intermediate frequency transformers can be employed. The input coil should be the one designed for use with the particular transformers.

The coils L and L1 consist of 84 turns of No. 32 D.C.C. wire on a 2-inch form. This can be tapped at some point along its length which may be best determined by experimentation, for the ground connection, giving the effect of an auto-transformer as indicated in the diagram. A standard three-circuit tuner with the tickler removed or not used may be connected as the antenna coil. The parallel tuning condenser should then be of the size required for the particular coupler employed.

The coupling coil that is placed between the radio frequency amplifier and the first detector has two parts, a stator and a rotor. The stator is 2¾ inches in diameter and is wound with 63 turns of No. 32 D.C.C. wire. This winding is split in the middle so as to allow the passage of the rotor shaft. The rotor comprises a coil 1¾ inches in diameter by 1 7/16th inches long wound with 24 turns of No. 32 D.C.C. wire. These two coils, the rotor and stator coils, are indicated by L2 and L3 respectively in our diagram.

The oscillator coils are wound as follows: Coil L5 is first wound on a 2½-inch form and consists of 84 turns of No. 32 D.C.C. wire. L6 is wound directly alongside of L5 and is started ⅛th of an inch distant. It consists of 25 turns of No. 32 D.C.C. wire. Directly over the end of L5 that is furthest away from L6, place a strip of empire cloth and over this cloth wind coil L4 which consists of 10 turns of No. 32 D.C.C. wire. All of these coils are wound in the same direction.

It is often found necessary in order to obtain good operation to shield parts of this set. This is accomplished by placing the parts to be protected in 1/32-inch thick copper boxes. The reader can design his own type of boxes with very little trouble.

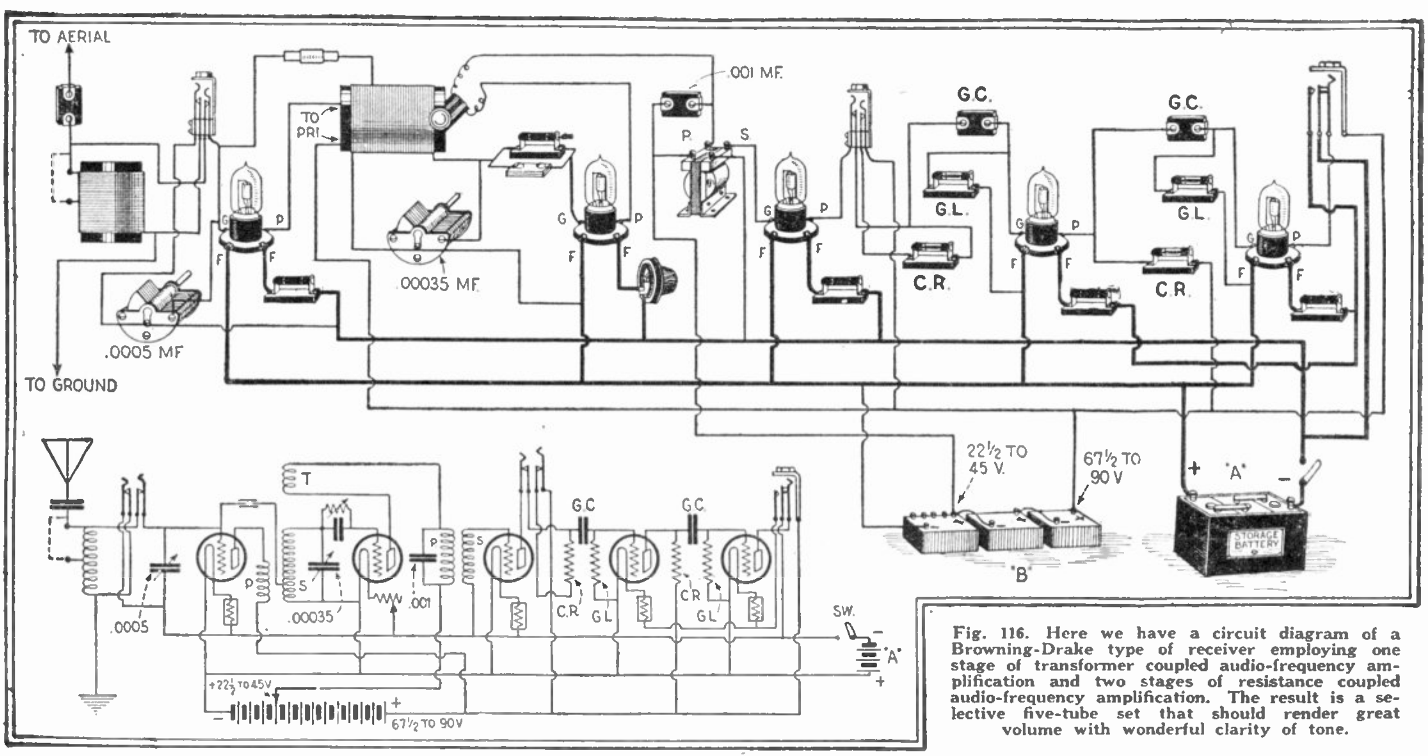


Fig. 116. Here we have a circuit diagram of a Browning-Drake type of receiver employing one stage of transformer coupled audio-frequency amplification and two stages of resistance coupled audio-frequency amplification. The result is a selective five-tube set that should render great volume with wonderful clarity of tone.

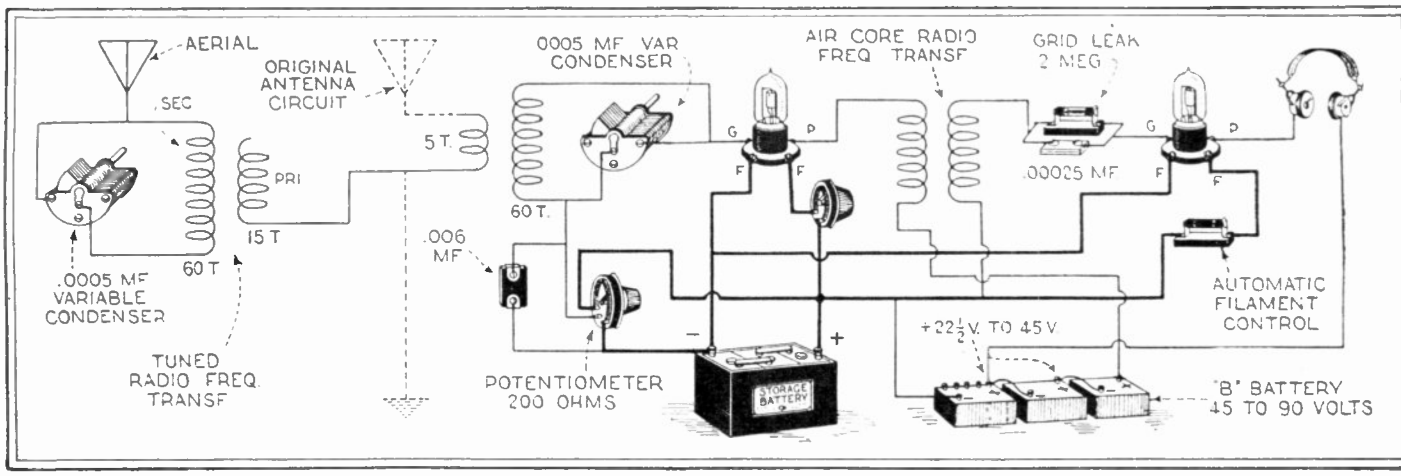


Fig. 122. The circuit above may seem rather strange, but it has been tested and found to be very selective. Both oscillating circuits are tuned sharply to the incoming wave. If a ground connection is desired, it should be made to the filament negative.

Three of them will be necessary. The first one encloses the first R.F. tube, the antenna coupler, a .5 mf. condenser which may be connected in series with the ground and which is optional and the variable condenser that tunes the antenna coil secondary. The second box shields the first detector tube, its grid leak and condenser, the .5 mf. condenser connected across part of the potentiometer and the tuning condenser for the input circuit of the first detector. The third and last metal box encloses the oscillator tube, the oscillator coils, the .5 mf. condenser connected from + 135 volts to ground and the oscillator tuning condenser. The antenna tuning condenser and the oscillator condenser can be grounded to their respective shields, but the first detector tuning condenser must be carefully insulated from the metallic parts. The reason for this can be readily seen by referring to the connections given in the diagram. In all cases, keep inductances that are enclosed within shields at least 1½ inches away from the metallic shield. This should be observed not only in connection with this particular set, but in all radio receivers.

SHARP TUNING WITH CRYSTAL DETECTOR

(120) Q. 1. Lester Delaney, New York City, has a crystal detector set using a fixed coupler for the tuning arrangement. The antenna circuit is untuned, while the secondary is tuned by means of a variable condenser. He asks: Can you tell me how to increase the selectivity of this set?

A. 1. Crystal detector types of receiving sets are inherently broad in tuning, although in some cases it is possible to produce a semblance of sharpness. In your particular instance, we would advise you to increase the coupling between the primary and secondary coils. This will, of course, result in slightly decreased volume, but you will notice an over-all increase in selectivity. This is of particular value in congested districts, and will undoubtedly solve your interference problems.

FOUR TUBE SET

(121) Q. 1. Horace Potter, East Orange, N. J., says that his radio set gives plenty of volume but the reproduced tones are not clear. He lists the apparatus employed and asks us to help him in locating his troubles.

A. 1. Probably the addition of a 3- to 4½-volt "C" battery to your radio set would aid in clearing up your trouble. Also there is a possibility that one or another of your tubes is poor and does not function properly. Changing tubes around in the set might help you out as might also the addition of a good variable grid leak, properly adjusted.

ADDING SUPER-SELECTIVITY

(122) Q. 1. Mr. Weston Bruner, Raleigh, N. C., asks how he can improve the selectivity of his present receiver.

A. 1. The diagram above shows a circuit employed by the Radio Editor of SCIENCE AND INVENTION Magazine to achieve the results acquired. This is an adaptation of the "X" circuit originated by Sir Oliver Lodge. Note that no ground connection is used, as the batteries act as a sort of counterpoise antenna.

MULTI-TUBE NEUTRODYNES

(123) Q. 1. John C. Hays, Indianapolis, Ind., asks: Why is it that a neutrodyne with five stages of radio-frequency amplification has not been put on the market? Would such a set be a success?

A. 1. We consider your inquiry very interesting. Sets having more than four stages of radio-frequency amplification are available, but there are no neutrodynes among the lot. Some of the points are:

1. Two stages require three dials; five stages, at that rate, would necessitate six dials! Take too much time to tune. One-dail controls are easy, in the laboratory. When it comes to commercial production, we have "an equine of a differing hue." A two-dial arrangement might prove practical, after a great deal of experimentation, but there would be plenty of work before the set was ready for the public. It takes a mighty good one-dial set, where the one dial operates two controls, to equal a 2-dial set where each dial has but one control.

2. Some current supply units will work well with five tubes but poorly with eight. The eighth tube also means added expense (the tube price) and battery consumption (if batteries are used) would be more.

3. Tube noises would be more pronounced. Detector tube would often be

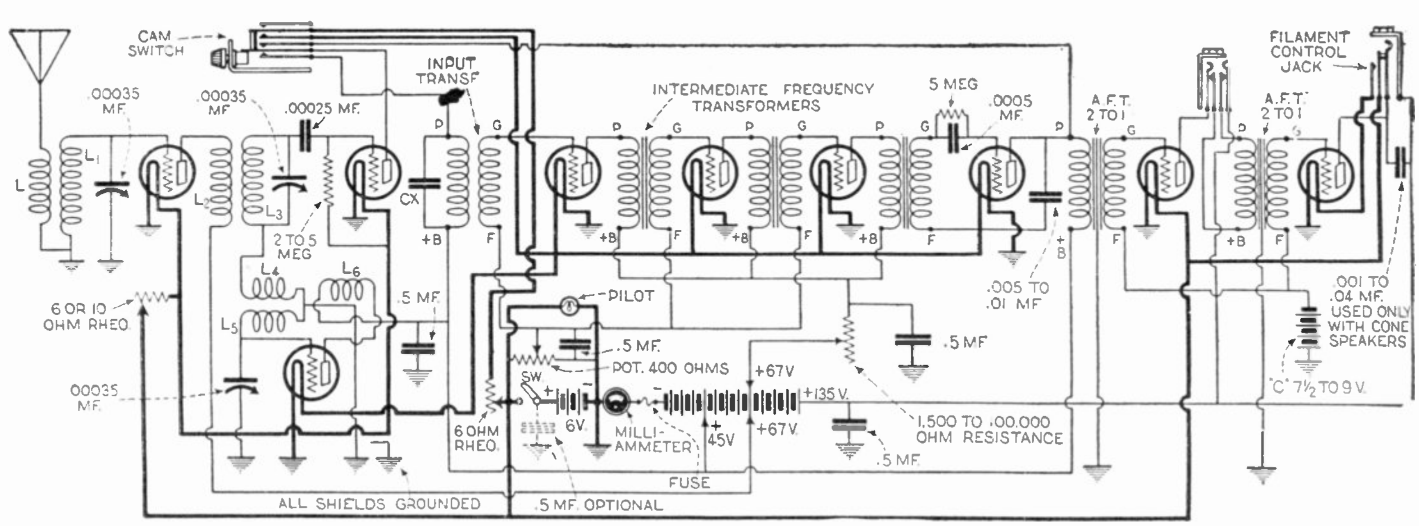


Fig. 119. The Fenway Super-Heterodyne is the latest set that has captured the attention of radio fans throughout the country and in answer to numerous inquiries received relative to this set, we are showing the complete circuit diagram of it directly above. It is possible to obtain complete blue prints covering this receiver at a nominal charge and all of the necessary parts can also be purchased. A letter addressed to the Radio Editor will bring complete information relative to the obtaining of the blue prints and of the parts, including the necessary shields.

overloaded, resulting in distortion. Audio amplifier would have to be a wonder to be really efficient, if the set were to include two stages of audio, for both tubes and transformers would have a terrific load when locals were operating.

4. If set is made on low-loss lines, one would have to put a "ring door-bell" sign out, and hope the signals could read, for the selectivity would be so high that it would take considerable time to tune in wanted signals originating at a distance of more than, say, 150 miles. Anyone who has tuned a neutrodyne can appreciate this.

5. Every stage requires neutralization. This is more or less easy to do at home, given all the time, knowledge and patience necessary for success. But to do this rapidly and certainly in production is an entirely different matter. Then again, a set balanced in the factory test-rooms would not necessarily be balanced (neutralized) when entirely different tubes and batteries are used by the broadcast listener.

6. There is the amount to be added to the purchase price of the set, due to several additional production costs. Considering everything, there would probably be a sale for a set having five stages of radio-frequency amplification, neutralized, if the above stated objections were overcome. The most important points we should say, would be (a) to keep down the number of tuning controls and (b) to have a resulting efficiency greater than could be secured by the use of a lesser number of tubes.

BROADCASTING STUDIOS

(124) Q. 1. Fred T. Barton of Chillicothe, Ohio, asks: Please describe the construction of a modern broadcast station studio.

A. 1. The walls may be constructed of gypsum block. Over this is placed a layer of lith. This is a sound absorbing material. It is also applied to the ceiling. A triple wall construction should be used. Between the walls a thick layer of sound-deadening material is laid. The furniture should be wood-doweled, not nailed.

Q. 2. Should draperies be used to prevent echoes?

A. 2. A certain amount of reverberation is required. By use of a partial drapery, the correct balance between reverberation and a total absence of echo may be easily obtained. If the special wall construction described above is used, no drapery is required.

Q. 3. What is the difference between reverberation and echo?

A. 3. Reverberation is a type of echo so closely spaced to the original sound that the separation connot be detected by the ear. An echo is so timed that the separation can be readily detected.

THE ULTIMAX CIRCUIT

(125) Dudley Caverson, Rochester, N. Y., inquires:

Q. 1. Will you please publish the circuit diagram of the Ultimax receiver, designed by Louis G. Pacent?

A. 1. You will find the circuit diagram of the well-known Ultimax receiver on this page, together with a drawing illustrating the winding data for the auto transformers used in the radio-frequency stages. The other constants are specified in the circuit diagram, where the values of the phase-changing condensers and radio-frequency chokes are indicated. This circuit has been found to be very efficient on the broadcast wave lengths, and is peculiarly characterized by its wonderful tonal qualities. The set is very simple to assemble and adjust and has proven to be quite a hit.

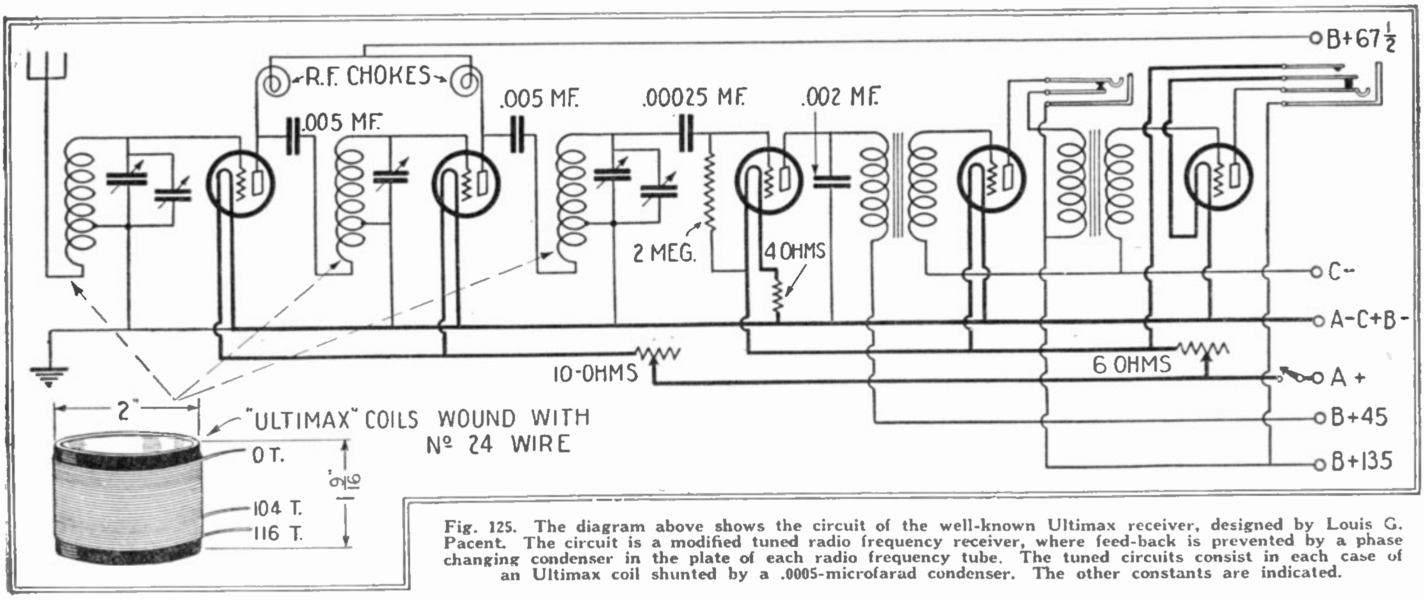


Fig. 125. The diagram above shows the circuit of the well-known Ultimax receiver, designed by Louis G. Pacent. The circuit is a modified tuned radio frequency receiver, where feed-back is prevented by a phase changing condenser in the plate of each radio frequency tube. The tuned circuits consist in each case of an Ultimax coil shunted by a .0005-microfarad condenser. The other constants are indicated.

ANTENNA "SUPER" OPERATION

(126) J. C. Stevens, Elgin, Illinois, writes:

Q. 1. I wish to use an antenna in connection with my Radiola Super, which is of a model about 2½ years old. Have tried several antenna connections, but they are not selective. How may this be done?

A. 1. While you could build an antenna tuner with antenna circuit separate from the secondary, and tuned by means of a variable condenser and loading coil, a stage of tuned R.F. amplification would be a better means of providing selectivity, added sensitivity, and freedom from radiation of energy into the antenna, to the great joy of your neighbors. In Fig. 126 is shown a suggested circuit for an antenna tuner, R.F. amplifier, and coupling transformer, requiring only one control and no critical adjustments. The output transformer, which in this case is a Silver Marshall Type 110-A, is designed so that the secondary is tuned with a .00035 mf. variable condenser, to cover the broadcast band. As the condenser shunted across the loop in your set is about .0008 mf., it would probably tune the 110-A coil through a range of from 250 to 800 meters and you would be unable to tune in the lower wave-length stations. Hence only one whole section of the stator winding should be used, with 6 additional turns from the other stator winding, the remaining turns being removed. It is best to unsolder the wire leading to terminal 3 of the transformer, and remove turns from the coil until only 6 are left, soldering the end of the 6 turn coil to terminal 3. Connect the terminals 3 and 6 of the coil to the binding posts in the set which are marked for "external loop" connection, and the loop condenser will thus be shunted across the coil. The filament and plate voltages for the R.F. tube may be obtained from the same set of A and B batteries supplying the main set.

"SUPERHET" TROUBLES

(127) B. H. Blaker, Westfield, N. J., writes:

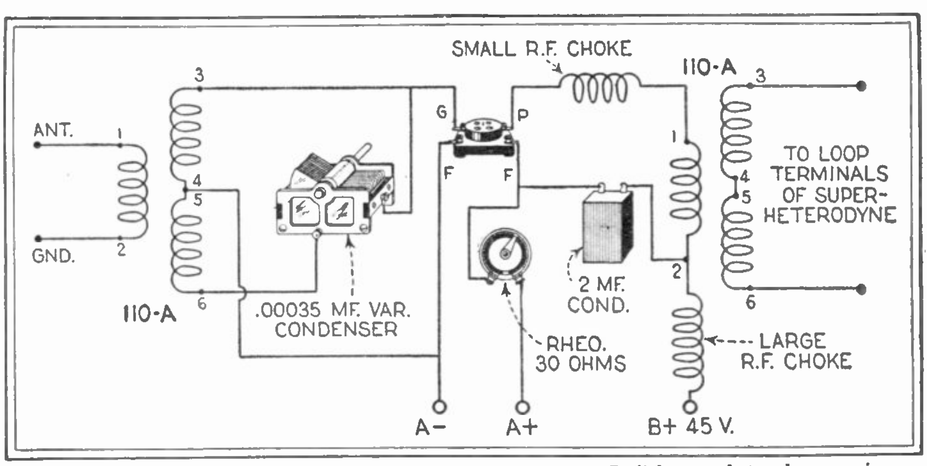


Fig. 126 The method of coupling the antenna and ground to a Radiola superheterodyne receiver is clearly shown above. This system will give excellent results and selective tuning.

Q. 1. I hooked up a superheterodyne using Victoreen transformers, following the circuit shown in a recent number of *RADIO REVIEW*. It does not work satisfactorily. Can you tell me where the trouble might lie?

A. 1. We believe that what has happened is that you have followed the Madison-Moore hook-up a little too faithfully in wiring your Victoreen transformers. The Victoreen transformers can be used, but where you got into trouble was when you hooked up the oscillator coupler.

You will note in looking over the recent article in *RADIO REVIEW*, that in the Victoreen circuit the oscillator variable condenser is really connected across both windings, i. e., the total inductance of both windings is used in shunt with .0005 condenser. In the Madison-Moore hook-up the .0005 oscillator variable condenser is connected across only one of the oscillator coupler windings, and in consequence you only reach to about 300 meters.

The thing to do is to follow the Victoreen hook-up in connecting up the oscillator coupler with particular respect to the oscillator variable condenser, but take care to connect the pick-up coil in the plate circuit of the first detector, as the Madison-Moore circuit indicates.

TROUBLE IN THE VICTOREEN

(128) R. C. Andover, Ironwood, Michigan, writes:

Q. 1. I have a Victoreen radio and would like to know if I can place the coils straight, instead of on an angle as it would make a better job. I am bothered with a lot of interference and I think by shielding I will reduce some of it.

A. 1. If you shield your Victoreen and have shielding between the stages, so that the coils you refer to are in separate compartments the angular placement can probably be done away with. Before bothering to put in the shielding, remove the loop (or antenna and ground) from the set and see whether the noise decreases or is entirely eliminated. If all the noise stops when the pick-up systems are removed, shielding will do you no good, as your pick-up of noises would be entirely through your antenna.

IMPROVING A T. R. F. SET

(129) K. Milton, Barnegat, N. J., asks:

Q. 1. I have a five-tube T. R. F. Set and desire to improve its sensitivity and selectivity. Can I add another tube, and how, in order to do the above?

A. 1. Instead of adding another tube we would suggest that you either reduce the primaries of the radio frequency coils, or add regeneration to the detector. This can be done by winding a three-inch coil with 20 turns of No. 22 D.C.C. wire and placing it at the grid end of the detector coil. This coil should, of course, be wound in the same direction as the detector coil. A variable resistance, say from 0 to 50,000 ohms can be used, shunted across this coil to control regeneration.

CONTROLLING REGENERATION

(130) A. Sohn, Bronxville, New York, asks:

Q. 1. Can you give me a method for controlling regeneration whereby the tickler coil can remain more or less stationary?

A. 1. You will find illustrated on this page a simple and efficient method for the controlling of regeneration by means of a high resistance in the tickler leads. Although the circuit shown here is a standard three-circuit receiver this method may be used in any circuit which em-

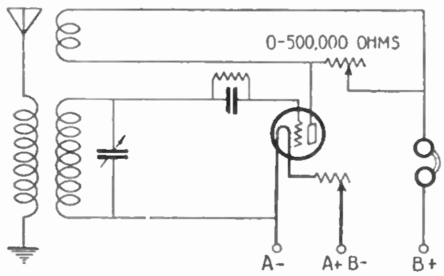


Fig. 130. One of the simplest methods of controlling regeneration.

ploys regeneration. The resistance should have a range of about 0 to 500,000 ohms.

COUNTERPHASE POWER SIX RECEIVER

(131) M. E. Thomas, Milwaukee, Wis., asks as follows:

Q. 1. Please furnish me with a description of the Counterphase Power Six-Tube Receiver, including those details which are necessary to obtain satisfactory reception with the receiver.

A. 1. The schematic wiring diagram for the Counterphase Power Six Receiver is shown in Fig. 131. It incorporates three stages of tuned-radio-frequency amplification, a special neutralizing system for overcoming oscillations in each R.F. stage, a detector and a two-stage transformer-coupled audio-frequency amplifier, in whose final stage a power tube is employed.

No constructional data for the special toroidal coils can be furnished as it is exceedingly difficult to construct a coil of this type without adequate facilities. Two tandem condensers with compensating verniers attached to each unit are employed for tuning.

Adjustment

After the receiver is completed, the following process of adjustment should be used. Adjust all neutralizing condensers so that the movable plate is halfway down. Tune in a station of moderate power on a low wavelength (200 to 300 meters) to exact resonance on both dials, using the small trimmer condensers to obtain fine adjustment. Adjust the 500,000-ohm volume control to give the greatest volume without oscillation or squealing in the loud speaker; which means to point where no whistling will be heard when the dials are rotated back and forth across the signal. Place a small piece of paper over the "F+" contact spring of the third R.F. tube socket, so that the tube filament does not light. The signal will, no doubt, still be heard; and the neutralizing condenser should now be adjusted back and forth with a small screw-driver, until the signal becomes weaker, or disappears altogether. Now retune the right-hand dial for the loudest signal, and again adjust the neutralizing condenser for minimum signal. If it can be tuned out entirely the correct adjustment of the condenser has been obtained.

Now remove the piece of paper from the filament spring and repeat the operation with the second R.F. tube. Retune both tuning dials before making the final adjustment of the neutralizing condenser, and make sure that the signals remain weak, or entirely disappear, over a band of one or more turns of the neutralizing condenser, before finishing the adjustment.

Replace the filament connection, and repeat the performance with the first R.F. tube; being very careful in adjusting the neutralizing condenser, as the band of silence in this stage is very small, and may be passed over.

FREQUENCY AND WAVELENGTH

(132) F. Kuntz, Jacksonville, Florida, asks:

Q. 1. Can you give me formula for determining the frequency when the wavelength is known and vice versa?

A. 1. To ascertain the frequency when the wavelength is known use the following formula:

$$\text{Frequency in kilocycles} = \frac{300{,}000}{\text{Wavelength in meters}}$$

To ascertain wavelength when the frequency is known, the formula becomes:

$$\text{Wavelength in meters} = \frac{300{,}000}{\text{Frequency in kilocycles}}$$

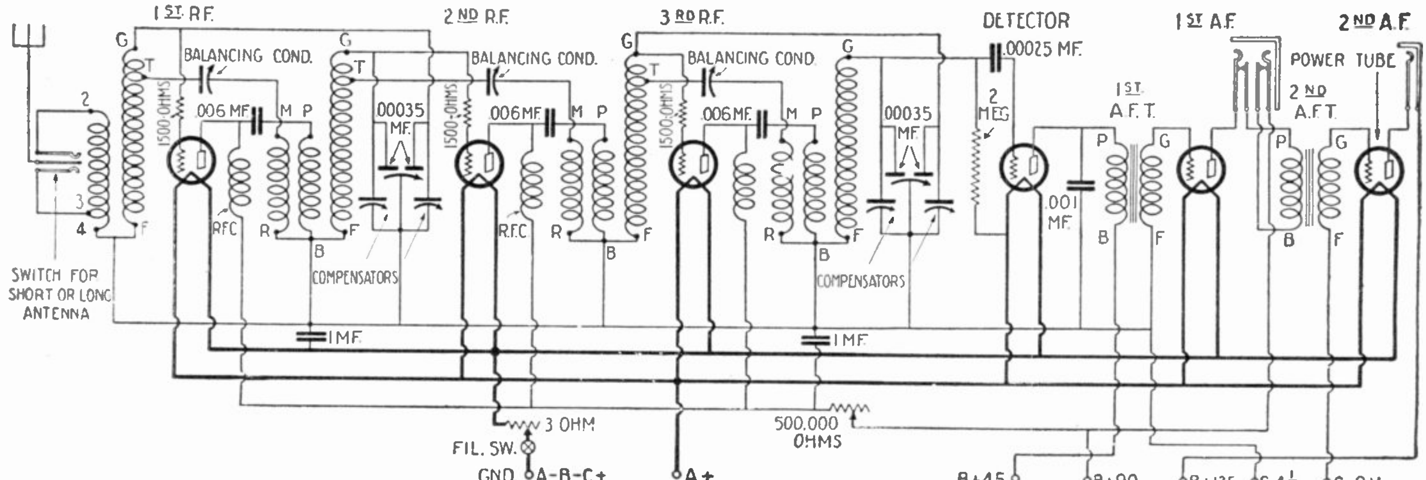


Fig. 131. This diagram shows the connections of the Counterphase Power Six Tube Receiver in schematic form.

Transmitting Circuits

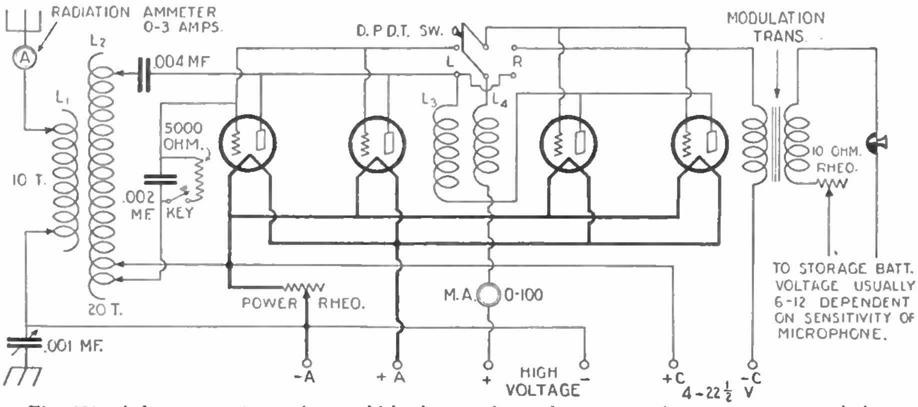


Fig. 134. A low power transmitter, which changes from phone to continuous wave transmission, by a throw switch. The very efficient Heising system of modulation is employed.

RADIO COMMUNICATION DISTRICTS

(133) Mr. Steve Tellep, Monessen, Pa., asks:

Q. 1. Please publish the circuit for a two-tube portable receiver.

A. 1. Two-tube circuits have appeared in print for a long time. Practically any set may be made portable. It is mostly a question of design. Small instruments carefully placed, will help to make the set compact. WD-11, WD-12 or UV-199 type tubes are best for small sets, since small batteries may be used as a current supply. Aerials ranging from a single wire reaching to the lower limb of a tree, to loop aerials two or three inches in diameter, are used for such sets. Loop aerials are not usually used with regenerative receivers, for the range is usually small.

Under good conditions, however, surprising distances may be covered with a loop aerial and a regenerative receiver. The loop aerial takes the place of the grid tuning coil. There must be some arrangement whereby the plate current can be transferred to the grid circuit, causing regeneration. One method is to build a small plate circuit loop into the regular grid circuit loop, making it variable in inductive relation. Another method is to insert about 15 turns of wire (wound on a small tube) in series with the loop and about 30 turns more in the plate circuit. When these two coils are coupled, variations in the plate circuit are reproduced in the grid circuit (regeneration).

Q. 2. Kindly advise me as to whom application should be made for station license information.

A. 2. We have had so many inquiries from all parts of the country for this information, that we are herewith printing the list of the nine radio communication districts, and the territory covered by each. Communications should be addressed to the Radio Supervisor at the Custom House in the principal city of the district.

(1) BOSTON, MASS.: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.

(2) NEW YORK, N. Y.: New York (county of New York, Staten Island, Long Island, and counties on the Hudson River to and including Schenectady, Albany and Rensselaer) and New Jersey (counties of Bergen, Passaic, Essex, Union, Middlesex, Monmouth, Hudson and Ocean).

(3) BALTIMORE, MD.: New Jersey (all counties not included in second district), Pennsylvania (counties of Philadelphia, Delaware, all counties south of the Blue Mountains, and Franklin county), Delaware, Maryland, Virginia, District of Columbia.

(4) SAVANNAH, GA.: North Carolina, South Carolina, Georgia, Florida, Porto Rico.

(5) NEW ORLEANS, LA.: Alabama, Mississippi, Louisiana, Texas, Tennessee, Arkansas, Oklahoma, New Mexico.

(6) SAN FRANCISCO, CAL.: California, Hawaii, Nevada, Utah, Arizona.

(7) SEATTLE, WASH.: Oregon, Washington, Alaska, Idaho, Montana, Wyoming.

(8) CLEVELAND, OHIO: New York (all counties not included in second district), Pennsylvania (all counties not included in third district), West Virginia, Ohio, Michigan (Lower Peninsula).

(9) CHICAGO, ILL.: Indiana, Illinois, Wisconsin, Michigan (Upper Peninsula), Minnesota, Kentucky, Missouri, Kansas, Colorado, Iowa, Nebraska, North Dakota, South Dakota.

A 20-WATT RADIOPHONE TRANSMITTER

(134) Mr. J. S. Anderson, Salt Lake City, Utah, asks:

Q. 1. I would like constructional details and circuit diagram of an efficient low-power (about 20-watt) phone and CW transmitter, which incorporates the Heising system of modulation, and employs some convenient means of quickly changing from phone transmission to CW, or vice versa.

A. 1. The Circuit diagram you request is shown in Fig. 134, and incorporates the Heising system of modulation. A double-pole double-throw switch is used for quickly changing from CW transmission to radiophone, simply by throwing the switch from the left to the right position for radiophone work. When the switch is on the left side, all four tubes are in parallel and used as oscillators; when on the right side, two tubes are in parallel and functioning as oscillators, the other two in parallel and functioning as modulators.

The parts necessary for the construction of this transmitter are as follows:

2 Specially constructed inductances, L-2 being wound on a 4-inch tube, and consisting of 20 turns of No. 12 or 14 D.C.C. wire, space wound. L-1 is wound on a tube 3¾ inches in diameter, or slightly smaller, and wound with the same size wire to the number of 10 turns. L-1 fits within L-2, but the tubing must have a ½-inch slot cut through it so that the amount of inductance desired may be varied at will by means of a small clip.
1 Variable condenser, .001-mf., preferably large-spaced transmitting type;
1 Radiation ammeter, preferably thermo-coupled type, and having a scale reading from 0 to 3 amperes;
2 Fixed condensers, .004- and .002-mf., transmitting type;
1 Transmitting grid leak, 5,000 ohms with center tap at 2500 ohms (10,000 ohms with center tap at 5,000 ohms if larger tubes than the 5-watt type are to be employed);
1 Double-pole double-throw switch;
1 Power rheostat;
1 Modulation transformer;
1 Rheostat, 10-ohm;
One Milliammeter (0-100 scale for 5-watt tubes, 0-300 if larger tubes are to be employed, such as the DeForest "H" tubes, Telefunken 20-watt, or American 50-watt type);
2 Honeycomb coils, 300-turn, which comprise the inductances L-3 and L-4; or 250 turns of No. 26 or 28 D.C.C. wire wound on a one-inch tube, approximately 6 inches long;
1 Microphone and one transmitting key;
4 Tubes, 5-watt or the new 7½-watt type.

Advice on Operation

For best results it is advisable that either a motor generator be used to supply the plate voltages for the tubes, or "B" batteries if expense is not considered. It is entirely possible to use either chemical or "Kenotron" rectified A.C., but then an elaborate filter system is required; and the results obtained either on phone or C.W. would be inconsistent and tedious experimenting would be required to obtain perfect modulation.

The antenna system may be either of the inverted "L" or "cage aerial" type, not exceeding 75 feet in length and a lead-in of 50 feet. Either counterpoise or ground may be used. Best results on phone transmission will be obtained when the transmitter is operated on a wavelength of approximately 195 meters, although the transmitter may be adjusted to operate to as low as 40 meters for CW transmission, as the circuit shown is very flexible. The wave-length of the transmitter may be changed by means of the .001-mf. variable condenser shown connected in series with the ground, or by changing the grid and filament taps, (the greater the amount of inductance between these two the higher the wave-length attained), or by both methods. It is suggested for finer adjustment that a .0005- or .00035-mf. variable condenser of the transmitting type be shunted across the grid and filament taps.

The 10-ohm rheostat shown in the microphone circuit should be of the heavy-resistance wire-wound type, and capable of withstanding approximately ¼ ampere. This rheostat is employed to obtain various voltages on the microphone, because some "mikes" work best on 6 volts, and some on 12.

In adjusting the transmitter, do not allow the plates of the tubes to overheat, or glow to "incandescence," as this shows that a good deal of the energy is being dissipated. A slight red glow would be normal.

BROADCAST STATION

(135) Mr. M. Halpern, Brooklyn, New York, asks as follows:

Q. 1. I would like complete constructional details, including the wiring diagram, of a broadcast station which I contemplate constructing. I am desirous of employing the 50-watt tubes, two as oscillators, and two as modulators, using the Heising system of modulation. Also a speech-amplifier system of some sort incorporated. A complete list of parts that would be necessary, and any pointers that you could give me concerning the adjustment of the transmitter, etc., would be of extreme help to me.

A. 1. It is an exceedingly difficult proposition to construct an efficient broadcast station. Nevertheless, as we have received numerous calls for similar information, we here describe a complete transmitter incorporating a speech-amplifier system, which may be used for broadcasting purposes. The circuit diagram is shown in Fig. 135; the Heising system of modulation is employed. Either 5- or 50-watt tubes may be employed, the plate voltage being the only variable feature, should it be desirous to switch from one to the other. The transmitter, of course, must be ruggedly constructed and well insulated to withstand high voltages.

The following are the items necessary for the construction of this transmitter:

1 R.F. Choke coil, consisting of 300 turns of No. 28 D.S.C. wire, wound on 1½-inch bakelite or rubber tube, approximately 9 inches in length;
1 Oscillation transformer, consisting of primary and secondary inductances employing flat copper ribbon, helically wound;
1 Transmitting-type variable condenser, .0005-mf. double-spaced;
1 Transmitting-type variable condenser, .00035-mf. double-spaced;
1 Thermo-ammeter, 0 to 5 scale, employed for indicating the antenna current which is being radiated;
4 50-watt type sockets (assuming that 50-watt tubes are to be employed);
2 Modulation transformers;
1 Non-inductive resistance, 5,000-ohm;
2 Fixed condensers, transmitting type, .002-mf.;
1 Milliammeter, 0 to 500 scale;
1 Voltmeter, 0 to 1,500 volts (an external resistance is necessary with this voltmeter due to the high voltage which it must indicate. The two are sometimes purchased in separate form, although each must be designed for the other);
1 Voltmeter, 0 to 15 scale;
1 Choke coil (transmitting type), 30-henry;
2 Fixed by-pass condensers, 4.0-mf., breakdown voltage 1,500 volts;
1 Fixed by-pass condenser, 4.0-mf., breakdown voltage 2,000 volts;
1 Plate reactor (RCA-UP 415);
2 Rheostats, heavy-current type designed for 50-watt tubes;
1 Sensitive microphone;
1 Motor generator (generator's output variable, maximum voltage 1,500 volts with a load. Also it should be rated at least 300 watts output);
1 Western Electric 7-A amplifier;
3 216A tubes for the above-mentioned amplifier;
1 Milliammeter, 0 to 100 scale;
1 Potentiometer, 200-ohm;
2 Double-pole single-throw switches;
1 Lighting switch;
1 Variable resistance, 0-25,000-ohm;
1 I Double-pole double-throw switch.

Miscellaneous, such as screws, bolts, angle iron for constructing framework for the transmitter. No 12 rubber covered wire for wiring the transmitter, etc.

The transmitter, as illustrated, is inductively coupled, and must be so to comply with the government requirements, as well as to emit a wave with a "sharp" characteristic. Ten volts is normally required for lighting the filaments of the 50-watt tubes. It would be best to employ storage batteries or a separate generator for this purpose. The use of A.C. for radiophone purposes is impractical unless the financial resources of the constructor are considerable.

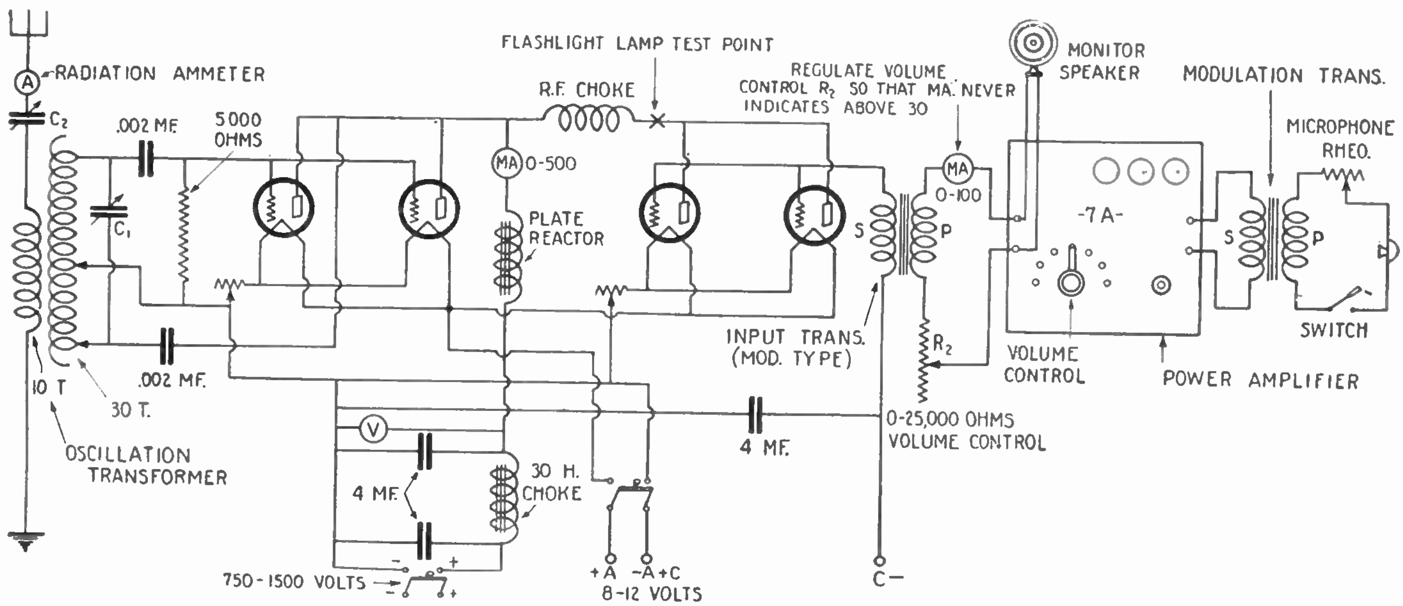


Fig. 135. The wiring diagram of a 100-watt broadcasting station. A reliable range of approximately 100 miles may be expected with this transmitter.

Adjustment of the Transmitter

Condenser C1 is the fundamental condenser for adjusting the wave-length of the transmitter. C2 is known as an antenna series condenser, and is usually employed in cases where the antenna is too long, and the fundamental wave too high. C2 is rotated until maximum radiation current is obtained, which is indicated by the Thermoammeter, otherwise known as the radiation ammeter. If the plates of the oscillator tube become incandescent, or near a "white heat," then either too high a plate voltage is being forced upon the tube, or the energy supplied to the tube is dissipated in the form of heat, instead of being supplied to the antenna. Varying the clips, on the primary inductance of the oscillation transformer, will vary the wave-length of the transmitter. The center clip or "A—" usually has considerable to do with whether the tubes are oscillating properly and supplying the proper antenna currents or whether dissipation of the energy takes place. In other words, if the plates of the oscillator tube heat up too much then it can be assumed that the center tap is in an incorrect position, and should be varied.

The speech amplifier is employed for intensifying the speech or music before it is fed to the modulator tubes. The volume control and variable resistance should be under the control of the operator at all times during the period of transmission. Should the speakers or singers increase the volume of their voices the operator must simultaneously increase the value of the resistance employed for this purpose, to keep the sound at an even intensity.

When testing for radiation it will be noted that while the plates of the oscillator tubes are glowing red, the modulator tubes seem to be comparatively cool. This is as it should be, as the modulator tubes do not function until the microphone and speech amplifier are connected up to the "input" terminals. A test for whether they are functing correctly or not, may be made in the following manner.

Insert an ordinary flashlight lamp (6- or 12-volt type) in series with the plate circuit of the modulator tubes and the R.F. choke. It this tube glows brightly or blows out when the microphone is spoken into, then we can assume that the tubes employed for modulation purposes are functioning correctly. The circuit should be jumped immediately after the modulation test is made; in other words, do not leave the flashlight lamp in the plate circuit as it will only serve to absorb energy from the modulator tubes.

AMATEUR LICENSES

(136) James F. Marcy, Milwaukee, Wis., asks:

Q. 1. Will you please publish the requirements which must be met to obtain an amateur transmitting license?

A. 1. We quote from the Radio Communication Laws of the United States bulletin, furnished to us by the Department of Commerce:

"Amateurs before applying for licenses should read and understand the essential parts of the International Radio Telegraphic Convention in force and sections 3, 4, 5 and 7 of the Act of August 13, 1912.

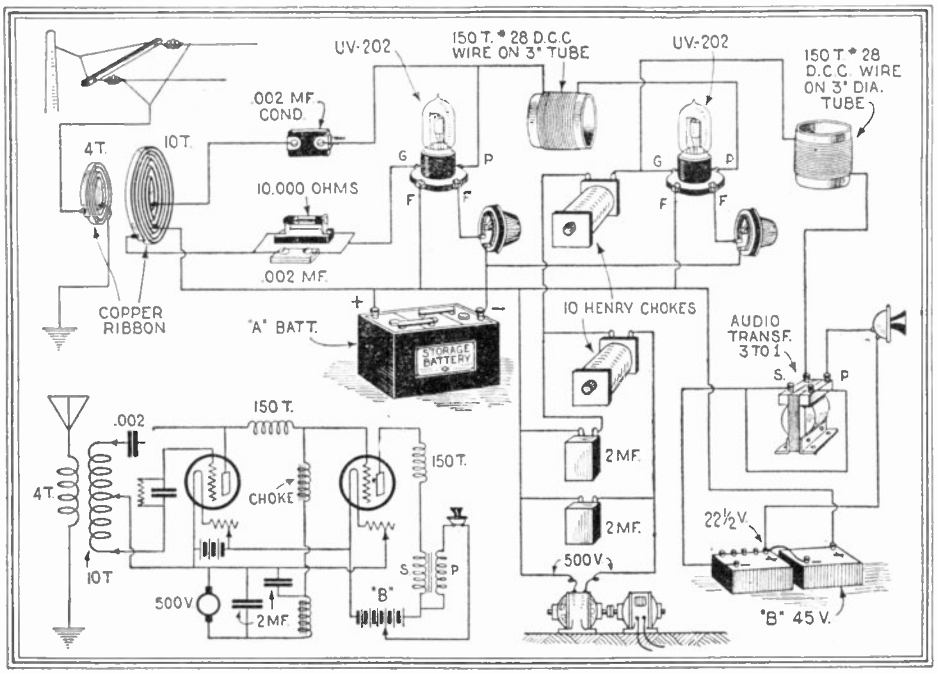


Fig. 141. The low power broadcasting set shown above can be used to communicate with stations about 10 to 15 miles apart. The modulation system is of the best and latest design.

The Department recognizes that radio communication offers a wholesome form of instructive recreation for amateurs. At the same time its use for this purpose must observe strictly the rights of others to the uninterrupted use of apparatus for important public and commercial purposes. The Department will not knowingly issue a license to an amateur who does not recognize and will not obey this principle. . . .

"Amateur First Grade.—The applicant must have a sufficient knowledge of the adjustment and operation of the apparatus which he wishes to operate and of the regulations of the International Convention and Acts of Congress insofar as they relate to interference with other radio communication and embody certain duties on all grades of operators. The applicant must be able to transmit and receive in Continental Morse at a speed to enable him to recognize distress calls or the official 'keep-out signals.' A speed of at least ten words per minute (five letters to the word) must be attained.

"Amateur Second Grade.—The requirements for the second grade will be the same as for the first grade. The second grade license will be issued only where an applicant cannot be personally examined or until he can be examined. An examining officer or radio inspector is authorized at his discretion to waive an actual examination of an applicant for an amateur license, if the amateur for adequate reasons cannot present himself for examination, but in writing can satisfy the examining officer or radio inspector that he is qualified to hold a license and that he will conform to his obligations."

DIFFICULTIES IN TRANSMISSION

(137) Q. 1. Miss Nancy MacDonald, New York, N. Y., asks: What are the difficulties in transmission of radio signals which cause varying ranges of reception, etc.?

A. 1. There are three principal sources of trouble encountered in practice which makes it difficult to receive readable radio signals: (1) Interference from transmitting stations whose signals it is not desired to receive. (2) strays or static, and (3) the "fading" of the strength of the received signal.

Interference from other transmitting stations can to a large extent be eliminated by selection of frequency (wave-length), particularly by the use of transmitting apparatus which radiate only single wave-length or a narrow band of wave-lengths. Laws have been enacted which are designed to minimize interference from other stations.

Strays are electrical disturbances giving rise to irregular interfering noises heard in the telephone receivers. They are also called "static," "atmospherics," "X's," and other names. In any particular case the possibility of getting a readable signal depends on the ratio of the strength of the signal to the strength of the static at that

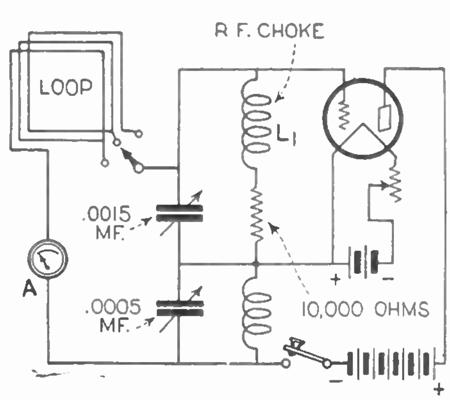


Fig. 138. A loop is used in this Portable Transmitter to give a directional effect to the signals.

time. Experienced operators have stated that it is possible to copy messages when the strays were four times as strong as the signals but much difficulty is often experienced even when the strays are much weaker than this. The most common type of stray produces a grinding noise in the telephones: this type causes the most serious trouble. Another type, which produces a hissing noise, is usually associated with snow or rain. Near-by lightning produces a sharp snap.

LOOP-ANTENNA TRANSMITTER

(138) Mr. K. Washburne, Newark, N. J., asks:

Q. 1. I intend going camping this summer and would like to construct a portable transmitter using a loop antenna. Will you please give me the necessary data, and diagram?

A. 1. For those who intend going to camp this summer, or contemplate week-end trips, this particular transmitter should be adaptable: since it has the necessary characteristics, such as portability, efficiency, ability to operate on a loop, etc. The advantage of the loop antenna in transmitting is that directional signals may be sent by simply pointing the loop in the desired direction.

An ordinary 5-watt tube should be used in this circuit. Plate voltage may be supplied by either "B" batteries, or a generator which may be coupled to the engine of the automobile, or a motor-generator whose motor runs on a single storage battery. Loop should consist of 3 turns of No. 10 wire wound on a wooden frame, about 3 feet square. Both variable condensers shown in the circuit should be of the transmitting type and able to withstand a fairly high voltage.

The radio-frequency choke coil L1 consists of 200 turns, wound on a 2-inch tube with No. 28 DCC wire. L2, the other, has 150 turns wound on a 2-inch tube with No. 28 DCC wire. The wave-length of the transmitter may be varied by changing the position of the switch lever on the various loop taps. When maximum deflection is obtained in the "radiation ammeter," the transmitter is operating at its maximum efficiency for that particular wave-length.

A regular transmitting license is necessary for this outfit, as for any other radio transmitter.

STANDARD FREQUENCIES

(139) Milton Sills, Staten Island, N. Y., requires information concerning the time of the transmission of standard frequencies from WWV, the station of the Bureau of Standards, located at Washington, D. C.

A. 1. The Bureau of Standards transmits, twice a month, radio signals of definitely announced frequencies, for the use by the public in standardizing wavemeters and transmitting and receiving apparatus. The signals are transmitted from the Bureau's station, WWV, at Washington, D. C., and from Station 6XBM, Stanford University, California.

The transmissions are by unmodulated continuous-wave telegraphy. A complete frequency transmission includes a "general call," a "standard frequency signal" and "announcements." The "general call" is given at the beginning of the eight-minute period and continues for about two minutes. This includes a statement of the frequency. The "standard frequency signal" is a series of very long dashes with the call letters (WWV or 6XBM) intervening. This signal continues for about four minutes. The "annoucements" are on the same frequency as the "standard frequency signal" just transmitted and contain a statement of the measured frequency. An announcement of the next frequency to be transmitted is then given. There is then a four-minute interval while the transmitting set is adjusted for the next frequency.

The signals can be heard and utilized by stations equipped for continuous wave reception at distances within 500 to 1,000 miles from the transmitting stations. Information on how to receive and utilize the signals is given in Bureau of Standards Letter Circular No. 92, which may be obtained on application from the Bureau of Standards.

LOOP TRANSMITTER

(140) Robert T. Morris, New York City, asks:

Q. 1. Will you please publish a diagram using a 5-watt transmitting tube in conjuction with a loop antenna and the other necessary materials to be used in a set capable of covering a range of approximately 25 miles?

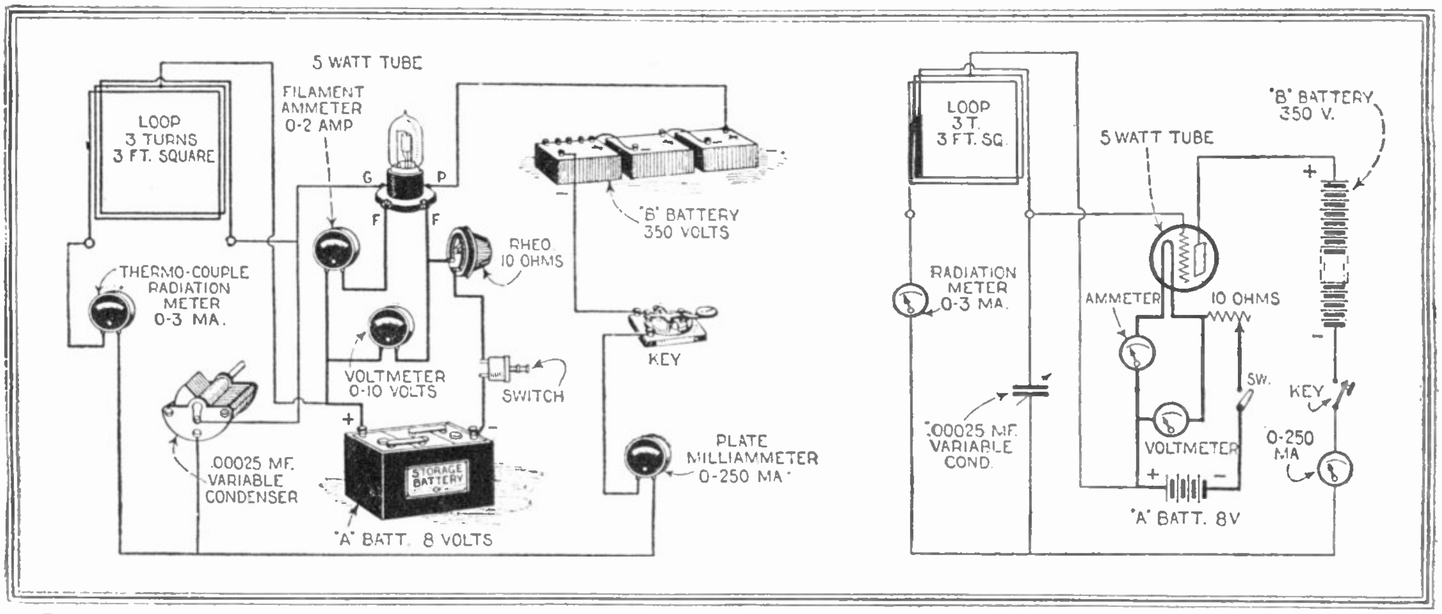


Fig. 140. A simple loop "C.W." transmitter. When properly built this set will give excellent service. Its low first cost and up-keep should make it very popular with the beginner. It can readily be equipped for phone transmission.

A. 1. As a foreword, your attention is called to the fact that unless one has an operator's license from the Government, he cannot lawfully operate a radio transmitting set.

The circuit shown in Fig. 140 has been found to be a very efficient one and under ordinary conditions has easily covered the 25-mile range. This set should be tuned, for best results, to 100 meters or thereabouts. By turning the loop, directional effects can be obtained very nicely. The indicating meters can be dispensed with if so desired, but for maximum efficiency, should be included. The loop is wound with three turns of No. 12 enameled copper wire spaced two inches apart and has a tap at its exact center. The .00025 variable condenser is of the double spaced type so that it can withstand high voltages. Anywhere from 90 to 350 volts of "B" battery can be employed, the higher the voltage the more power radiated. If desired, a grid leak and grid condenser can be connected in the circuit, in which case it is possible to control the tube's oscillations more readily.

For phone transmissions, a 3-to-1 ratio audio-frequency transformer is connected with its secondary in series with the grid and loop. A microphone and a 6-volt battery are connected in series with the primary of the transformer, which completes the modulation system. Of course, the transmitting key is closed when transmission of the voice is desired.

Care should be taken to prevent overloading the tube by allowing too much filament current to operate it. A slight increase of filament current is far more dangerous to the longevity of a tube than a rather large increase of plate potential.

BROADCASTING TRANSMITTER

(141) Q. 1. J. C. Coggill, Concord, N. H., please send me a diagram and explanation for the construction of a small portable broadcasting set with a range of about 10 miles.

A. 1. First of all, you must be examined and have a license for broadcasting. The circuit for the set is given in Fig. 141. For the plate supply, we recommend that you couple a generator to the motor of the truck or vehicle you are going to house the transmitter on. The filaments can be supplied by the storage battery used for the starting system or ignition system of the truck. A good antenna must, of course, be available. The ground connection can be obtained by driving a six-foot copper or iron bar into the ground.

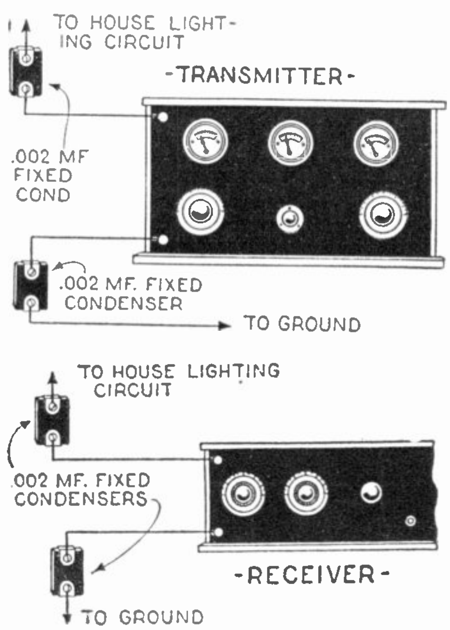


Fig. 143. Two circuit diagrams for experimental wired wireless, both transmitting and receiving, are given above.

A CAUTION TO AMATEURS

(142) Q. 1. Jerome Russell, Jr., Deep River, Conn., says that he has repeatedly heard a short wave radiophone station signing the call letters APRC on phone. He asks: Can you tell me who gives this station call?

A. 1. There is a possibility that the person signing these call letters is some unlicensed experimenter, as we have no record of any such call ever having been assigned by the United States Government. Let us sound a warning here to all experimenters interested in radio transmission. It is positively against the laws of this country to operate any type of radio transmitter without first obtaining a government license for that station and a second license for the operator thereof. There is no charge for such licenses, but an examination must be passed by the applicant for the operator's license. Experimenters living at too great a distance from examining centers to warrant their personal appearance can obtain a second grade license upon filling out the required blanks. These may be had from the Radio Inspector who is located at the nearest Custom House.

WIRED WIRELESS

(143) Q. 1. Mr. Paul Davis, Denver, Colo., inquiries about **wired wireless** and asks for a circuit for experimentation with it.

A. 1. Wired wireless is the transmission of radio-phone messages over power lines. The ordinary transmitting and receiving set may be made use of in connection with this method of transmission and reception. The circuit used with wired wireless is given in Fig. 143. Condensers are placed in the aerial and ground leads of both the transmitter and receiver in order to prevent any catastrophe to the tubes or power lines.

PHONE TRANSMISSION

(144) Q. 1. R. B. Prichard, St. Petersburg, Fla., asks us to give him the circuit diagram of a phone transmitter to be operated on a wave-length of 40 meters.

A. 1. We must inform you that only C.W. (continuous wave) transmission is allowed on the short wave bands. Phone transmission is not allowable. Do you desire a circuit of a C. W. transmitter for short waves?

TRANSMITTING QUERIES

(145) Q. 1. Alfred B. Anderson, Procter, Vt., sends us a circuit diagram of a standard transmitter using a combination filament and a plate transformer. He asks if he can eliminate all power transformers by using a storage "A" battery to heat the filament and by connecting the A. C. directly to the rectifier.

A. 1. You would not be able to eliminate the transformer in the circuit as you mention, because you would not be applying enough potential to the plate to get appreciable radiation. Also, the voltage drop in the rectifier would be so great that we do not believe you could even get your transmitter to oscillate.

MODULATION TRANSFORMER

(146) Franklin M. Crawford, Newark, N. J., asks as follows:

Q. 1. How can an automobile spark coil be used as a modulation transformer? The coil referred to is of the three-terminal type.

A. 1. In order to use your spark coil as a modulation transformer, you should take the case off the same and separate the connections so that you obtain two primary and two secondary leads. These can be hooked up in the conventional manner.

LOCATION OF KEY

(147) James C. M. Miller, New York City, writes as follows:

Q. 1. How can my radio set be used as a C.W. transmitter? In other words, where should the key be connected?

A. 1. To use this set as a C.W. transmitter, place the key in series with the plate supply. This key is to be closed when transmitting by radiophone.

WAVE-METER QUERY

(148) Q. 1. J. K. Woods, Dallas, Texas, says that he has a calibrated wave-meter but that it is not equipped with a driver and desires to know whether or not it can be used for checking the wave-length of a station that is being received on an ordinary regenerative tuner.

A. 1. This work is quite possible and is rather simple. Tune in the station to its greatest volume and then place the set in oscillation. Place the wave-meter coil near the secondary circuit and vary the condenser slowly. Two clicks will be heard in the receivers, the clicks being about two degrees apart on the wave-meter dial. Now, move the wave-meter further away from the receiver by 2 or 3 inches and try again. This time the clicks will be closer together. Keep doing this, moving the wave-meter only a short distance at a time until the two clicks are so close together that they sound as one. This point will be the desired one and from it you can find the wave-length of the station being received.

COMBINATION TRANSMITTER AND RECEIVER

(149) Q. 1. H. F. Gustine, Jr., New Orleans, La., mentions a circuit of a standard combination transmitter and receiver and asks what "B" battery voltage should be applied to a fairly hard tube being used in the circuit.

A. 1. A "B" battery voltage between 100 and 250 volts should be used. The higher the voltage, up to the limit of the tube, the better the transmission will be.

Q. 2. What kind of an aerial should be used for transmission between 150 and 200 meters?

A. 2. Regarding the aerial for use in connection with this set, we would advise a 1, 2 or 4 wire affair, 50 feet long over all and situated as high as possible. Either a ground or counterpoise can be used and for transmission, the latter will probably give the best results. It should be the same size as the aerial and should be located about six or eight feet from the ground. It need not necessarily be placed directly under the aerial, but can be run in any convenient direction. It is to be connected to the ground binding post of the combination set, whereupon the ground itself is not used for transmission.

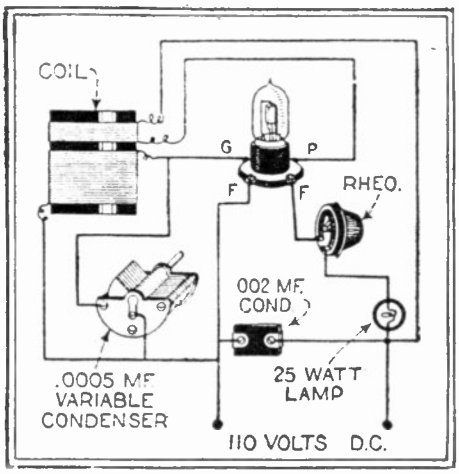


Fig. 151. The diagram above shows the hook-up of an oscillator and wavemeter which operates from the 110-volt lighting circuit.

GENERATOR FOR TRANSMITTER

(150) Q. 1. H. C. Davidson, Montreal, Canada, asks how a generator may be connected to the transmitter described in the December, 1925, issue of SCIENCE AND INVENTION Magazine, said generator to take the place of the rectified A.C. current supply shown.

A. 1. It is merely necessarily to connect the terminals of the generator in place of the output of the rectified and filtered A.C. circuit. Connect the positive pole of the generator to the plate through the R.F. choke and connect the negative pole to the filament circuit.

OSCILLATOR AND WAVEMETER

(151) Q. 1. Walter Davis, Reed City, Michigan, asks that a hook-up be published for a simple combination oscillator and wavemeter operating entirely from a 110-volt direct current source.

A. 1. The wiring diagram desired is shown in Fig. 149. In order that the filament of the tube may receive the proper amount of current, a lamp should be connected in series as indicated. For an 01A tube the lamp may be of 25-watt rating. For a finer adjustment a variable resistance may be connected in series with the lamp. The condenser connected across the line has a capacity of about .002 mfd. The 2 coils are closely coupled and are wound on a 3-inch diameter tube. The actual number of turns on each coil will depend upon the range of wave-lengths to be covered. For the broadcast band approximately 50 turns will be required on each coil. The variable condenser may be of .0005 mfd. capacity.

ANOTHER B BATTERY TRANSMITTER

(152) C. Ferber, Santa Monica, Calif., asks:

Q. 1. Will you please recommend a radio telephone circuit using receiving tubes and dry cell B batteries?

A. 1. You will find on this page a circuit diagram of a type of transmitter which has been tested and found very satisfactory for the medium wave-lengths. We do not recommend this circuit for short-wave work, and we find a modified Reinartz circuit to be best for the new short-wave experiments. You will notice that the transmitter uses two of the 210 type tubes, which are rated at about 7½ watts output. You will find these tubes of about equal efficiency to the 5 watt tubes formerly used. In the diagram, the modulation transformer, M, may be simply a telephone induction coil connected as shown. The choke coil indicated at X need not necessarily have a value of exactly 6 henries, but it should not be smaller than this figure. The oscillator system, consisting of Coil L_2, and Condenser C_2, of the simplest design practical, and the constants of these parts depend entirely upon the wave-length range.

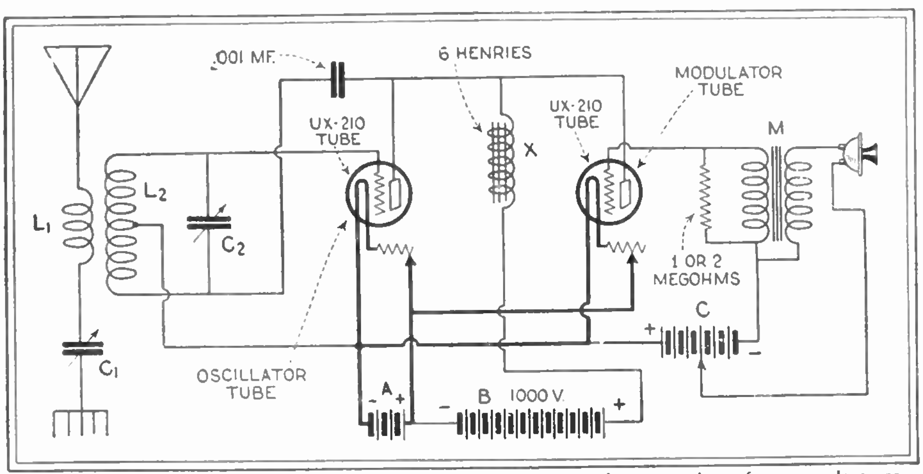


Fig. 152. Compact low power transmitters seem to interest a large number of our readers, so we are publishing another diagram suitable for this type of work above. Note that a B battery voltage of 1000 is used. This is the maximum for the 210 type tube, but less may be used if desired.

Current Supply

A.C. ON FILAMENTS

(153) Mr. George Faulkner, Atlanta, Ga., asks:

Q. 1. Is it possible to make a radio frequency set using the electric light lines as a current supply for the filaments? The current rating is 110 volts, alternating current.

A. 1. We are showing a design that makes this possible. The biasing batteries C1, C2, C3, C4, and C5 have a value of approximately three to four and one-half volts. It is good practice to use a separate potentiometer across the filament of each tube in order to more surely arrive at the correct balance. P_1, P_2, P_3, P_4, and P_5, should each be about 400 ohms resistance.

The current supply transformer must have a secondary capable of supplying one and one-quarter to one and one-half amperes, at six volts.

Regular neutroformers, or else transformers designed for use in tuned radio frequency amplifier circuits of the unneutralized type, may be satisfactorily used. The correct variable condensers for the particular coils employed should be used.

Since radio frequency amplification is being used, it would be best to use audio-frequency transformers of only medium ratio, such as 3:1, 4:1 or 5:1.

Q. 2. What size copper wire should I procure to have a resistance that need only be fairly close to the value of one ohm per foot?

A. 2. No. 40 B. & S. gauge copper wire will closely approximate this figure.

NOVEL PLATE SUPPLY

(154) Mr. Jno. J. Ruby, Brooklyn, asks:

Q. 1. Please show how to combine an amplifier using UX-112 tubes and the radio frequency circuit accompanying this inquiry.

A. 1. We believe you will find the circuit shown in the diagram will meet your requirements. (See Fig. 154.)

The constants are as follows:

L 48 turns of No. 24 D.C.C. wire tapped at 2 turns from the filament end of the coil for "L," 8 turns for "M" and 15 turns for "S." L-1 50 turns of No. 24 D.C.C. wire wound on a 3-inch tube. One-eighth of an inch from the filament end of this coil is wound L-2, 25 to 40 turns (depending upon tubes used) of the same size wire, wound on the same tube with a separation between L-1 and L-2 of about ⅛-inch. For UV-201A type tubes 25 turns will probably be found about right. For dry cell tubes, more nearly 40 turns will be required. L-3, 15 to 35 turns (depending upon tubes used) of No. 24 D.C.C. wire, on a 3-inch tube. L-3 is separated from L-1 by a distance to be determined by test. It will probably be about 3 inches, and in inductive relation as shown. All coils are wound in the same direction. Condenser C-1 may have a maximum capacity of .0005. C-2 has a value of about .00025 mf.

It may be advisable to connect a choke coil at "X," this coil to consist of about 200 turns of No. 30 D.S.C. wire on a 2-inch tube.

To insure greater quality, grid-bias rectification is used, instead of the more ordinary grid-leak rectification.

Good audio-frequency transformers must be used. Chokes one and two may be Auto-formers with a voltage step-up ratio of 1:1½.

To eliminate strong hand-capacity effect, the writer has shown the rotor of C-2 connecting to the "C" battery side of the instrument.

An illustration of the radio frequency instrument and a lay-out that may be followed appear on page 796 of the December, 1925, issue of RADIO NEWS.

The electrolytic rectifiers are very easily made. The tubes are 1 x 6-inch test tubes filled with a solution of sodium phosphate made by dissolving about a teaspoonful of the chemical to a cup of water (use the natural salt, not acid, sodium phosphate). The electrodes are thin aluminum and iron strips, ¼-inch wide and 6 inches long. The positive element, the aluminum, must be of the purest grade obtainable.

The iron, or negative electrode serves only as a connection to the electrolyte. It is the aluminum oxide film, the formation to be described, with which we are most concerned.

The transformer is a 50-watt, 110-volt, 60-cycle transformer with a 220-volt secondary winding tapped about evenly. This secondary voltage, *which is very critical,* is the plate potential to be determined by test.

Although 8-mf. condensers are shown, condensers of larger capacity will reduce any ripple that may remain in the out-put.

Before using this rectifier on the set, switch Sw.C should be set for the lowest possible voltage and the trasformer connected to the 110-volt line for about 10 minutes. The oxide film will by then be formed on the aluminum electrodes.

Switch Sw.B may be a push-pull arrangement, for selecting either the first or second stage of power amplification. The tubes recommended for the two-power stages marked 4 and 5, are UX-112-type tubes. Type UX-210 tubes can also be used in these two positions with extra-

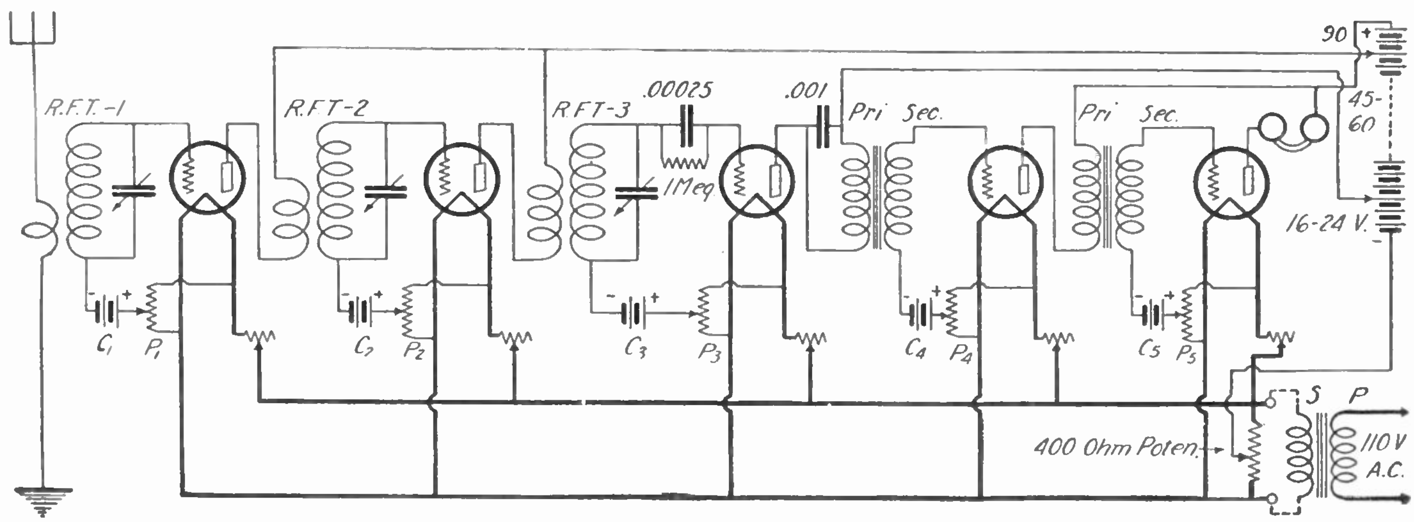


Fig. 153. This circuit uses the house lighting current for filament heating. A transformer steps the current down to six volts A.C. To prevent a tube burn-out by overloading, all tubes should be lighted when set is in use.

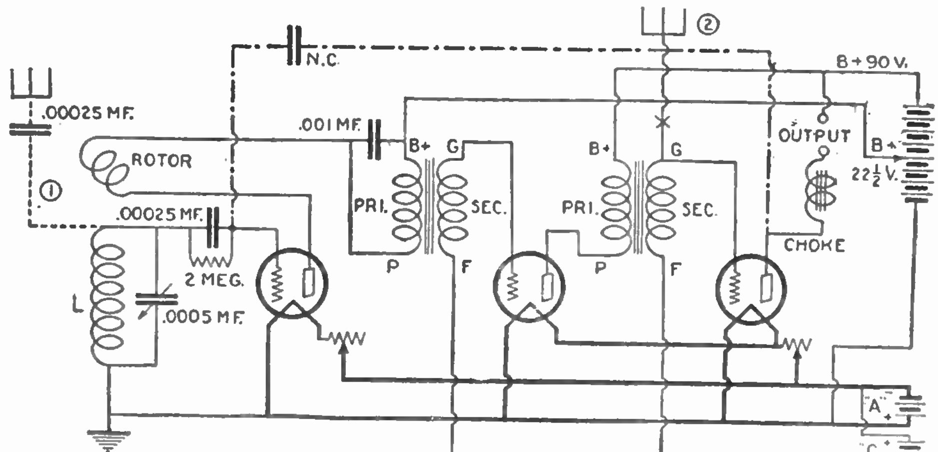


Fig. 154B. A single circuit receiver designed so as to reduce radiation to a minimum.

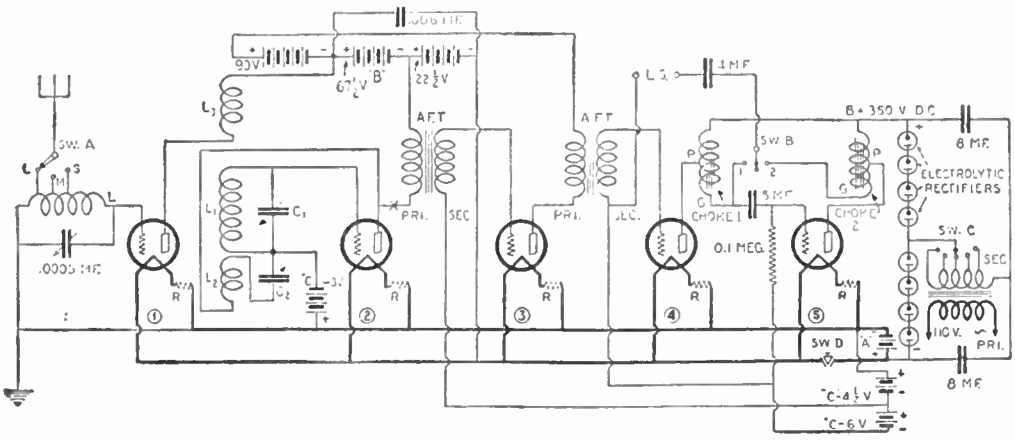


Fig. 154. An unusual circuit employing the use of electrolytic rectifiers to supply B voltage for the places of the last two amplifier tubes.

ordinarily good results. In the event that these tubes are used, no filament resistance is required at "R," with a 6-volt supply. When UX-112 tubes are used a *resistance capable of carrying ½ ampere* per tube must be provided for the set. The UX-210-type tube will require a negative "C" bias in the neighborhood of 15 volts.

The 8-mf. condensers must have a high insulation value.

By use of the unusually efficient and high plate voltage supply described above, one need not give the attention needed by "B" batteries of the usual type which age rapidly under such heavy duty service and eventually become noisy, or the storage "B" battery that requires frequent recharging, or the next best proposition, the motor generator with its attendant and undesirable commutator noises.

This circuit is an unusually efficient one for driving cone-type reproducers.

Readers will be interested to know that a set built with this form of plate supply reproduced the signals of a broadcast station fifty miles away so loudly and clearly as to be perfectly understandable at excellent audibility, two miles from the loud speaker.

Experimenters desiring more detailed information regarding the tuning system and circuit, selected for the qualities of selectivity and sensitivity, and the plate supply selected for the reasons enumerated above, are advised to study these references:

"The One-Stage Radio Frequency Amplifier," page 21, in the November, 1925, issue of *QST* magazine (Hartford, Conn.): "The Reactrodyne Circuit," page 796, December, 1925, issue of RADIO NEWS; "Electrostatic A.C. to D.C. Converters," page 1077, March, 1923, issue of SCIENCE AND INVENTION.

Q. 3. If it is possible to incorporate the new DeForest Anti-Radiation device of Roy A. Weagant with a regenerative receiver of the so-called single-circuit type, so as to prevent radiation of squeals and whistles, please show how it can be done and give all details necessary. Would the large Acme audio transformer work satisfactorily in the set? Or would the Erla code transformer work best?

A. 3. Yes, it is possible to apply the principle you mention with no difficulty at all. The changes are probably made sufficiently clear in circuit diagram 154B.

The aerial is removed from its usual position (1) and placed as shown at (2). The .00025 mf. condenser shown in the first position of the aerial may be tried at point "X" of the aerial in the second position, but it will probably not be found at all necessary for its usual purpose—increasing selectivity.

The coil marked "Choke" may be the secondary of a good radio-frequency transformer of the *aperiodic* type, such as the Acme R-2, the Duratran, the All-American R-201A, etc.

A Chelton Midget condenser may be used as N.C. Other condensers of the type used in neutrodynes for neutralizing purposes will probably prove satisfactory, if 50 mmf. capacity can be obtained.

Any good make of audio-frequency transformers may be used, with the lower ratio transformers in the second stage.

The ratios of the new and old model Acme transformers, and other comparative data are:

No.	Ratio	Ht.	Dep.	Wid.	Wt.
A-2	4½ :1	3″	2″	2½″	8 oz.
MA-2 ...	5 :1	3″	4″	4 ″	16 oz.

It is inadvisable to use the code transformers mentioned, unless it is desired to receive mostly code signals, in which case inductances "L" and "rotor" would be entirely different from their broadcast values; which may be, for example, "L," 50 turns of No. 20 D.C.C. wire on a 3-inch tube; "rotor," 20 to 40 turns of No. 24 D.C.C. wire wound on a 2½-inch form, the exact number of plate coil turns determined by the particular tubes used.

The Erla code transformer is called the "1,000 cycle" transformer and at this frequency at which it peaks, a voltage amplification ratio is approximately .30:1 and is the most suitable transformer on the market for the amplification of code signals of 1,000 cycles frequency (approximately).

BATTERY CHARGER

(155) Mr. J. Reed, Springfield, Mass., asks:

Q. 1. Please give complete constructional details and how to make a Tungar type of battery charger.

A. 1. Fig. 155 is a schematic diagram which shows the electric apparatus and connections necessary to assemble a two-ampere battery charger, which will operate on the usual 110-volt A. C., 25 to 60 cycles. The diagram shows a transformer with three windings, which we will designate as P, S1 and S2. P is the primary winding and is connected to the 110-volt A.C. light socket. S1 is the filament secondary and supplies the power for heating the Tungar bulb filament. This winding is provided with a center tap B which is used as the positive lead for the charger. Winding S2 is the charger winding and supplies the necessary potential to operate the rectifier tube proper. Leads are taken out from points B and C and run, respectively, to the positive and negative terminals of the storage battery.

To construct the transformer a core is necessary. The simplest way to obtain it is to go to your local electric-light company and ask for a junked pole transformer of about 1-kva. capacity. These transformers can usually be obtained for a small sum. Both primary and secondary windings of the transformer should be removed.

Now for the winding of the coils. A simple way to calculate the correct number of primary turns is to divide the cross-sectional area of the core in inches into 588. For instance, if the core should measure 2x2 inches, the required number of primary turns is 147, of No. 20 DCC wire, wound on one segment of the core. The charging winding S2 should have one-quarter as many turns as the primary or in this particular case, 37 turns of No. 15 DCC wire, wound on a different segment of the core. The turns of the filament winding S1 are one-fiftieth the number of the primary turns; in this particular instance 3 turns of No. 12 DCC wire. A tap is taken off from the second turn and is used as the midpoint of this winding. Of course, all these different numbers of turns depend on the size of the core, as stated above.

After assembling and wiring the charger as per circuit diagram, an inspection should be made to determine the initial performance. If possible, the charging rate should be measured, if only by connecting a Ford-dash ammeter or similar device in one of the charging leads. When a 6-volt storage battery is being charged, the rate should be 2 amperes; on a 12-volt battery the rate will be 1 ampere. If the charger delivers less current than the above amounts, and still gives some appreciable current, turns should be added to the winding S2 until the proper rate is obtained.

In case the charger fails entirely to operate, first look for loose wires or broken connections. Then try reversing the battery leads or clips and observe if charging ensues. Occasionally it will require the addition of several turns of wire to the winding S2 in order to obtain satisfactory starting of the Tungar arc; but this should be necessary only when the transformer has been assembled or wound carelessly.

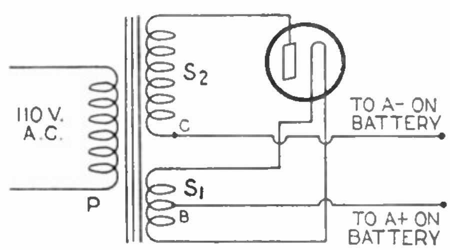


Fig. 155. Wiring diagram of a Tungar type battery charger, showing charging (S2) and filament (S1) windings of transformer.

BATTERY ELIMINATOR

(156) I would like to construct a battery eliminator, to be used in conjunction with my receiving set. The set requires "A," "B" and "C" batteries, and the current supply is of the alternating type. Can you furnish me with a diagram and any other necessary data to construct such an eliminator?

A. It is possible to construct an eliminator, operating from an A.C. source, for lighting the filament of a radio receiving set, as well as to provide "B" battery and "C" battery voltages. A few changes in the wiring of the set will be necessary, although the high efficiency of this eliminator will more than compensate the builder for his additional pains.

The particular arrangement shown was designed for use with a five-tube receiver, although receivers employing a different number of tubes may be used by changing the values of the resistances connected in series with the filaments. You will note that the filaments of the tubes of the receiver are placed in series instead of the conventional parallel method. Parts necessary are:

1 Power transformer,
1 Filter choke—general radio, amertran, tran.
1 Rectifier tube socket,
4 1,500-ohm potentiometers,
5 2-mf. filter condensers.
3 .5- to 2-uf. by-pass condensers,
1 Binding post strip—5 posts,
1 200-ohm potentiometer, or Black's polarizer,
1 5-watt bell-ringing transformer,
10-100 milliammeter (optional).
1 1½-ohm filament rheostat,
1 UX-213 or CX-313 rectifier tube, (Raytheon helium tube may also be used),
1 Baseboard, 12x18 inches.

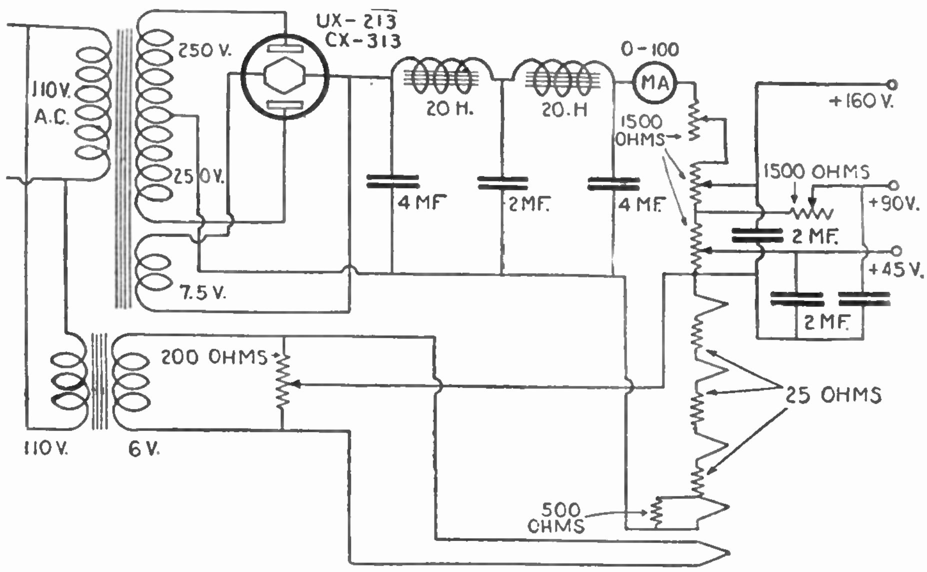


Fig. 156. "Just what you wanted." An "A," "B" and "C" battery eliminator, giving an unusually "pure" output, free from A.C. hum or distortion. Note that the filaments of the receiving tubes must be connected "in series," instead of the usual "parallel method."

The new rectifier tube, mentioned above, has two filaments and two plates contained within the one glass bulb; and when connected to the transformer secondary, as shown, will deliver both halves of the A. C. wave in the form of pulsating D. C., with a voltage of 250 under normal load. If the General Radio power transformers are used, a 1¼-ohm resistance must be placed in series with the rectifier filament lead, as the CX-313 tube draws two amperes at 5 volts. The resistance may be of the filament-rheostat type. The Raytheon tube, which does not have a filament, may also be used as the rectifier.

The filtered 250 volts D.C. is used to provide plate and filament voltages for the various tubes in the receiver by means of a set of resistances which are so designed and placed that the load across the rectifier draws exactly 70 milliamperes constantly. In series with these resistances are placed the filaments of the vacuum tubes, which are wired so that they are in series instead of in parallel, as is the usual custom. Bias voltages for the various grid circuits are obtained through wiring the series filament circuit in such a manner that the voltage drop across the filament of each tube can be used to furnish "C" voltage for some other tube in the same circuit.

WHY "A" and "B" BATTERIES?

(157) Mr. N. R. Sordeil, Charleston, South Carolina, asks:

Q. 1. In connecting up radio receivers, I have often heard the expressions "A" and "B" batteries, as applied to the various batteries that are connected to the receiving set; and have often wondered why there are two batteries necessary? Why the different expressions "A" and "B" are used? What the functions of each are? Why one has only 6 volts, whereas the other has at least 90? Perhaps you can clear up some of these difficulties.

A. 1. To explain why we have "A" and "B" batteries in a receiving set, the functions of each, and why one high-voltage and one low-voltage battery is used, it is necessary to go into an explanation of the principle of the vacuum tube as used for radio purposes. We will attempt to make this explanation as clear and non-technical as possible. For a technical and lengthy explanation of the evolution and functions of a vacuum tube, the reader is referred to the December, 1925, January and February, 1926, issues of **The Experimenter**; or to Morecroft's "Principles of Radio," or Van Der Bijl's "Thermionic Tubes."

Through the researches of scientists, such as Thomson, Richardson and Millikan, we know now that when certain metals are heated to incandescence, particles of matter are thrown off. These particles are called electrons and the theory explaining this phenomenon is called the "Electron Theory." Incidentally, these electrons are negative particles, and at present the smallest particles of matter known.

In 1904 Fleming (another scientist) was granted a patent on the device called a "Fleming valve," which consists of a filament-and-plate element enclosed in an evacuated glass vessel. In school, in the physics or science class, we learned that positive attracts negative, or vice versa, depending upon which has greater strength. Fleming inserted in his device a battery of high potential. The positive side of this battery was connected to the plate within the vessel, thus making the plate highly positive, thereby enabling it to attract the electrons which were thrown off by the heated filament. This device was of little practical use as far as radio (in those days called "wireless") was concerned, until 1906 when DeForest inserted the third element called the "grid," thereby making the most sensitive detector known.

Now to show how "A" and "B" batteries are concerned. The battery required to heat the filament to incandescence is called the "A" battery (probably because it is the first battery to be taken into consideration, or primary battery). The battery required to give the plate its positive potential is called the "B" battery. However, since the filament consumes an enormous amount of current compared to that used by the plate element of the tube, the battery necessary to heat the filament must have a high amperage capacity, ranging from 28 to 120 amperes, depending upon the number of tubes used in the receiving set, and the type of tubes. In the early days tubes were manufactured with filaments which required six volts and consumed about an ampere. At present, due to research and developments made by the General Electric engineers, we have radio tubes which operate from a dry cell or two, and consume only from .06 to .25 an ampere.

The "plate" of the tube consumes very little current, as aforementioned, but requires an extremely high potential, varying from 22½ volts for a "soft" or detector tube, to 90 volts for the ordinary amplifier tube, and about 135 volts for a power-amplifier tube. Ordinary "B" batteries are constructed (consisting of a number of very small cells) so that, although their amperage capacity is very low, ranging from two to seven amperes (of total output) the voltage delivered is high because of the small cells, each delivering 1½ volts, being connected in series.

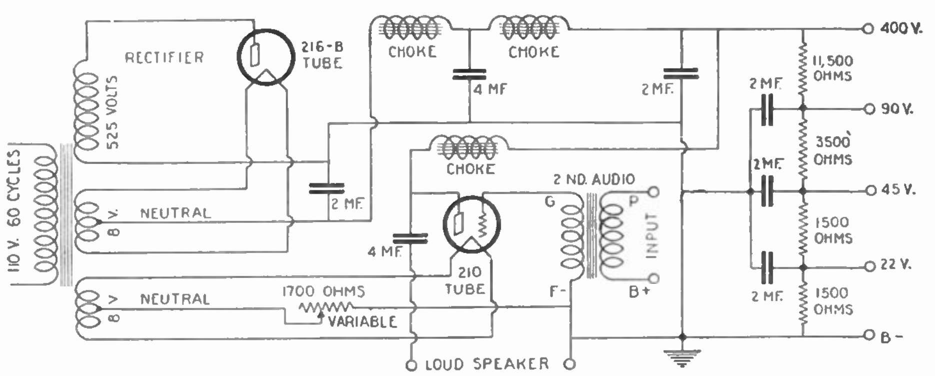


Fig. 158. A one-stage power audio amplifier, operating direct from the A.C. lighting socket, which supplies both A and B current for this particular unit. There is also a sufficient remainder to supply "B" current for the receiver.

BATTERYLESS POWER STAGE

(158) Mr. F. C. Becker, Providence, R. I., asks as follows:

Q. 1. Can you furnish me with any practical information relative to the construction of a power stage unit, which I can add to my present two-tube Crosley receiver so that sufficient volume may be obtained from a loud speaker to be heard approximately 100 feet away? I have

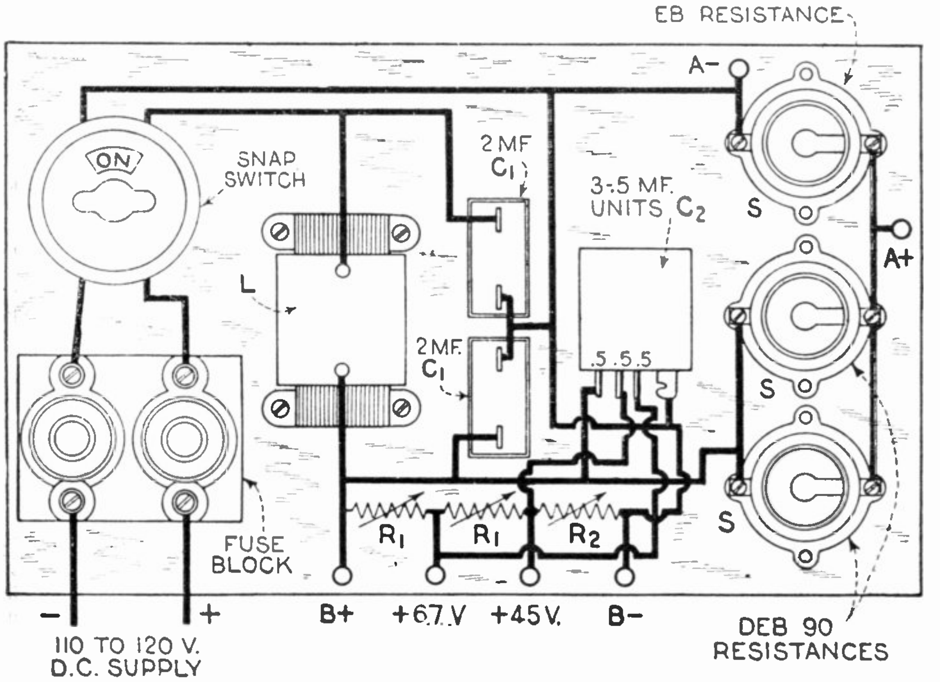


Fig. 159. An "A" and "B" battery eliminator, operating from a Direct Current source only. The "B" battery voltage output is approximately 100 volts at maximum. By varying the amount of D E B resistances employed, any number of tubes up to 10 (201-A type) will be supplied with filament current (see the table, "Figuring the Resistances.")

heard that such a unit can be constructed to operate direct from an alternating current source, which feature I would desire very much to combine with the aforementioned power stage.

A. 1. The schematic wiring diagram of a unit such as you desire, is shown in Fig. 158. The unit operates from a 60-cycle A.C. source, and besides furnishing plate and filament current for the power amplifier stage, furnishes additional "B" current for a receiver.

The parts necessary for the construction of this unit are as follows:

Three choke coils, 10 henry;

One step-up power transformer, having four windings; one primary winding and three secondaries consisting of the step-up winding (output 525 volts) and two 8-volt filament windings:

Six by-pass condensers, 2.0-mf.;
Two by-pass condensers, 4.0-mf.;
Two standard sockets;
One 216-B tube;
One UX-210 or CX-310 tube;
One A.F. transformer;
One variable resistance, 0- to 5,000-ohm;
Two Fixed resistances, 1500-ohm;
One Fixed resistance, 3500-ohm;
One Fixed resistance, 11,500-ohm;
Eleven binding posts, and baseboard 12x24x½;
Miscellaneous.

Two special input binding posts are provided for, to which the output of the receiving set is connected. The output of the unit, indicated as "loud speaker," connects to the loud speaker. More than sufficient plate voltage is delivered by this power unit, and it will operate practically any type of receiving set.

"A" AND "B" ELIMINATOR FOR D.C.

(159) Mr. Robert Schwartz, Boston, Mass., asks:

Q. 1. The current supply in my particular vicinity is of the "direct" type. I have been informed that it is exceedingly simple to construct an "A" and "B" battery eliminator to operate with that type of current; and that a power unit having the requisite characteristics has been designed by F. G. Logan and is called the "Varion" D.C. Eliminator. Can you furnish me with the necessary details?

A. 1. Mr. Logan has described the Varion D.C. eliminator in the radio section of the **New York Telegram.** Because of numerous requests for a device of this type, we reprint the complete description of this unit. Additional information concerning parts, source for same, etc., will be furnished to those requesting it. A self-addressed stamped envelope should accompany the request.

"Until recently little attention has been given to the requirements of the radio owner with direct current in his home. Many a man has walked hopefully from one radio store to another in search of data on the construction of a good 'A' and 'B' eliminator for direct current. But he has met with disappointment on every hand. 'We don't know of any such thing,' was the unsatisfactory answer he received in every store.

"True, direct-current eliminators have been put on the market, but we have seen none which supplies both 'A' and 'B' current and which has voltage variation over the wide range necessary to take care satisfactorily of detector, radio-frequency and oscillator tubes, many of which operate at their best only if just the right voltage for the particular tube is applied.

"Why there has been a lack of attention to the design of an all-around, efficient eliminator for direct current is hard to understand. Certainly not because of lack of demand, for in Manhattan and Brooklyn alone there must be several hundred thousand installations with direct current. As far as the difficulties in design and building go, there is, of course, much less trouble and expense involved in the construction of a good eliminator for direct current than in one for alternating current. The necessity of rectifying is done away with, and with it the use of a number of expensive chokes and condensers to smooth out the rectified (and often very interrupted) direct current. The cost of a D.C. eliminator is naturally much lower, since less apparatus is required. So, if you are one of those fortunate individuals with direct current in your home, prepare to eliminate 'A' and 'B' batteries at small cost and without sacrifice in operating efficiency.

"The D.C. eliminator described in this article replaces both 'A' and 'B' batteries at a cost of approximately $33.00 for the complete equipment required, a little less than the investment necessary to purchase a good 100-ampere-hour storage battery and a charger. The expense of a set of 'B' batteries would bring the cost considerably higher. With this cost in mind it can be seen that building for oneself a D.C. eliminator is decidedly an economy.

Simplicity of the Varion

"In designing the Varion every effort was made to keep assembly and construction as simple and safe as possible. That this effort succeeded quite well is attested by the fact that the eliminator has been constructed and placed in successful operation on a receiver by a non-technical builder in an hour and three-quarters time. There is really nothing difficult or complicated about it, as there are only fourteen soldered connections and there are no special coils or chokes to wind. All the parts required can be purchased at any well-stocked radio store.

"The second, and probably the more important, point is that there is nothing to deteriorate or wear out in this particular eliminator. The resistances, of course, are good for a lifetime; and as they practically constitute the eliminator one is fixed for many years when he builds this unit.

"If the eliminator is constructed with the apparatus, and following the layout shown here, no difficulty will be had in conforming to all the specifications of the Underwriters' Laboratory. Both legs of the incoming D.C. line are equipped with fuses, and in case of an overload, even a very slight one, they will blow and protect your equipment and accessories.

Details of the Varion

"The Varion does away with both 'A' and 'B' batteries in the following manner: The direct-current line is shunted by a current-carrying resistance or resistances, as shown in the wiring diagram. The filament supply is taken off from the negative side of the line at a point between resistances AR-1 and AR-2. By variations of the resistances AR-1 and AR-2 the unit will accommodate any filament-current drain from ¾ ampere to 2½ amperes. This takes in sets ranging from 3 to 10 tubes. If a heavier current drain is imposed upon the unit it is possible to obtain extra current by means of suitable resistances. To figure the correct resistances to use, let us assume you have a 5-tube Neutrodyne set, with one power tube in the last stage. Four 201-A tubes draw ¼ ampere each at 5 volts, or a total of 1 ampere; the power tube will draw ½ ampere at 5 volts. This gives us a total of 1½ amperes for the filament consumption.

Figuring the Resistances

Filament Consumption Amperes	Resistance	Resistance
.75	1 DEB 90	1 EB 12.5
1.	2 DEB 90	1 EB 5
1.25	2 DEB 90	1 EB 6
1.75	2 DEB 90	1 EB 10
2.	3 DEB 90	1 EB 3.5
2.25	3 DEB 90	1 EB 4.25
2.5	3 DEB 90	1 EB 5

"Looking at the table above, it will be seen that resistance "DEB" should consist of two Vitrohm units (DEB 90) and "EB", of one Vitrohm resistance (EB-7.) This is simple and should offer no difficulties to any one utilizing this current supply for any type of set. Almost any combination of voltage up to 110 can be obtained without difficulty. If necessary you may have three different voltages for your receiver. This feature makes the eliminator particularly desirable for use with the superheterodyne and some types of tuned-radio-frequency sets where a number of different "B" battery voltages are desired.

Determining "B" Battery Voltages

"A total of 200,000 ohms is placed across the 115-volt D.C. line, as shown in the wiring diagram. There are three units used and two possible voltage variations. The 'B' voltage outputs shown in the diagrams are those commonly used: but the experimenter may vary the resistances to produce almost any voltage value from 10 to 110 volts. If more than three 'B' taps are brought out from the resistance line, however, be sure that an 0.5-uf. tap condenser is shunted from the extra tap to the negative 'B' battery line. This precaution is taken to eliminate the resistance as far as possible from the radio circuit.

Assembling the Varion

"The assembly of the unit is simple and the wiring self-explanatory from the accompanying diagram. Make all leads of No. 14 wire and be sure that they are as short and direct as possible. Solder each connection thoroughly and be sure that contacts in the bottom of the tube receptacles are clean. There are very few precautions to take in placing the Varion in operation on your receiver. The first and most important is to connect a fairly heavy condenser, such as an 0.5-mf., in series with your ground lead. This is to prevent burning out your tubes in case the polarity of the plug is incorrect when the unit is first put in operation.

"It is not necessary while using this unit to connect up the 'B'—post on your set, as this is automatically a common connection through the eliminator. While the voltage from the eliminator at the filament supply tap is six, when all the tubes are in your set and lighted, it is very decidedly not 6 volts with only one tube in your set. When no loan is placed on the circuit the voltage jumps up to nearly 20, and you are very likely to mourn the loss of a tube if you place it in the set without all its mates being in position. These simple precautions are really the only things you will need to give attention to while placing the eliminator in working order."

List of Parts

One Choke Coil (L), large current-carrying capacity (Amertran);

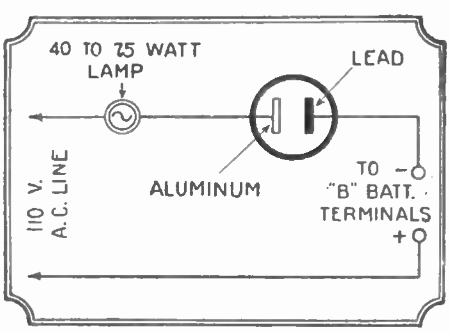


Fig. 160B. The parts and connections necessary for a "B" battery charger, operating from an A.C. source are shown. With this device, it is possible to charge only one 45-volt block at a time.

Two By-Pass Condensers (C1), 2.0-uf.;
Three By-Pass Condensers (C2), 0.5-uf.;
One Snap Switch and three Porcelain Sockets (S), 110-volt type;
One Porcelain Fuse Block, with two holders, and two fuses, 110-volt 10-ampere type;
Three Variable Resistances; two (R1), 0-50,000 ohms, and one (R2), 0-100,000 ohms ("B"-eliminator type);
One Resistor, type "EB" and two Resistors, type "DEB" (Ward-Leonard). (See table above for computing the number of these required for various sets.)

TRICKLE CHARGER

(160) Mr. J. K. Stone, Christopher, Ill., asks as follows:

Q. 1. I would like to construct a trickle charger, one which can be used with a storage battery even while the set is in operation. Can you furnish me with any constructional information and other data which will enable me to construct this device?

A. 1. The parts necessary for the construction of the trickler charger are a step-down transformer (toy-train type, or bell-ringing transformer, with approximate output of 10 volts) and a chemical rectifier cell, consisting of a fruit jar, one aluminum rod element and one lead element, approximately ½-inch in diameter and supported by a rubber cap (see illustration). The solution employed is a saturated solution of ammonium phosphate and distilled water.

Arrangement For Storage "B" Battery Charger

Q. 2. Can I employ the same device for charging my storage "B" battery, which is composed of two 46-volt blocks (23 cells in each block, two volts to each cell, lead-plate type battery.) If not, please furnish me with details of construction of a storage "B" battery charger that will operate economically and satisfactorily.

A. 2. It is impossible to employ the trickle charger as arranged in Fig. 160-A for charging a storage 'B' battery; the voltage output is insufficient.

However, the changes in wiring, and necessary additions to convert it into a "B" battery charger, are really very few and simple. A 75-watt lamp in place of the step-down transformer and a few changes in the connections are all that are required.

THE VARION A.C. RECEIVER

(161) Mr. E. F. Palm, Flint, Mich., writes:

Q. 1. Since your description of the Varion D.C. eliminator unit, there has appeared somewhere the description of a Varion A.C. receiver, which is a 6-tube affair and obtains all power from the light socket (A.C. source). Can you furnish me with any information and circuit diagram employed, battery eliminator system, etc?

A. 1. The Varion A.C. Receiver has been described in the current Radio Listeners' Guide & Call Book, and Radio Review by Bert E. Smith. However, the essentials, such as circuit diagram and list of parts needed, are herewith given. The circuit diagram for the receiver is shown in Fig. 161-A; that for the eliminator device in Fig. 161-B.

The following are excerpts from Mr. Smith's description in Radio Listeners' Guide, which we believe, will be helpful to the constructor:

"'A' battery elimination in the Varion is accomplished by means of a special circuit

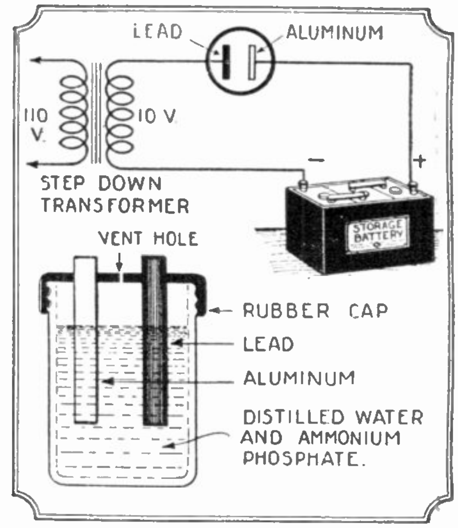


Fig. 160A. Wiring diagram of a trickle-charging system, and the construction of a chemical rectifier employed in trickle chargers.

in the eliminator and receiver. The problem of 'A' elimination depends entirely upon the quantity of current to be passed through the filter system. Referring to the diagram of the receiver, it will be seen that five 199 tubes are employed before the final or output tube. These five tubes require approximately sixty milliamperes of current each, at three volts, to operate the filaments. If these five tubes were placed in a circuit with their filaments in parallel, a total of three hundred milliamperes current would be required and this would be more than an efficient filter could easily handle. However, if we were to place these tubes in series, it would then be necessary to have only sixty milliamperes of current available, but the voltage across the filament series terminals would have jumped to fifteen.

"Obviously, since we have up to two hundred and fifty or more volts at our disposal with the Varion, and there are eighty-five milliamperes of current, it is only necessary to find some way to apply some of this excess current and voltage to the tube filaments. Glancing at the eliminator diagram, we find a resistance has been placed in shunt across the total output of the unit. Current will flow through this resistance, varying in quantity with the resistance across the circuit. Now, if we break the 'B—' line and insert our filament series connection, we shall have, assuming that the value of the shunt resistance is correct, the right amount of current flowing through each tube; and in doing this we have lost but fifteen volts from the maximum of our plate voltage supply. This, in effect, is what is done in the Varion.

"There are a number of other points to take into consideration, however, before actually building a receiver to operate in that manner. In the first place, the plate current of the tubes, including that of the power tube in the Varion circuit, will be added to the filament supply; and this must be compensated for by raising the value of the shunt resistance, so that the total of the two currents does not exceed sixty milliamperes. We also have the factor of line-voltage fluctuation. This is easily taken care of by making all values in the eliminator proper for a minimum line-voltage, and then absorbing the excess current by means of an additional shunt resistance. The manner in which this is done is shown very clearly in the various receiver diagrams.

"The 'C' bias voltage on the power tube is supplied by the voltage drop across the 2,250-ohm resistance. We still have, though, the problem of bias voltages for the balance of the tubes in the receiver. As we have already placed the tube filaments in series,

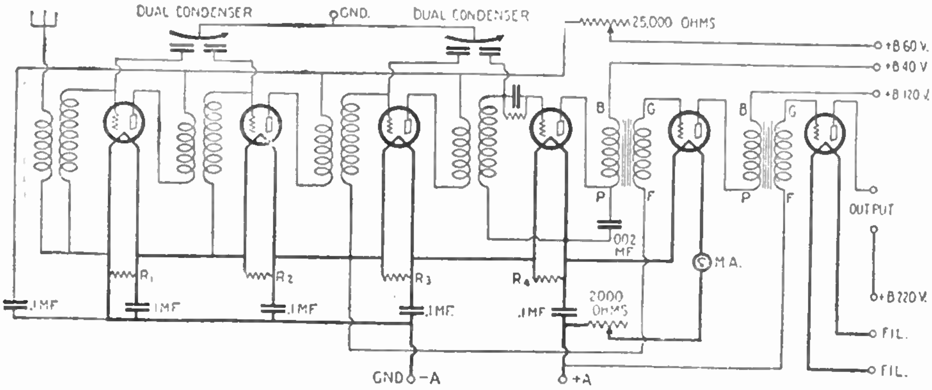


Fig. 161A. Hook-up of the Varion, which is designed for use with an "A, B & C" battery eliminator, such as that shown in Fig. 2205-B. The filaments of all tubes are wired in series to keep down their current consumption. Ballast resistances are placed across each tube. Only 199-type tubes may be employed in the first five stages of the receiver.

we may readily utilize the fact that there is a three-volt drop across the filament of each tube in the circuit. By properly positioning the various tubes we have the detector operating at a positive bias of one and one-half volts, the three radio-frequency tubes at a negative bias of three volts, and the first audio tube at a negative bias of nine volts. These values, in respect to the particular plate voltage under which each of these various tubes operates, are exactly those called for by the tube manufacturers.

Correcting the Filament Current

"There is one point about the receiver circuit which many of you have probably noticed. That is the presence of resistances placed across all of the tubes in the series connection except the first tube. These resistances are placed at these points to compensate for the addition of the plate current to the filament supply by each tube in the connection. If this extra filament current were not taken care of in some manner, the last tube in the line would be getting approximately ten milliamperes more current than the first tube.

"Reference to the circuit diagram of the eliminator, as shown herewith, will disclose that it is very similar to the standard Raytheon circuit. There are several refinements, however, which have not been heretofore included in eliminators; for example, experienced constructors will appreciate the fact that successful design and operation of the receiver is largely dependent upon the quality and design of the apparatus used throughout. In selecting parts for the Varion receiver, apparatus of the highest grade was used and in several cases where present apparatus was not satisfactory, special instruments have been designed and manufactured especially for the Varion.

"The plate voltages supplied are sixty-seven for the radio frequency tubes, forty-five for the detector, and one hundred and thirty-five to one hundred and eighty for the power amplifier. Independent of the type of power tube used the 2,250-ohm resistance in series with the centre tap of the filament winding will give it a correct negative bias. The 'C' bias voltage is obtained by the drop across this resistance. The heavier the current drawn through this resistance, the greater the voltage drop will be and, corresponding to the heavier current drawn by the UX-171, the grid bias will increase correspondingly over its value when a 112 is used.

"The parts necessary for the construction of the receiver and eliminator are as follows:

Parts For Receiver

2 Double condensers (.0003-mf. each unit);
1 Panel (radion or bakelite), 17x3/16x28 inches;
1 Sub-panel (radion or bakelite) 7x3/16 x26 in.;
6 Sockets;
2 Illuminated controls;
1 Variable resistance, 2,000-ohm;
1 Variable resistance, 25,000-ohm;
1 Milliammeter, 2 inch, 0-100 milliamperes;
3 Brackets;
3 Aluminum shields;
4 T. R. F. coils;
3 Binding posts;
1 Condenser, .001-mf.;
1 Condenser, .00025-mf.;
5 Condensers, 0.1-mf.;
1 R. F. choke;
1 First-stage transformer;
1 Second-stage transformer;
4 Filament resistors;
1 Grid leak, 3-meghohms;
1 Six-conductor cable;
1 Two-conductor cable;
25 Feet No. 18 flexible wire, etc.

Parts For Eliminator

1 Metal box 10x12x24 inches;
1 UX socket;
1 Condenser block;
1 Transformer;
8 Binding posts;
2 Transformer brackets;
1 Cord and plug;
2 Socket bushings, 1/4 inch;
1 Strip insulating paper;
1 Resistor, 2,250-ohm;
1 Rectifying tube;
1 Condenser, 2.0-mf.;
1 Resistance (Ward-Leonard ABC);
2 Choke coils 30-henry;
1 Binding-post strip, drilled;
8 Feet No. 18 flexible wire, etc.
Nuts, bolts, lugs, etc.

Controlling Oscillation

Q. 2. I have a home-made three-coil honeycomb set which oscillates very freely causing unearthly squeals. How can I remedy this?

A. 2. First cut down your "B" battery voltage, if higher than the normal rating required by both detector and amplifier tubes. Turn the filaments down if too brightly lighted. If you have a filament current ammeter, check up to see that you are not overloading your tubes.

Next, loosen tickler feed-back coupling until the set is just on the verge of breaking into oscillation. If squealing still occurs, change value of grid leak.

A .00025 mf. fixed grid condenser can be used for practically all tubes and when shunted with a leak of from 1/4 to 2 megohms resistance will give the best results. It may be that the honeycomb coil used as the tickler is too large, having too much inductance. Try a smaller tickler coil.

IMPROVED FRESHMAN MASTERPIECE AND "A, B & C" POWER UNIT

(162) Mr. S. Lorenz, Waukon, Iowa, writes:

Q. 1. In the "I Want to Know" columns of the Jnuary, 1927, issue of RADIO NEWS were given the details of the Freshman Masterpiece receiver. In the schematic wiring diagram of this set is illustrated a resistance (lettered "R") whose value is not specified. I would like to know the size of this resistance and also have information on the "New Improved Freshman Masterpiece Receiver," providing that the description in the January issue is not of this improved model. I would also like details of an "A", "B" and "C" socket-power unit which will operate satisfactorily in conjunction with the above mentioned set.

A. 1. The Freshman receiver described in the January, 1927, issue of RADIO NEWS, although one of the late models, is not the latest. A schematic wiring diagram of the new improved (latest information available) is shown in Fig. 162. The values of the various items employed in this receiver are mentioned in the schematic wiring diagram. The small inductance indicated as "L" in the "B" circuit, is an R. F. choke coil, which prevents radio-frequency energy from escaping into this circuit. The Lorenz type of low-loss coil is used, each coil being mounted or secured to the end plate of each variable condenser. This particular feature facilitates control of

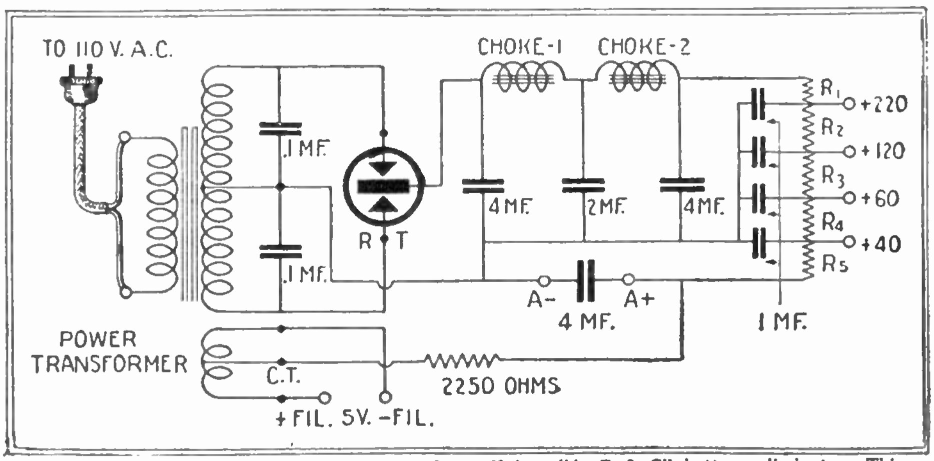


Fig. 161B. The schematic wiring diagram of an efficient "A, B & C" battery eliminator. This power unit may be used in conjunction with any type of receiver constructed along similar lines to those of the Varion A.C. set diagramed above. A rectifying tube with a current output of 80 milli-amperes should be used.

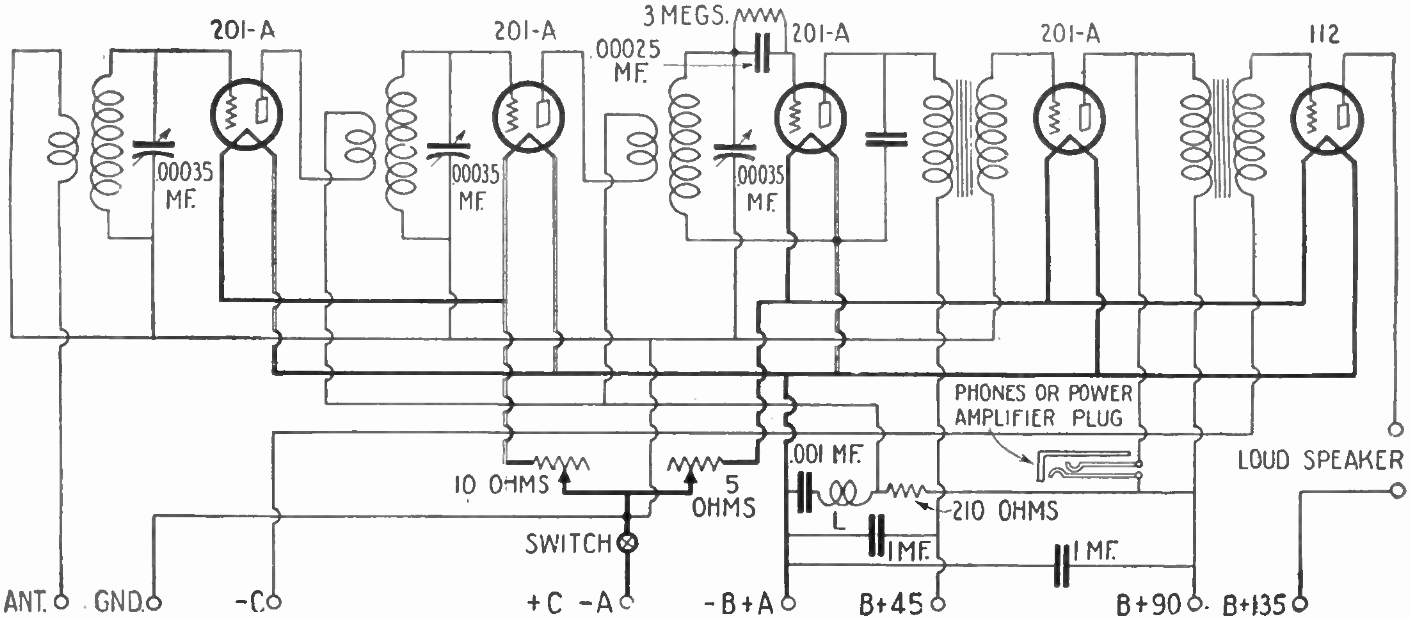


Fig. 162. The latest available circuit diagram of the Freshman Masterpiece three-control receiver. A special R.F. choke and a fixed resistance, which do not appear in the earlier types, are employed in this receiver. The receiver is also designed for power-tube operation.

oscillations in the radio-frequency stages. A 210-ohm fixed resistor is inserted between the plate return leads of the R. F. tube and the "B+90" terminal to create a voltage drop, thus preventing any possibility of the R. F. tubes going into oscillation. If a fixed resistor of this size is unavailable, then an ordinary 0-to-1,000-ohm variable resistor of a type made by several manufacturers can be used in its place. If the latter is used, simply adjust the resistance until satisfactory reception is obtained on stations operating on low wave-lengths (200 to 300 meters).

A circuit diagram of a practical "A, B & C" battery eliminator (also manufactured by the Chas. Freshman Co.), is illustrated in 162-B. The device does not really eliminate the "A" battery but uses a trickle charger to which a storage battery is attached. This combination requires practically no attention and amounts to an "A" socket-power unit. A relay is employed for switching or connecting the trickle charger to the storage battery when the receiver is turned off. No alternating current hum can be heard from the loud speaker during operation, since the "B" unit alone operates when the set is turned on. The trickle-charger tube employed is of a special type. However, the conventional 2-ampere tungar-type may be employed, if the transformer windings are designed for it.

BALLAST TUBES IN ELIMINATOR

(163) Mr. J. Caruso, Spring Valley, N. Y., asks:

Q. 1. I have constructed a "B" socket-unit using standard parts, but I am not obtaining satisfactory results. I have tested the voltage with a "B"-unit voltmeter and find that it reads only 90 volts on the 180-volt tap with the tubes in the set. When the tubes are removed it reads 180 volts. Is there any method of regulating the output of the eliminator in order to maintain a constant output voltage?

A. 1. A large number of fans are disappointed with the operation of some "B" socket-supply devices with their receivers. They cannot determine why; but they know that the results with them do not equal the results obtained when "B" batteries were the source of plate potential. The following may therefore be of interest:

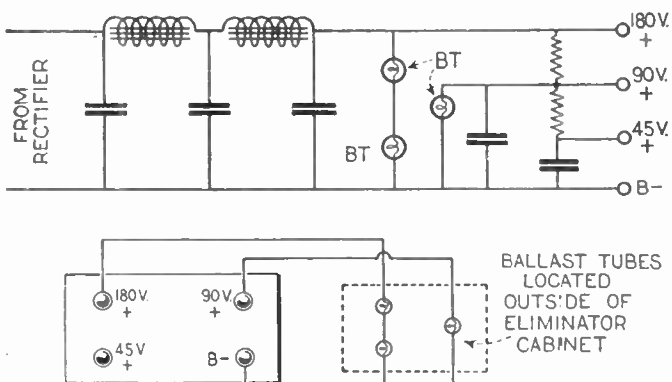


Fig. 163. The use and location of ballast tubes, to regulate the output of an eliminator, is indicated here.

The selection of the resistances, that is, the ohmic values of the resistances in the supply unit, is governed by the voltage desired and the flow of current through the resistance. Consequently, the lower the load upon any one tap, the higher the voltage at that tap. Conversely, the higher the load at one tap, the lower the available voltage at that tap. This condition obtains if the unit is without a voltage-balancing device, such as some of the ballast tubes available on the market at present. With these devices in use the voltages at the various taps (90 or higher) will remain constant regardless of the load applied, within certain current limits. Hence, with a socket-power device supplying 180 volts maximum and with a 90-volt tap, the use of three of the 90-volt ballast tubes (arranged as shown in Fig. 163) will give voltage control at the 90-volt tap and at the 180-volt tap.

To obtain the 180-volt control the two 90 volt ballast tubes are connected in series; and to obtain the 90-volt control the ballast tube is connected between the 90-volt tap and the "B—." In view of the characteristics of the tubes, it is necessary that the 180- and the 90-volt taps be so designed that the voltage at these taps, without these ballast tubes, is higher than 180 and 90 respectively.

If the fan is having trouble with exces-

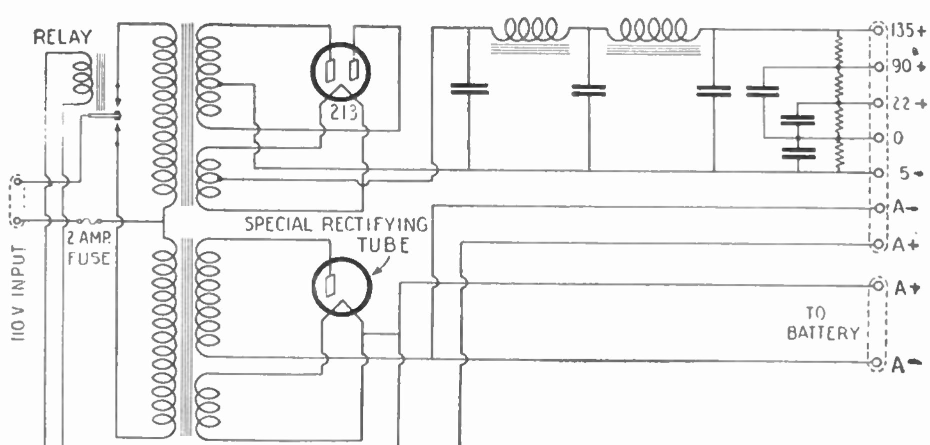


Fig. 162B. The wiring diagram employed in the Freshman "A, B and C" power unit. The "A" current delivered is really that of a trickle charger and is connected to a storage battery. This current is sufficient to keep the storage battery in a constantly charged state.

sive voltages at these taps, such ballast tubes can be added to the socket unit, locating the tubes outside of the cabinet or case. The connections of the ballast tubes would then be across the respective binding posts or voltage terminals.

A HIGH-VOLTAGE RECTIFIER

(164) Mr. C. L. Maynard, Chicago, Ill., asks:

Q. 1. Having just obtained my amateur transmitting license, I am desirous of going on the air. I have a 50-watt tube hooked up in a Hartley circuit, but am puzzled as to what I shall use for plate supply. Can you give me any suggestions for obtaining a high-voltage supply of about 1,000 volts D. C.?

A. 1. There are several means of obtaining the high-voltage D. C. necessary for the plates of transmitting tubes. The motor generator is about the most convenient way of obtaining this D. C. supply, but unfortunately the cost of a machine of this type is rather prohibitive and since most "hams" usually are possessed of vacant pockets, we will have to look to some other source of plate supply.

The next best method is that of using a step-up transformer with some type of rectifier. There are four means of rectification usually employed for obtaining D. C. from an A. C. source; namely, vacuum tubes, a synchronous motor driving a revolving disc, the mercury arc, and the electrolytic rectifier. Of these the last is the simplest and cheapest, although it requires regular maintenance in order to keep it operating properly. However, if constructed with care, this type of rectifier, with a good filter system, will give a pure D. C. supply that compares favorably with that obtained from a motor generator.

Of the different metals used as elements in the chemical cell, aluminum and lead have proven cheapest and best. It is absolutely necessary that the aluminum be of the highest grade obtainable, because any impurities will hinder the rectifying process and tend to cause rapid disintegration of this electrode. The lead need not be of high quality, any vailable form of this element being satisfactory.

For the average amateur transmitter using a 50-watt tube, the size of the elements should be about 1x4x⅛ inches, with 3 inches immersed in the solution and the remaining inch bent at right angles to serve as a connecting lug. (The size of these elements depends upon the current to be passed. It has been found that a square inch of aluminum will efficiently handle a current of 80 milliamperes. It will be seen, therefore, that the dimensions given above are such that the elements will safely pass 240 milliamperes. The plate current of a 50-watt tube seldom exceeds 150 milliamperes, so that there is a safety margin of 60 per cent).

Half-pint glass Mason jars make excellent containers for the solution and the electrodes, or even ordinary drinking glasses will be satisfactory. There is no necessity for using larger jars, as some "hams" do, as the efficiency of each cell depends on the size of the plates and not on the amount of solution used. The number of cells used in the rectifier depends directly on the applied A. C. voltage. Each cell will safely withstand a potential of 50 volts, so that it is necessary only to divide the total A. C. voltage obtained from the plate transformer by 50 in order to arrive at the number of jars required. This number, however, is only one-half of the total number required, since we are going to employ full-wave rectification.

When the step-up transformer is supplied with a center tap, the cells are connected as shown in Fig. 164-A. Of course, it is understood that the total desired output voltage must be obtained on either side of the center tap. In the case of a transformer having no center tap, the bridge method shown in Fig. 164 is employed. Both of these methods operate with equally efficient results.

There are several chemicals that can be used for the rectifying solution. Ordinary borax has been known to give ex-

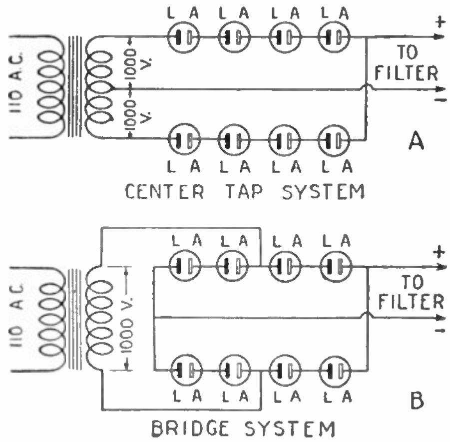


Fig. 164. Two very effective methods of connecting a high voltage rectifier. The number of jars is computed as explained in the text.

cellent results, but of late has been supplanted by sodium phosphate and ammonium phosphate; at any rate use the one that you can obtain. Make a saturated solution of the chemical in water, using enough to supply the particular number of jars you are using. There is no noticeable improvement to be had by using distilled water. After the solution has been stirred until no more of the chemical will dissolve, it should be allowed to stand overnight, to allow any excess to sink to the bottom. The plates are now bolted together, lead to aluminum, etc., and the clear solution is poured into the jars to within a quarter of an inch of the top.

The next step is known as "forming." A 100-watt lamp is placed in series with the primary of the transformer and the currrent turned on. The bulb will light up, because the current is being partly shorted through the uniformed cells. After running for about half an hour, it will be noticed that the bulb has ceased to glow, showing that the plates are beginning to form. At this point a lower resistance, such as an ordinary electric iron,

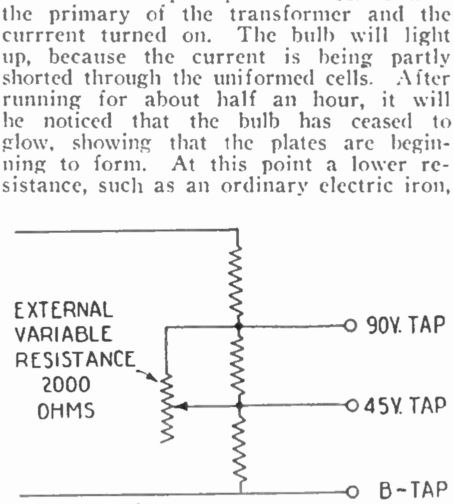


Fig. 165. Showing the use of a separate resistor to stabilize the output from a "B"-power unit.

should be substituted for the bulb, and the current allowed to run for another period of time until the input has dropped to practically zero. The iron should then be removed and the full 110 volts connected directly to the primary. During the process of formation the transformer may heat, somewhat, but after the plates have been thoroughly formed the load drawn from the line should not exceed 25 watts. A good grade of oil should then be added to the top of each cell, to prevent evaporation of the water.

Best results will be obtained from the rectifier after it has been in operation four or five days, and it should continue to give a continuous supply of high voltage over an extended period of time.

POWER-UNIT REGULATION

(165) Mr. D. Robert, Sea Cliff, L. I., ask:

Q. 1. I am using a superheterodyne with a "B" power unit with the 45-volt tap used to supply the detectors and intermediate stages. I do not obtain satisfactory reception and upon measuring the voltage across this tap I find it registers only 28 volts. Could you suggest some way, whereby I could maintain the voltage of this tap at 45?

A. 1. Very often the drain from the 45-volt tap on a "B" power unit is in excess of that provided for in the design of the device, with the result that the voltage is below normal. This is particularly true with superheterodyne receivers. In these instances five or six tubes are supplied from one tap, resulting in an excessive drain.

By connecting a variable resistor between the 45- and 90-volt taps, the voltage at the 45-volt tap can be raised to the desired figure. The position of this resistor is shown in Fig. 165. Its selection is governed by the current-carrying capacity of the unit. It should at all times be capable of carrying at least twice or three times the actual current flow.

"C" SOCKET-POWER UNIT

(166) Mr. L. Miller, Annandale, N. J., asks:

Q. 1. I have constructed a power unit, using a resistor and condenser to obtain the necessary "C" bias. However, I have not been obtaining very satisfactory results, and I think the trouble lies in the method of obtaining the "C" voltage. Is the resistor and condenser method of obtaining negative bias satisfactory, or should the ordinary type of "C" battery be used instead?

A. 1. A series of experiments carried out by Mr. R. P. Clarkson upon "B" power units, which also supplied the "C" bias necessary for the power tube in the audio amplifier, has brought the conclusion that in altogether too many instances trouble encountered with "B" supply devices can be attributed to the "C"-bias resistor and condenser.

"The utilization of the 'C'-bias resistor and condenser in a 'B' or 'C' unit was found to be the cause for 'motor boating' with some power-transformer-coupled audio amplifiers." Mr. Clarkson states in an article of recent date in the *New York Sun*. "With the normal 'C' arrangement, consisting of a resistor of approximately 1,100 ohms to supply the bias for a 171-type power tube, and a by-pass condenser of 1-mf. for this resistance, there was pronounced 'motor boating' with a transformer-coupled audio amplifier, when the amplification was adjusted to maximum. But when the 'C'-bias arrangement was removed from the unit and the 'C'-bias obtained from a battery, the trouble was immediately removed. Now, with the original 'C' biasing arrangement in the circuit, it was found that the use of a higher value of by-pass capacity for the 'C'-bias resistance was necessary if the 'motor boating' was to be removed. To all intents the by-pass condenser of 1-mf. was insufficient.

"The value of the 'C'-bias by-pass capacity brings into discussion the item of cost. Judging from the experiments, a capacity of at least 4-mf. is necessary across the 'C' biasing resistor. The cost of such a capacity and the proper resistor is equal to, if not greater than that of a 'B' battery unit utilized as a 'C' block.

"Constructors of 'B' power units would do well to heed the following advice: Build your 'B' supply and omit the 'C' biasing resistor. Utilize a separate 'C' battery for the purpose. This can be carried out with perfect satisfaction whether D. C. or A. C. is supplied to the filaments. Experimental work carried out over a period of six months seems to show that the 'C'-bias arrangement in socket-power units is a cause for all sorts of noises in the receiver as heard in the speaker.

"From an angle of economy and efficiency a separate battery for 'C'-bias is more satisfactory. This is particularly true when the average 'B' supply unit is applied to the average radio receiver. Excessive hum in the output circuit of the receiver was found to be due to the 'C'-bias arrangement. The removal of the 'C'-bias resistor and the use of a separate 'C' battery in several cases reduced the hum to almost inaudibility.

"The statements in the preceding paragraphs should not be construed as signifying that all 'C' battery arrangements in use at present are deficient in operation. Many are satisfactory, as are many supply units; but it is also true that many are unsatisfactory. For the constructor the advice is to use a battery for the source of 'C' voltage."

These conclusions may be endorsed, unless the constructor is working with very high-grade material, and a plan and specifications which have been worked out satisfactorily and approved by radio engineers.

BATTERY CHARGER

(167) B. Steinmetz, West New York, N. J., asks for:

Q. 1. Constructional details of a transformer to be used in conjunction with a 5-ampere-hour capacity Tungar rectifier tube.

A. 1. The time has come when the recharging of storage batteries, both "A" and "B" types, necessitates a much more convenient way than carrying them several blocks to the nearest battery station, with perhaps, the dire results accruing from spilling the acid over one's clothes. The best means of overcoming this difficulty is to charge them at home. A transformer for that purpose has been designed along the lines given in the above diagram and will meet all requirements. It is of the auto-transformer type, having three different windings on it. The core is made of laminated silicon steel, "L" shaped, in two sections, which are butted together and securely fixed after the coils have been put in place.

One hundred and twenty-five laminations are placed in a pile 1¾ inches high and constitute one leg of the core. Two or three layers of tape are wound tightly over it, after the laminations have been squeezed together as tightly as possible. On this are wound 197 turns of No. 14 B. & S. D. C. C. wire, taps being taken off at the 161st, 173rd and 185th turns. The winding must be confined within a space 2½ inches wide. This is shown as coil "B" in the diagram.

After having prepared the second leg of the transformer as outlined above, six turns of No. 6 B. & S. D. C. C. wire are wound on and serve as the filament winding. Directly over this are wound 73 turns of No. 10 B. & S. D. C. C. wire, which furnishes the current for charging the "A" battery. It will be noted that the two coils are connected in series with the winding on leg "B".

Having finished the windings, they are carefully taped and shellacked. The legs are then butted together and securely held together with wooden cleats. The variable resistance shown in a bank of five 40-watt lamps which is used to regulate the charging current. A 10-ampere fuse is connected in series with the battery and prevents overcharging. The transformer should be mounted on a slate or asbestos base.

"B" BATTERY ELIMINATOR

(168) Q. 1. Joseph Rapaport asks for a circuit of a good "B" battery eliminator.

A. 1. The circuit of the "B" battery eliminator is given in Fig. 168; by following closely the constants given you will hear no hum in the receivers. To some people, the cost at first seems prohibitive, however, the equipment will pay for itself in a short while. For obtaining variable "B" battery current for the detector use a high value variable resistance.

CHOKE COIL

(169) Q. 1. Harry Bertman, Dallas, Texas, desires to know the construction of a five-millihenry inductance.

A. 1. A five millihenry choke coil consists of about 250 turns No. 28 D. C. C. wire on a two-inch diameter tube.

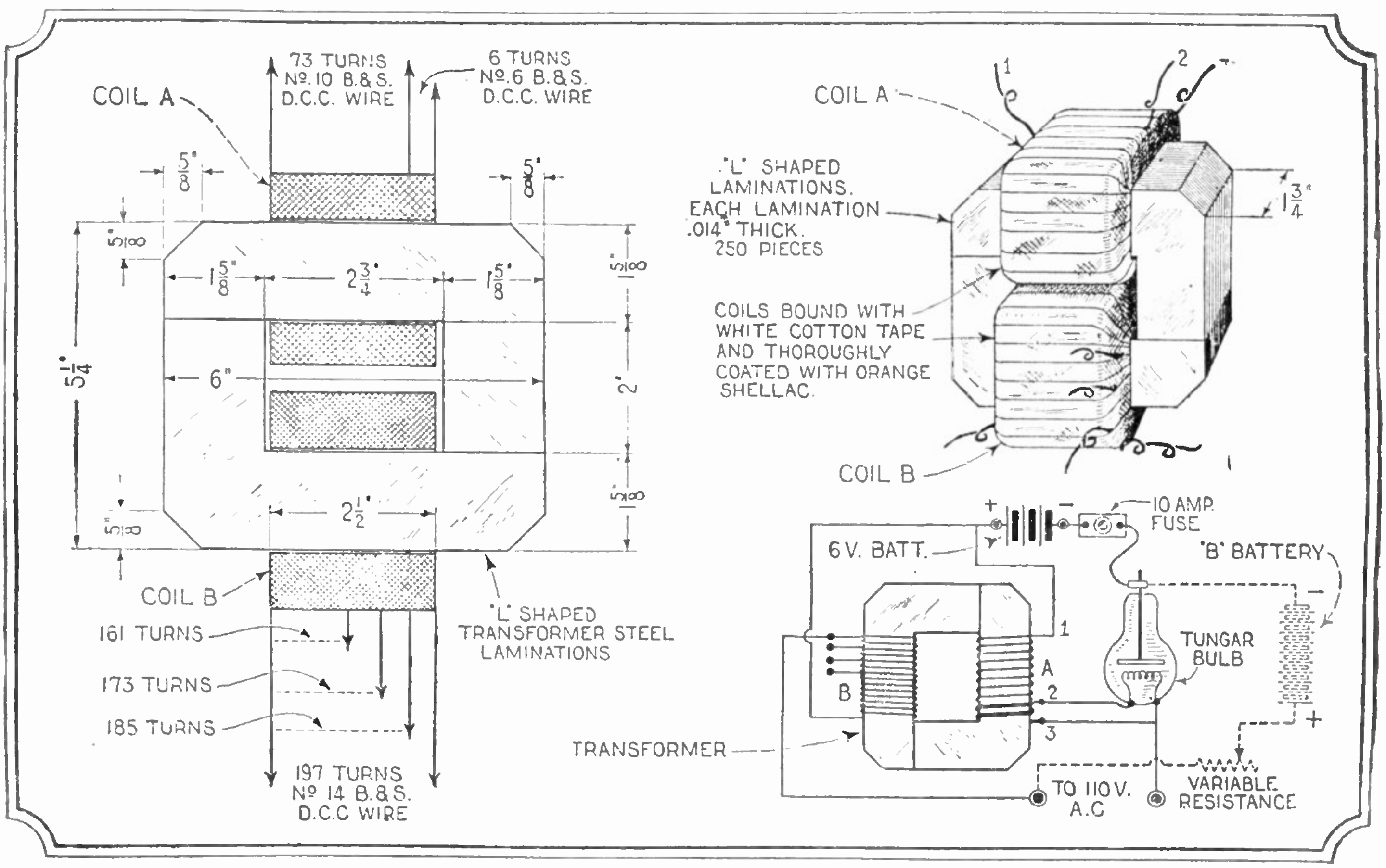


Fig. 167. A transformer for the purpose of charging both the "A" and "B" batteries is detailed clearly above. It is well worth the trouble to construct. It is designed for operation on 110 volt, 60 cycle alternating current, and if carefully built will last indefinitely.

BALKITE CHARGER

(170) Q. 1. Mr. P. Vinder, Scranton, Pa., wishes to know what metal is used in the Balkite charger.

A. 1. The metals used in the Balkite charger are tantalum and lead immersed in a special solution of sulphuric acid.

Q. 2. Why must sections be connected in parallel when charging a high voltage battery?

A. 2. Because certain rectifiers only deliver from 30 to 40 volts.

MORE DATA ON "B" BATTERY ELIMINATOR

(171) Q. 1. E. F. Morse, La Crosse, Wis., refers to the "B" battery eliminator described on page 66 of the May, 1925, issue of RADIO NEWS and asks for further information on the construction of the various parts illustrated therein.

A. 1. The following data is correct for the various instruments to be used in the construction of the "B" battery eliminator that you mention.

The core of the transformer is constructed of silicon steel strips .014 inches thick by 1½ inches wide. The outside dimensions of the core are 5 inches square and the legs should be built up to 1½ inches high.

The 110-volt primary consists of 384 turns of No. 22 D. C. C. wire, wound 48 turns per layer in 8 layers. The secondary consists of 980 turns of No. 26 D. C. C. wire, wound 65 turns per layer in 15 layers. A center tap is brought out at the 490th turn to be connected as shown in the diagram in this magazine. In the above data, space is allowed at the ends of the windings for supports for the same. Both coils should be well insulated from the core and may be wound on opposite legs.

The electrodes of the rectifier are made of lead and aluminum plates as indicated in the article. They may be 1 inch wide by 3 inches long with an additional length allowed for projection above the surface of the liquid. The latter may consist of a saturated solution of ammonium phosphate or borax in water. The surface should be covered with a ⅛th-inch thick film of mineral or paraffin oil to prevent evaporation. The electrodes should be thoroughly sandpapered before being placed in the solution.

The 2mf. condensers may be purchased from any telephone equipment supply house.

The 30-henry choke may be wound as follows: Make up a core of a bundle of iron wires, 4 inches long by ½ inch in diameter. Provide suitable ends and a winding space 3½ inches long. Wind No. 38 enameled wire on the core until the outside diameter is 2½ inches. Provide suitable terminals.

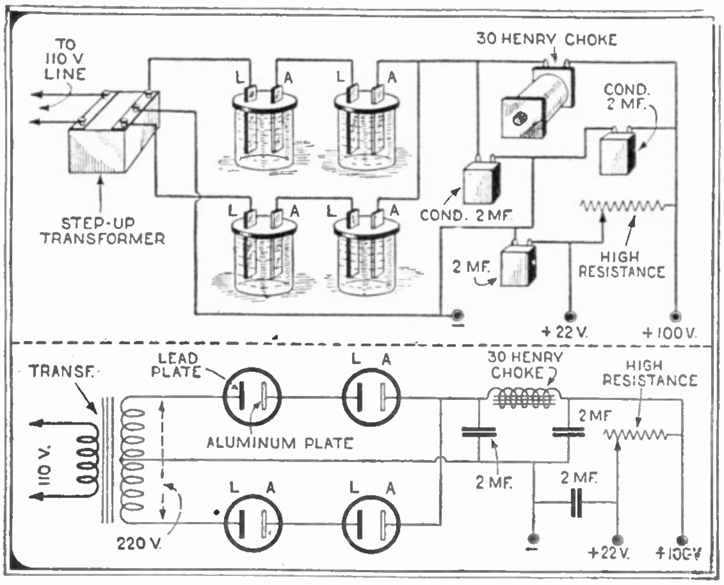


Fig. 168. No modern set is complete unless a good "B" battery eliminator is used to supply the "B" voltage to the plates of the tubes. By the use of large condensers and correct size choke coils the A. C. ripple can be eliminated.

Any adjustable resistance with a range of 10,000 to 100,000 ohms may be used for cutting down the voltage for the detector plate supply. The carbon pile type is suitable.

SEPARATE "A" BATTERIES

(172) Q. 1. Milton Bausch, Hartford, Conn., asks if there is any advantage in using "A" batteries for the various tubes in a multi-tube set.

A. 1. Of late, practically every circuit shown various periodicals uses a common "A" battery. This is done in order to conserve batteries. The advent of vacuum tubes operating with a single dry cell for the filament supply makes possible the use of separate batteries. Fig. 172 shows the method which may be followed. It is a five tube set employing WD 12 type tubes with one dry cell for each tube.

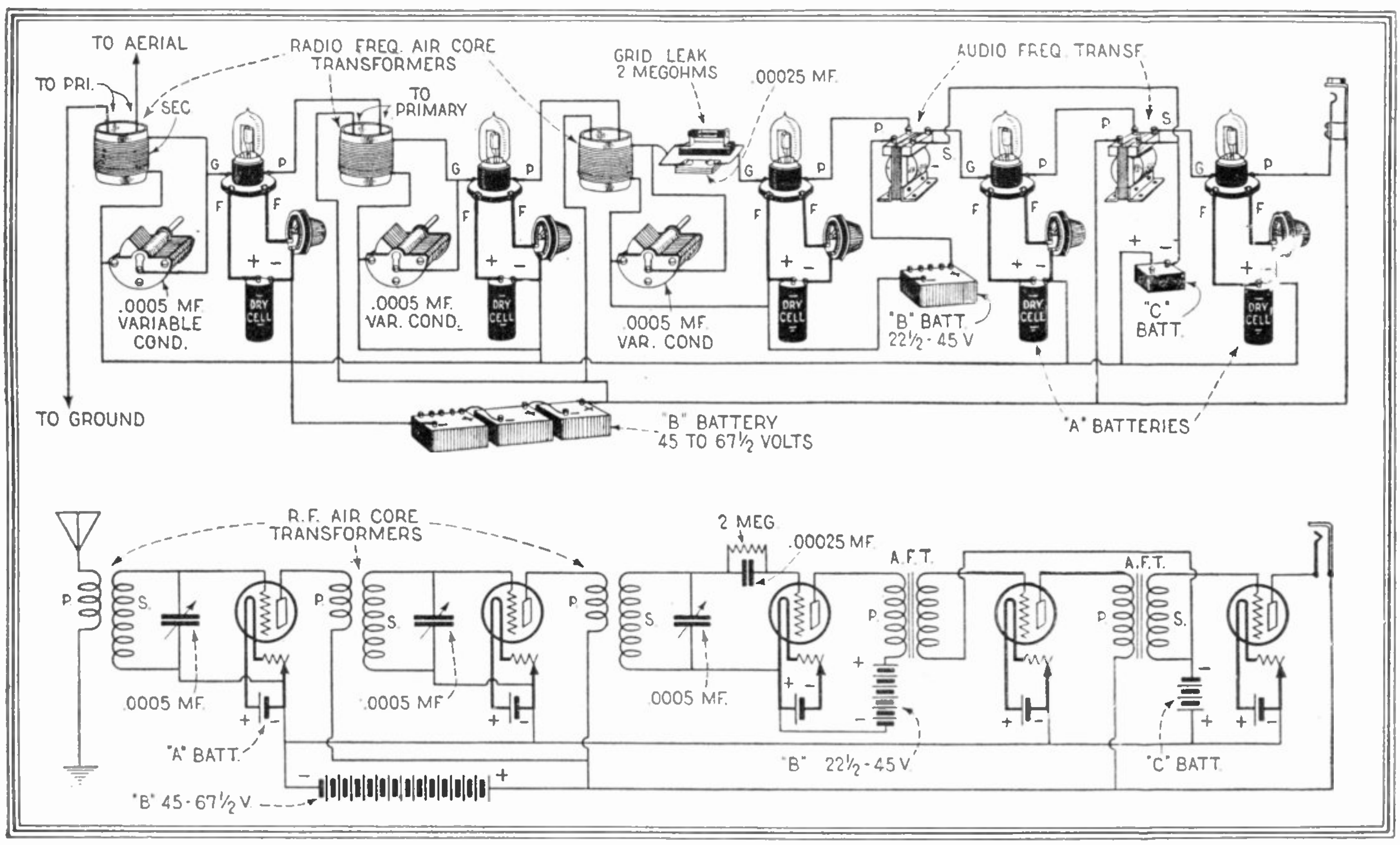


Fig. 172. When using dry cell tubes, one "A" cell can very readily be used for each tube. Use either separate rheostats or fixed resistances in the amplifier filament circuits. Many experimenters report excellent results with the system as shown with all filaments and batteries in parallel.

STORAGE "A" BATTERIES

(173) Q. 1. Orlan Brown, Niagara Falls, N. Y., refers to an article describing the construction of a storage "A" battery published some time ago in the pages of RADIO NEWS. He asks whether or not the holes punched in the plate go all the way through.

A. 1. The holes punched in the plates of the "A" battery you mention are to go all the way through the metal. A 10-penny nail may be used for this purpose. We would suggest that you follow the directions given in the article you mention and use plates of the size advised therein. A completed battery of the size described will have an ampere-hour capacity of approximately 12.

Q. 2. In the storage battery charger, described in the same issue of the magazine as the "A" battery, what use is the 100-watt lamp put to?

A. 2. In this simple battery charger, a 100-watt lamp is used to reduce the amount of current passing through the rectifier. If you place a 40-watt lamp in the circuit in place of the 100-watt lamp, the charging rate would be lowered to about two-fifths of an ampere.

"B" ELIMINATOR PARTS

(174) Q. 1. William T. Edwards, New Rochelle, N. Y., asks where he can purchase parts for the various "B" eliminators described in September, 1925, issue of RADIO NEWS.

A. 1. We will be only too glad to forward you the names and addresses of companies supplying the various parts upon receipt of a stamped addressed envelope.

Q. 2. Kindly give me the reason why mica is used instead of paraffin paper in fixed condensers and also define dielectric constant?

A. 2. The dielectric constant of a substance is the ratio of the capacity of a condenser when its plates are separated by a substance, to its capacity when its plates are separated by air. Paraffin paper has a lower dielectric value than mica and is much inferior for the reason that it absorbs moisture more readily than mica, and cannot withstand potentials as high.

Mica has an average dielectric constant of 6. Due to the extreme thinness of the mica and this high dielectric constant, it is possible to obtain high capacities in small fixed condensers. Air is the unitary dielectric, but is used mostly for variable condensers. The closer the plates of a condenser are, the greater the capacity, hence if a fixed condenser of a known value were put between the jaws of a vise and compressed, its capacity would rise above its rated one, but this condenser could not possibly withstand the voltage under which it was tested at first.

CURRENT SUPPLY

(175) Q. 1. George Kinsman, Chicago, Ill., asks whether or not the use of a "C" battery will decrease the "B" battery consumption.

A. 1. By applying a certain voltage, which must be determined by experimentation, to the grids of the amplifier tubes, a decrease in "B" battery current consumption will be noticed. To make this addition, remove the amplifier grid return leads from the negative "A" connections. Connect the amplifier leads together and to the negative side of the "C" battery. Connect the positive side of the "C" battery to the negative side of the "A" battery. Try voltages of from 3 to 6 volts for the "C" battery and use the voltage that seems to give the best results.

"B" ELIMINATORS

(176) Q. 1. C. G. Lindahl, Seattle, Wash., refers to the "B" eliminators described in the September, 1925, issue of RADIO NEWS and asks whether or not they can be used on all types of sets.

A. 1. All of the "B" eliminators with the exception of the first one described can be used with parctically any radio receiving set. In the case of the first eliminator, this cannot be used on a set in which the filament circuit is grounded. If such is the case, the connection between the filament circuit and the ground must be removed before the "B" eliminator is connected to the set.

BATTERY CHARGER

(177) Q. 1. Ross L. Douglas, Bellflower, Calif., asks why taps are arranged on the primary coil of the transformer used in connection with a tungar rectifying bulb.

A. 1. In the battery charging transformer that you mention, the taps on the primary are to compensate for line voltage changes. The transformer is designed to operate on ordinary 110 volt 60 cycle line, but since the voltage is slightly different in different locations, taps are taken off the coil.

Q. 2. Do both "A" and "B" batteries give off the same type of current?

A. 2. There is no difference between the type of current given by "B" batteries and that given by "A" batteries.

Q. 3. How can I place an ammeter in my battery charger circuit so as to show the rate of charge?

A. 3. You can connect an ammeter in the circuit of this battery charger in series with one or the other lead to the battery.

BATTERY CHARGER

(178) Q. 1. C. D. Bowie, West Haven, Conn., refers to the battery charger described in the Radio Oracle Department in the March, 1925, issue of SCIENCE AND INVENTION and asks whether the filament winding should be under or over the secondary winding.

A. 1. In regard to the battery charger you mention, we would advise as follows: The filament winding may be either over or under the secondary winding or placed directly alongside of it. Less wire is used if it is placed under the secondary.

Q. 2. What voltage is supplied to the filament and to the plate by the transformer described for use in connection with this battery charger?

A. 2. The voltage of the filament supply secondary is 2½ and of the plate supply secondary 30. The amperage is 6 for the filament and 5 to 8 for the plate.

"B" ELIMINATOR

(179) Q. 1. E. B. Harris, Galveston, Texas, says that he has built a "B" eliminator of the type described in this magazine and that "everything seems to work well with the exception of the transformer which has a hum and when same is connected to second or third stage is set, the hum is so loud that no music can heard." He asks how this can be remedied.

A. 1. You do not quite make your trouble clear in your letter of recent date. It is quite possible that you have placed your "B" eliminator unit too close to your receiving set. In such a case, the magnetic fields set up by the windings of the transformer would interact with the coils in your receiving set and cause a hum.

If you have constructed your filter circuit consisting of the choke coil and condensers properly, there should be no hum in your receiver at all. Possibly you have not done this and we would advise you to check it over.

The fact that the core of the transformer itself hums somewhat does not have any particular bearing on the actual results. However, be sure to place all the instruments of the "B" eliminator unit at least four or five feet away from the receiving set proper.

ELECTROLYTIC RECTIFIER

(180) Q. 1. Robert K. Jones, Chicago, Ill., is contemplating the construction of a complete transmitting set using rectified A.C. for supplying the plate voltage to a UX-210 tube. He asks how many cells should be used in his electrolytic rectifier, since this is the type that he desires to use for changing the current from A.C. to pulsating D.C.

A. 1. It is safe to figure about fifty volts per cell in an electrolytic rectifier for transmitting purposes. Presupposing that you use a transformer with the secondary tapped in the center and delivering 550 volts on either side of the center tap, use 11 jars in each of the outside secondary leads or a total of 22 jars in all. The method of connecting an electrolytic rectifier with this type of transformer was clearly shown in *The Radio Constructor* article appearing in the December, 1925, issue of RADIO NEWS. We would suggest that anyone interested in transmitting refer to this article for further information.

"B" ELIMINATOR

(181) Q. 1. Frank Wiesuski, Los Angeles, Calif., built the "B" eliminator described by Max Kuhne in the September, 1925, issue of SCIENCE AND INVENTION Magazine and says that he has had some trouble with it due to a reproduced hum. He asks us to give him some advice on this eliminator.

A. 1. We have communicated with the author of the article you mention in your letter of recent date and he has offered several suggestions which may aid you in making your "B" battery eliminator work correctly. In the first place, your "B" eliminator unit may be positioned too close to the receiving set. It should be at least 4 or 5 feet distant therefrom. It is also true that if a perfect ground connection is not employed, a hum will be present. Be sure that your ground wire is securely clamped or soldered to a cold water pipe or to a 7- or 8-foot length of 1-inch iron pipe driven in the ground. Still another suggestion is that you connect another capacity from the positive detector post to the negative "B." Use a ¼- or ½-mf. condenser between these two points. If there is a by-pass condenser from the negative "A" of the positive "B" binding post in the receiving set itself, take it out as it is not necessary and may be causing some trouble. Then again, if there is no connection between your filament circuit and the ground, one should be placed in the circuit for otherwise the eliminator will not operate correctly. We are quite sure that one of these points will be the solution to your trouble.

"A" BATTERY CHARGER

(182) Q. 1. William F. Brockenbrough, Richmond, Va., requests information on how to construct an "A" battery charger, using a type 200 or 201A tube.

A. 1. It is impossible to construct an apparatus of this sort for charging "A" batteries, because a rectifier employing a 201A tube delivers only a very slight amount of current and would be entirely unsuitable for the purpose you mention. The type 200, being a soft tube, is unsuitable even in a rectifier supplying plate current. For an "A" battery charger we recommend using a rectifier tube of the Kenotron type.

R. F. AMPLIFICATION WITH COLLOIDS

(183) John Hendrickson, Tallahassee, Fla., asks:

Q. 1. Can colloidal suspensions be used as receiving detectors and what are some of their characteristics?

A. 1. One of the most interesting developments has been the use of colloidal liquids to replace the crystal and the vacuum tube. Though as yet this form of rectifier has not been developed to an efficient stage, the experiments now going on tend to show that there are possibilities in their use.

The definition of a colloid is a compound which when placed in a liquid absorbs that liquid and the particles of the colloid are held in suspension by it. When the liquid is evaporated one of two things may occur—either the colloid will become a hard solid mass, incapable of reabsorbing a liquid or will become a solid, capable of doing so. There are two classes into which colloids are divided, the emulsoids and suspensoids. The emulsoids, when mixed with water, have the water penetrate their particles, while the suspensoids are those which are not penetrated by the water. As a matter of fact, the emulsoids are mostly organic substances while the suspensoids may be metals. It is the latter that find use. Under a powerful microscope there is observable a constant movement of the particles in a colloidal solution. These are called Brownian movements. One theory is that each particle is charged with electricity of the same amount and polarity, consequently, there is a constant repulsion between them, thus causing the movement noticed with a microscope.

The rectifying action of a detector of this nature becomes rapidly weaker and at the end of a few hours may become totally inoperative, but it is a peculiarity that its activity may be renewed if the connections to it are reversed. Thus a continuous reversal of connections will keep the detector in action indefinitely. Another outstanding point is that continuous wave reception is possible without the use of an external heterodyne.

Ultra-Violet Rays

Q. 2. Would be very much obliged to you if you would give me some information on ultra-violet rays.

A. 2. It is, of course, known that ultra-violet rays are invisible to the naked eye. It is also claimed that light and electricity are closely related, light being of a very high rate of vibration and of very short wave-length. By the phenomena of fluorescence, the wave-length of light is lengthened, whereby ultra-violet rays become visible. In a similar manner, it may also be possible to shorten the wave-length of light to produce electricity. Due to the ionizing properties of ultra-violet rays, Hertz discovered that a spark discharge took place more readily in the presence of violet rays.

A little later, Sella, following Hertz, attempted to use the latter discovery for the transmission of speech and had some success with it. He used a quartz bulb in which were placed two electrodes, one a disk of platinum and the other, a metal ball. It may be interesting to note that ordinary glass is opaque to ultra-violet light. Hence comes the use of quartz glass. There are quite a number of books on the subject of ultra-violet rays and we would be glad to furnish you with the names of the publishers if you so desire.

TRANSFORMERS AND CHOKE DESIGN

(184) Q. 1. Mr. Edwin Thompson of Wichita, Kansas, asks for the dimensions of form and winding required for B-battery eliminator, transformers and filter chokes.

A. 1. The following dimensions are furnished us by the manufacturers of the Raytheon tube.

Transformer core 7/8 square, as shown here in Fig. 184.

Primary 1140 turns No. 28 enamelled copper wire. Tap at 910 turns.

Secondary 4200 turns No. 31 enamelled copper wire. Tap at center.

Wound in layers with .0015" paper between layers.

Elec'r static shield between primary and secondary (.005" copper).

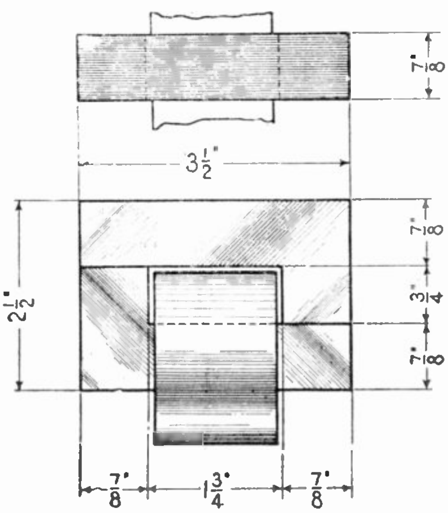


Fig. 184. The form above is that recommended by the manufacturers of the Raytheon tube for chokes and transformers in their "B" eliminator circuit.

Core material is Apollo special electrical steel No. 29 gauge. Laminations are assembled to give staggered air gaps.

Primary d.c. resistance is approximately 25 ohms.

Secondary d.c. resistance is approximately 300 ohms, total.

Two halves of secondary should be balanced for voltage output at full load output within two per cent.

Choke Coils—Core 7/8" square, same design.

5800 turns No. 28 enamelled copper wire on each coil.

D.C. resistance of each coil is approximately 190 ohms.

Laminations are assembled to form a butt joint, with .003" insulated air gap.

ELIMINATOR TRANSFORMER

(185) Mr. Edwin Thompson of Wichita, Kansas, asks:

Q. 1. For the dimensions of form and winding required for "B" battery eliminator, transformers and filter chokes.

A. 1. Core built up of L-strips in shades of square. Outside dimensions 2½"x3½", inside ¾"x1¾". Winding on one leg. Core ⅞-inch square.

Primary 1140 turns No. 28 enamelled copper wire. Tap at 910 turns.

Secondary 4200 turns No. 31 enamelled copper wire. Tap at center.

Wound in layers with .0015 in. paper between layers.

Electrostatic shield between primary and secondary (.005 copper).

Core material is Apollo special electrical steel No. 29 gauge. Laminations are assembled to give staggered air gaps.

Primary d.c. resistance is approximately 25 ohms.

Secondary d.c. resistance is approximately 300 ohms, total.

Two halves of secondary should be balanced for voltage output at full load output within two per cent.

Choke Coils—Core ⅞-in. square.

5800 turns No. 28 enamelled copper wire on each coil.

D. C. resistance of each coil is approximately 190 ohms.

Laminations are assembled to form a butt joint, with .003 in. insulated air gap.

Two choke coils required for each eliminator circuit.

"B" BATTERY ELIMINATOR

(186) E. B. Lupton, San Francisco, Calif., asks:

Q. 1. For technical information concerning the "B" battery eliminator described in the May, 1925 issue of RADIO NEWS.

A. 1. The following data is correct for the various instruments to be used in the construction of the "B" battery eliminator that you mention.

The core of the transformer is constructed of silicon steel strips .014 inches thick by 1½ inches wide. The outside dimensions of the core are 5 inches square and the legs should be built up to 1½ inches high.

The 110 volt primary consists of 384 turns of No. 22 D.C.C. wire, wound 48 turns per layer in 8 layers. The secondary consists of 980 turns of No. 26 D.C.C. wire, wound 65 turns per layer in 15 layers. A center tap is brought out at the 490th turn to be connected as shown in the diagram in this magazine. In the above data, space is allowed at the ends of the windings for supports for the same. Both coils should be well insulated from the core and may be wound on opposite legs.

The electrodes of the rectifier are made of lead and aluminum plates as indicated in the article. They may be 1 inch wide by 3 inches long with an additional length allowed for projection above the surface of the liquid. The latter may consist of a saturated solution of ammonium phosphate or borax in water. The surface should be covered with a ⅛-inch thick film of mineral or paraffin oil to prevent evaporation. The electrodes should be thoroughly sandpapered before being placed in the solution.

The 2-mf. condenser may be purchased from any radio or telephone supply house or possibly from your local telephone company.

RECTIFIER SOLUTION

(187) Q. 1. Mr. George Smith, Philadelphia, Pa., inquires for the proper method of preparing the solution for an electrolytic rectifier of the lead-aluminum type.

A. 1. The solution used in the type of cell you mention is generally specified as a "Saturated Solution of Borax in Water." In the first place, a "saturated" solution is one in which the greatest possible amount of solid material has been dissolved. In this case it is done as follows: A quantity of water is heated to a temperature somewhat below boiling. To this water is added borax (obtainable at any grocery store) until the excess of borax begins to collect at the bottom of the container in the form of a white powder. The solution must be stirred constantly to insure the dissolving of as much borax as possible. The solution should be allowed to stand over a period of time necessary to dissolve as much borax as possible. This gives a saturated solution. After all the solid has settled, the liquid should be siphoned or decanted off and used in the rectifier cell. Due to evaporation, the liquid will have to be replaced occasionally.

D.C. FOR HIGH VOLTAGE ELIMINATOR

(188) Mr. Luther Steward, San Antonio, Texas, writes as follows:

Q. 1. Can you tell me of any way in which I may utilize the direct current lighting circuit of my residence to replace the "B" batteries for an amplifier using a 210 tube?

A. 1. If you have 115 volts D.C. running into your apartment or residence, there is little doubt that the line installation to your meter is a three-wire Edison circuit. In such a circuit, there are three wires run to the top of the meter box. The voltage across the two outside wires is 220 volts, while that of either of the other pairs is 110. The center wire is neutral relative to outside leads. Therefore, a voltmeter placed across the two outside leads will read from 220 to 240 volts D.C. If this voltage is impressed upon the plates of a 210-amplifier tube, it will be found quite sufficient to cause the tube to operate at highest efficiency. It will probably be necessary to install a filter system to reduce the line noises, in which case we would recommend any of the standard filter circuits. Various voltages may be drawn from this line by the use of a potentiometer of some sort, which will divide the voltage into those values required.

A FILTER CIRCUIT

(189) George Murphy, Knoxville, Tenn., asks:

Q. 1. Will you please illustrate in your book a filter system which may be adapted to any type of "B" eliminator to quiet the noises coming through from the line?

A. 1. You will find on this page a diagram of a typical filter system which has been found highly efficient. This filter system is made up of 30-henry chokes and 1- to 4-mf. condensers, three of each. It is absolutely necessary that the input and output sides be not confused, as a reversal of the filter will make it inoperative. This filter is adaptable to use with "B" batteries, to cut down any noises due to the age of the batteries, or with A.C. or D.C. "B" eliminators. Note that *this is not an eliminator*, but is simply a filter system to be applied to the output of any type of eliminator.

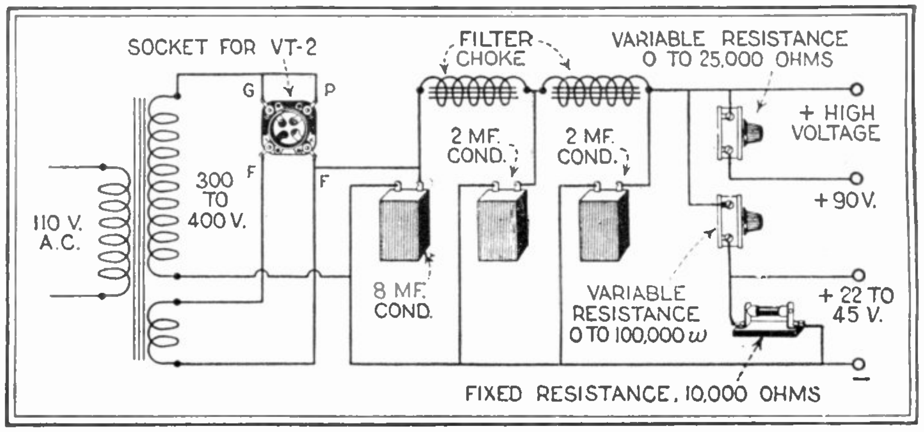


Fig. 190. The above diagram shows a good method for utilizing the VT-2 tube as a rectifier. As the tube is capable of operating at a plate voltage of 400 volts, it will deliver sufficient voltage when used as a rectifier.

VT-2 AS A RECTIFIER

(190) Harvey Seton, Sacramento, California, writes:

Q. 1. I have several VT-2 Western Electric tubes which I believe could be used in a "B" eliminator. Can you suggest an appropriate circuit in which one of these tubes could be used to supply plate voltage for a six-tube set?

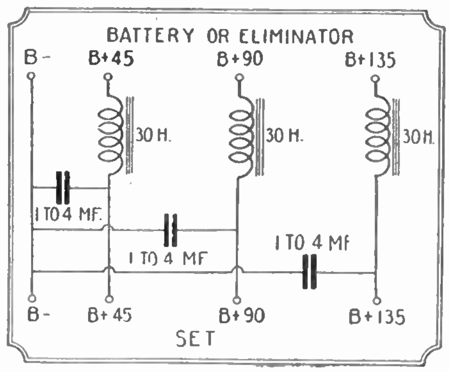


Fig. 189. The circuit above shows the connections for a filter system which may be connected to the output of any type of B eliminator. This filter will serve to iron out line noises and fluctuations in voltage which might otherwise cause considerable trouble. Aged B-batteries will be helped by the use of such a filter.

A. 1. A good circuit for the VT-2 tube is shown in Fig. 1. As the tube is capable of operating at a plate voltage of 350 to 450 volts, you can supply sufficient voltage, using it as a rectifier, to operate a type 310 power tube, as well as a number of tubes of lower voltage requirements. One of the power transformers designed for use with either the CX-316-B rectifier tubes, or the heavy duty Raytheon rectifier can be used, provided that the transformer has a filament winding of at least 6 volts. If no filament winding is furnished with the transformer, a small bell-ringing transformer having a 6-volt secondary can be used, with the primary connected in parallel with the plate transformer primary. The filter circuit is the same as for any of the "B" eliminator circuits now in use, and the voltage reducing resistances are connected in the customary manner, as is shown in the diagram. The grid and plate of the tube are connected together, at the socket terminals.

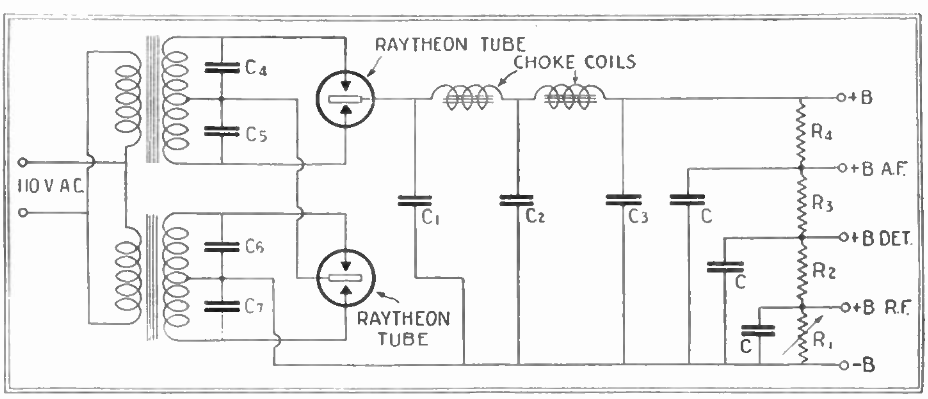


Fig. 191. The connections for a B-power supply unit, employing two Raytheon tubes, and two transformers having an output of about 435 volts D.C., are shown above. Using the type B Raytheon tube 20 milliamperes of current will be delivered and with the type BH 35 milliamperes.

B-POWER SUPPLY UNIT

(191) H. Moriarity, Antioch, Michigan, writes:

Q. 1. Can you give me the hook-up of a B-power supply unit, employing two Raytheon tubes and two transformers which will have an output of about 400 volts?

A. 1. You will find illustrated on this page the correct hook-up for the B-supply unit. Two Raytheon tubes are connected in series to furnish plate voltages up to 435 volts D.C. at 20 milliamperes, when using the type B, and at 35 milliamperes, when using the type BH. Standard designs of approved transformers and choke coils are employed, the same as are found in the usual B-power unit employing a single tube. The condensers C1 and C2 have a capacity of 2 microfarads; C3, 8 microfarads; C4, C5, C6, and C7, 0.1 microfarad. However, the condensers should be designed for a working voltage of 750. If the plate supply is to be furnished to the usual four or five tube receiver using 201 type tubes, a variable resistor should be used for R1, allowing a range of 0 to 20,000 ohms, and fixed resistors of 10,000 ohms each for R2 and R3, and 18,000 ohms for R4, with by-pass condensers C of 1 microfarad in each case, as indicated. While the C or grid bias can be obtained for the power tube by means of a suitable resistance drop, it is advisable to employ a tapped "B" battery. The full voltage when applied to the power tube will be approximately 425 volts.

POTASSIUM HYDRATE BATTERIES

(192) Newman Stern, New York, N. Y., writes:

Q. 1. Kindly give me the specific gravity necessary in mixing a new solution of potassium hydrate for Todd storage "B" batteries. Is the distilled water poured upon the potassium hydrate or the hydrate dropped into the water?

A. 1. The electrolyte solution consists of one part of potassium hydrate to four parts of distilled water. This is approximately one pound of hydrate to a quart of water. The specific gravity will be from 1200 to 1250.

Tube Data

TUBE ACTION

(193) Mr. Charles C. Taylor, Richford, Vermont, asks:

Q. 1. In what way does a detector tube function differently than a radio-frequency tube; and why doesn't a radio-frequency tube detect?

A. 1. With a certain grid and plate voltage conditions are usually satisfactory for the radio frequency amplification, detec-

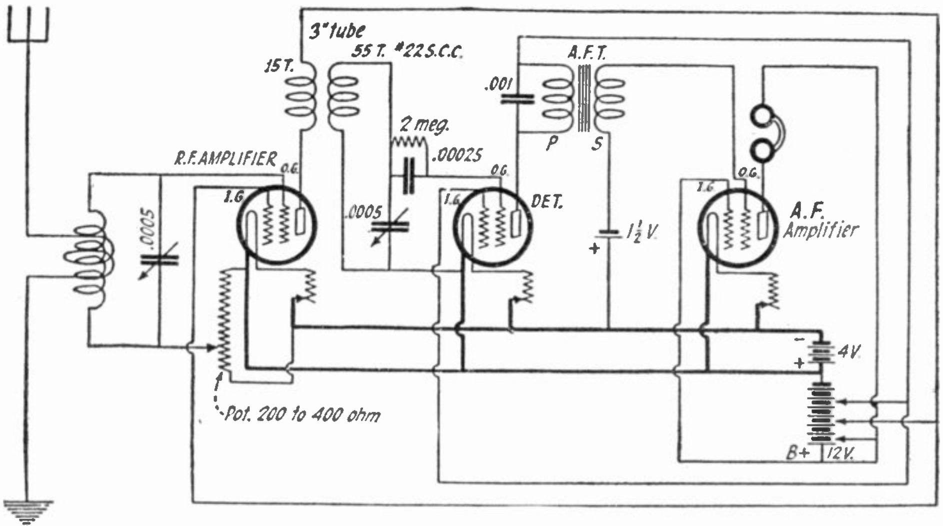


Fig. 197. The use of double grid tubes as radio-frequency amplifiers, detectors and audio-frequency amplifiers is clearly shown. Solodyne tubes might work in this circuit.

tion and audio frequency amplification of radio signals. It is understood that the grid, plate and filament voltages are maintained within certain prescribed limits, each limit depending upon whether the tube is to amplify, oscillate or detect.

With a certain grid voltage and a certain plate voltage (usually about 22½ plate volts and zero grid volts) the grid has been found to cause the greatest amount of change in the plate current, when a very slight voltage (the incoming signal) is applied to the grid. Under these conditions the tube is found to function particularly well as a detector. The rectification is most perfect with the above values. Incoming signals are not amplified to nearly as great an extent as they would be with different grid and plate voltages.

Since a tube is capable of functioning as an oscillator, amplifier, or detector, it is only natural to believe that there are different conditions necessary for the best operation of a tube for any one of these three actions.

The best condition for amplification depends upon whether the amplification is to be at audio frequency or radio frequency. If at audio, high plate voltages are best, plus a high negative grid voltage. Under these conditions the tube could be made to oscillate strongly, if placed in radio-frequency circuit, which would cause great distortion, however; as a detector, under the same conditions, results would be relatively unsatisfactory, as a small, incoming signal would have very little effect upon the highly negative grid.

Under the conditions for best radio frequency amplification, the radio-frequency transformer secondary connects directly to the grid. The other side of the transformer connects to a potentiometer. Often, the grid voltage may be zero, but the plate voltage is preferably between 45 and 90 volts. For best results as a detector a grid condenser is usually employed. In the radio-frequency amplifier no grid condenser is used. If a very low plate voltage is used on the radio-frequency amplifier, detection will be had, to a certain extent on the radio-frequency tubes, but amplification will not be high. This detection is rather slight as compared to the amount of detection which will take place in the properly arranged detector tube circuit. The grid condenser, when used, is a determining factor in the best rectification of radio-frequency currents.

It is thus seen that associated tube apparatus must be of a design that will work in harmony with the desired function of the tube. Various charts and other data have appeared in past issues of RADIO NEWS explaining the above.

The information just given must be taken as general, since a complete exposition of vacuum tube actions cannot be made in the amount of space available in these columns. The facts pointed out should explain, in only a general way, the reasons for the various grid and plate voltages used on the various tubes of receiving sets.

SINGLE TUBE IN TRIPLE ROLE

(194) Norman Sigler, Syracuse, New York, asks:

Q. 1. Kindly give me a hook-up that employs one tube having the three functions of detection, regeneration and audio frequency amplifications.

A. 1. The circuit you desire is shown herewith.

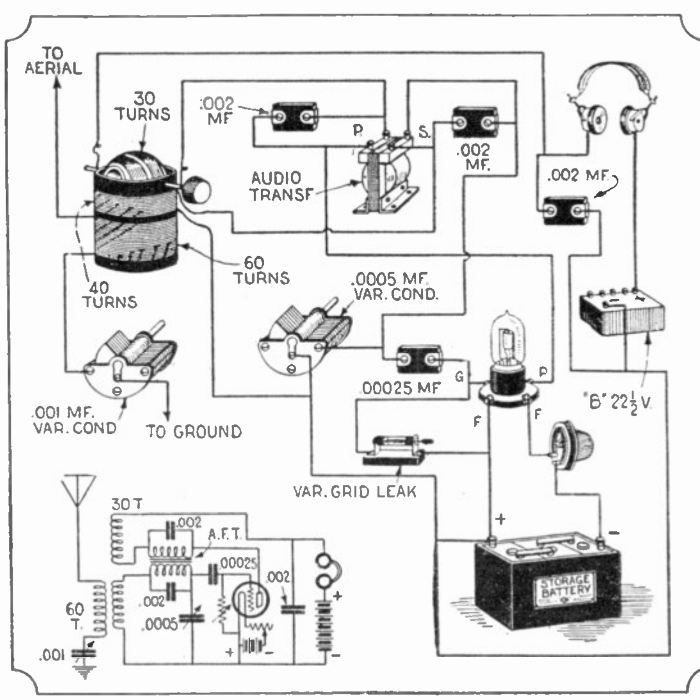


Fig. 194. One tube can be very successfully used to function as a detector and audio-frequency amplifier. However, the use of one tube as a radio-frequency amplifier detector and audio amplifier has not been successfully solved. A detector tube acts as a radio-frequency amplifier.

DRY CELL TUBES

(195) Q. 1. William J. Baker, New York City, asks what "A" and "B" voltages should be used on the standard WD-12 tubes.

A. 1. When a WD-12 is used in a set, a standard No. 6 dry cell will give very good results as the "A" battery. The "B" battery should be as high as will give good results, and will vary somewhat in accordance with the particular tube used. Some of these tubes will stand up to 80 volts on the plate, while others will not operate satisfactorily on more than 22½ volts. We would, therefore, suggest that you experiment along this line, starting with 16 volts and noting the results. Increase the plate voltage until the signals do not get any louder. You will find this point is the best for the operation of the tube you are trying out.

POWER TUBES

(196) Q. 1. Morris Steiner, Rochester, N. Y., asks: Will the addition of a power tube in the second stage of my three tube receiver result in better signal strength?

A. 1. Louder signals will undoubtedly be found if a standard power tube is employed, and if care is taken to apply a higher voltage to the plate than is ordinarily used for a second stage audio-frequency amplifier. With the power tubes on the market today use at least 135 volts on the plate; 150 volts will probably be found even better. Also increase the "C" battery to at least 6 volts and preferably to 9 volts for the last stage amplifier. With certain types of power tubes, it will be necessary to change sockets or use an adapter, whereas with others, the standard socket may be employed, but it will be found that more current will be drawn from the "A" battery. In such an event a suitable rheostat must be employed to handle this current.

FOUR ELEMENT TUBES

(197) Mr. Earl Owen, Astoria, Ore., asks:

Q. 1. What is the diagram of connections of a set incorporating one stage of tuned radio frequency amplification, detector and one stage of transformer coupled audio frequency amplification, employing the Philips' Tetrode?

A. 1. The circuit for these double grid tubes is shown in Fig. 197.

Note that the plate voltage on the amplifier tubes should never exceed 12 volts. The detector voltage will range between 2 and 4 volts. The amplifier voltage will range between 4 and 10 volts.

The inner grids connect to the positive connections of the respective plate battery taps, as shown. This inner grid connection is the small binding post on the shell of the socket.

These tubes require a special socket since the foreign method of isolating the plate prong is used.

It must be remembered that the terminal filament voltage is only 3½ volts, at ½ ampere.

The standard system of connections for three element tubes is followed throughout, with the exception of the inner control grid shown.

Q. 2. What is the best height for a counter-poise?

A. 2. Ten feet may be considered the average height.

REJUVENATING TUBES

198) Q. 1. Mr. Bert Reith, Oklahoma City, Okla., asks about a method for the rejuvenation of vacuum tubes.

A. 1. The circuit diagram used in connection with the rejuvenation of vacuum tubes is given in Fig. 198. UV-201A tubes are lit with about ten volts on the filament for about ten to fifteen minutes. If the tube has not come back in that length of time, try again until it does work. UV-199 tubes are lit with about four volts on the filament for about five to ten minutes or until they work again. Be careful about rejuvenating tubes because there is a possibility of burning them out if carelessly handled.

Q. 2. Will the use of a counterpoise in place of my usual ground connection enable me to tune out local stations?

A. 2. If your present ground connection has a high resistance, due to natural or created causes, the resistance should be less with the counterpoise, thus serving to sharpen the tuning of your aerial circuit by decreasing the damping. Whether you will be thereby enabled to tune out your local stations will depend upon the design of the remainder of your set.

R. C. A. TUBE DATA

(199) Mr. Joel Martin, Newark, N. J., asks;

Q. 1. Please give construction details of the Greene Concert Selector and the Splitdorf receiver.

A. 1. The schematic circuit of the Splitdorf receiver, and all available information in regard thereto, appears in an article starting on page 53 of the July, 1925, issue of RADIO REVIEW. All available information on the Green Concert Selector also appears in RADIO REVIEW, in an article starting on page 59 of the October, 1925, issue.

Q. 2. Is it possible to obtain a list of foreign broadcasting stations operating on wave-lengths below 550 meters? A list showing wave-lengths above this maximum appeared in the "I Want to Know" department of the December, 1925, issue of RADIO NEWS.

A. 2. The list of foreign broadcasting stations appears in the Summer Edition, 1927, of the Radio Listeners' Guide and Call Book, obtainable from the Book Department of RADIO NEWS.

Q. 3. Please state the particular usages of the new "UX" type tubes.

A. 3. The "tree" in Fig. 199 shows the particular uses to which the complete line of R. C. A. receiving tubes and auxiliary receiving tubes are best adapted.

CORRECT PHRASEOLOGY

(200) Richard Coleman, Sioux City, Iowa, wants to know:

Q. 1. Will you kindly decide for us which is the correct phrasing for a 201A, UV-199 or other receiving tube?

A. 1. While audions are often called tubes, lamps, valves, electron relays and bulbs, the proper phraseology would be to call them by their correct trademarked name such as UV-201A, UV-199, C-300, etc.

INTER-ELECTRODE CAPACITIES

(201) Jonas Kaufmann, Syracuse, New York, asks:

Q. 1. Will you kindly tell me the frequency limits and the inter-electrode capacities of the 201A tube?

A. 1. Due to the very nature of the questions you ask, we have referred your letter to the Director of the Research Department of the General Electric Co., Dr. W. R. Whitney, who writes as follows:

"As far as the tube itself is concerned, there is no lower frequency limit. The tube will amplify any frequency no matter how low and the lower limit at which it can be made to oscillate depends entirely upon the capacity, inductance and resistance of the circuit.

"As regards the high frequency limit, this is determined by the capacity between the tube elements and the length of wire in the tube and outside wires connecting these elements. These wires, no matter how short, have a certain inductance and this in combination with the capacity of the tube gives a certain natural electrical period, which represents the highest fundamental frequency that can be obtained from the tube oscillating in the usual manner. In the small standard Radiotron tubes available at the present time, it is probable that this limit is somewhat in the neighborhood of two or three meters. Utilization of harmonics, however, may allow this figure to be exceeded. These limitations, of course, apply only to the use of the tube in the usual forms of oscillating circuits employed in radio work. Some interesting experiments on very high frequency oscillations from tubes in which the ordinary types of circuits are not used have been described in the following references:

"Die kürzester, mit Vakrumrohren herstellbaren Wellen."
H. Barkhausen & K. Kurz,
Physihalische Zeitschrift,
January, 1920—Page 1.

"A Singular Case of Electron Tube Oscillations."
G. Breit,
Journal of the Franklin Institute,

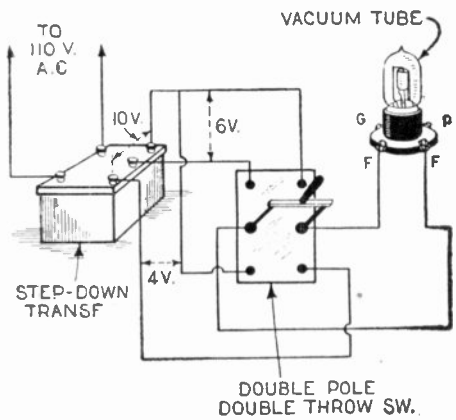


Fig. 198. If your tube stops functioning and you wish to renew its efficiency, use the above circuit to rejuvenate it.

March, 1924.

The inter-electrode capacities of the UV-201A average about the following values:

	Grid-Filament	Plate-Filament	Plate-Grid
UV-201A	—6.0 mmf.	6.0 mmf.	7.5 mmf.

These values are not arrived at mathematically but by actual measurement. There is little need or reason to calculate these values and they are obtained entirely by measurement."

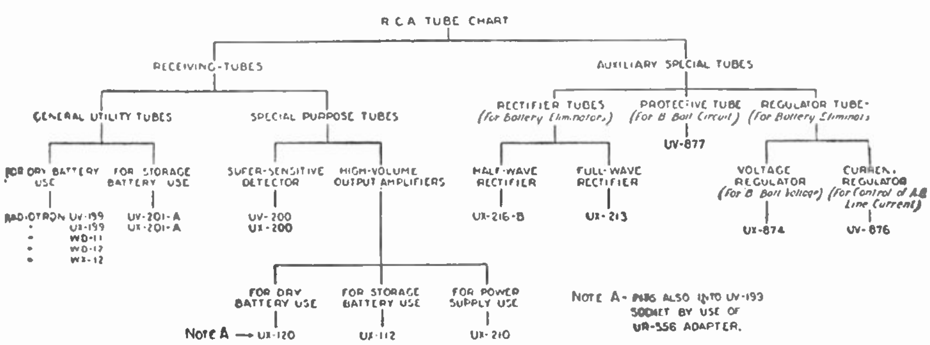


Fig. 199. This chart may be used to determine the best tube for receivers, both plain and those employing various methods of amplification, or using dry cells in place of storage batteries.

TUBES

(202) Martin Colitar, Oshkosh, Wis., wishes to find out:

Q. 1. Whether the "silver" coating on the inside of a tube affects its operation or is a means of determining its value.

A. 1. So many people are under the impression that an unsolved mystery lies in the use of the silvered coating used on the inside of a tube, that they are prone to believe if the coating is not completely deposited there is something wrong with it. This is far from being the case, the so-called silver deposit being a film of condensed magnesium.

In the process of evacuation, which is in itself a very difficult task in view of the fact that even the best air pumps cannot remove sufficient gas, a small piece of metallic magnesium is affixed to the plate of the tube. The plate is then heated using high frequency induction currents. Volatilization of the magnesium takes place, the matallic vapor absorbing the remaining gases, and upon cooling, condensing on the surface of

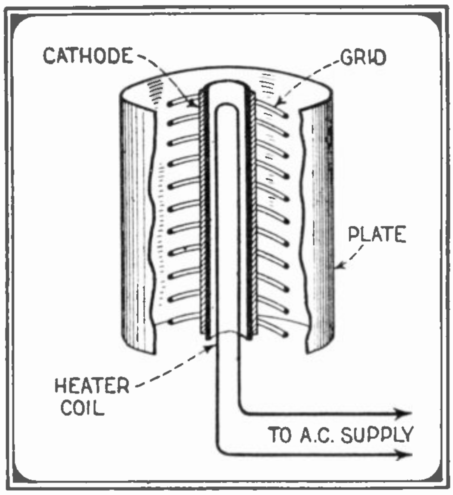


Fig. 206. This diagram shows in simplified form the internal construction of a new vacuum tube that operates on alternating current.

the tube. The condensation does not obey any fixed law as to where most of the deposit will occur, hence its irregularity.

TUBE TESTER

(203) Q. 1. Mr. A. Weinstein, Brooklyn, N. Y. Kindly give me the circuit of a reliable tube tester.

A. 1. The circuit diagram requested is given in Fig. 203. The key which is normally on the negative side of the "A" battery terminals allows the milliammeter to give a certain reading. When the key is depressed a different reading will appear on the milliammeter scale. The greater the change in this reading, the better the tube acts as an amplifier. If the change is less, the tube is a good detector.

COATED FILAMENTS

(204) Q. 1. H. Calames, Van Nuys, P. O., Calif., asks how the so-called coated filaments are made and of what they consist.

A. 1. The coated filaments in vacuum tubes consist of the tungsten wire which becomes incandescent upon the passage of an electrical current, which has been treated with a thorium compound, which forms successively films of oxide which, when subjected to the heat generated by the central core, increase the electronic stream discharged from the filament toward the plate, thereby rendering the tube more efficient in operation. The exact composition of the "coating" of these filaments is not available for publication.

TWO ELEMENT TUBE

205) Q. 1. Joseph G. Bartos, Dayton, Ohio, asks us to outline the advantages and disadvantages of employing a two-element vacuum tube in place of a crystal detector in a reflex circuit.

A. 1. The greatest advantage of such a change is that the two-element tube is very stable in operation and does not require the frequent adjustments that a crystal does. As to volume and selectivity, we would advise that there is possibly a slight margin in favor of the tube as a detector.

The principal disadvantage in using a tube detector is that a greater filament and plate consumption is required for the entire set and consequently the batteries must be replaced or recharged more frequently with the tube detector than with the crystal. However, this is the only noticeable disadvantage and the clarity and tone with either detector will be very good. We believe that you will obtain greater satisfaction from your set if the tube is used.

A. C. TUBES

(206) Q. 1. Eugene Davis, Minneapolis, Minn., asks several questions regarding vacuum tubes which operate on alternating current.

A. 1. We will answer all of your queries compositely. Our illustration in Fig. 206 shows in schematic form the disposition of the elements of one type of tube designed to operate on alternating current at a pressure of 6 volts, this current being supplied by a small step-down transformer. The current at a pressure of 6 volts heats the small heater coil indicated, whereupon the heat radiated through the insulating material imparts its warmth to the cathode or metal sleeve enclosing the insulating rod. This cathode gives off an electronic stream and the operation of the tube from this point onward is similar to that of any other type of tube. A grid and plate of usual design are included as shown. The one great advantage found in the use of a tube of this type is that the wiring in a receiving set using these tubes need not be passed by the Board of Fire Underwriters inasmuch as low voltage is employed. However, other tubes are beginning to appear which are designed to operate directly from the 110-volt line without any intervening transformer. We fear that trouble will arise from the use of these tubes inasmuch as every radio set manufactured to use these tubes will have to be made according to specifications laid down by the Board of Fire Underwriters and the incorporation of tubes of this nature in home-made sets will be a rather hazardous proposition unless great care is taken with the insulation of the 110-volt leads.

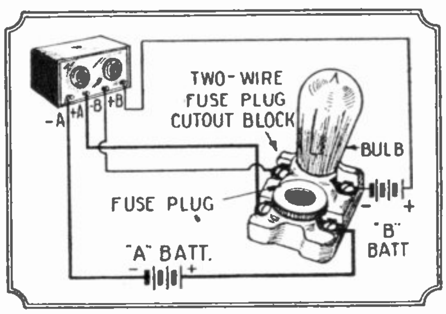


Fig. 209. One of the simplest methods of protecting the tubes of a radio set from being burned out is to place a current-controlling device in both the filament and plate circuits. Above, a 40-watt bulb is placed in series with the negative B-battery lead, with a small fuse in the A-battery circuit.

TUBES

(207) Q. 1. Charles Reiss, Ont., Canada, asks: What is the best type of detector tube for use in a three-tube receiving set?

A. 1. Any of the standard tubes on the market today will usually operate as detectors. It is best, however, to pick out one that operates well on a plate voltage of between 22½ to 45 volts. A tube that requires higher voltage than this for detection is usually not a good detector. A WD-11, WD-12, UV-199 or UV-201A that fulfills the above requirements will usually give good results.

Q. 2. What are the requirements for an amplifier tube?

A. 2. An amplifier tube should be capable of standing quite a high plate voltage without paralyzing.

BALANCING TUBES

(208) Q. 1. J. B. Bennett, Holton, Kan., asks how to determine what tubes will be best to use in certain parts of a Super-Heterodyne receiver.

A. 1. We would suggest that you try balancing your tubes in the following manner:

Remove all tubes from the set except the last detector tube and last intermediate radio-frequency amplifier tube. Light both tubes and keep all values constant, with the exception of the potentiometer. Varying the potentiometer arm should result in the production of a rushing sound, or a click, at one position of the arm. This denotes oscillation of the tube. Three tubes that oscillate at exactly the same spot (position of the potentiometer arm) are to be used as intermediate frequency-amplifier tubes. All tubes to be tested are placed in the last intermediate frequency-amplifier tube socket, one after the other, the one detector tube being used throughout the test. A tube that oscillates readily will make a good oscillator tube. Tubes that will not oscillate at all are not very good. After these general characteristics of your tubes have been found you may place them in the set in the positions determined as desirable for them.

PROTECTING TUBES

(209) Fred Heenan, White Plains, N. Y., asks:

Q. 1. Can you recommend any simple method of protecting the vacuum tubes of a set from actually burning out?

A. 1. This very simple method would no doubt be of interest to you. As you will see from the illustration on this page, a device is shown which comprises a double-fuse block which is arranged with a bulb in one side and a small fuse in the other, the values of both the bulb and the fuse depending entirely upon the current requirements of the set and the safety margin which is desired. This may be easily figured out by estimating, in the case of the "A" battery, the current draft for the tubes used. The bulb used in the "B" battery circuit is simply there to limit the current flow and to prevent burning out the tubes in case the batteries are incorrectly connected.

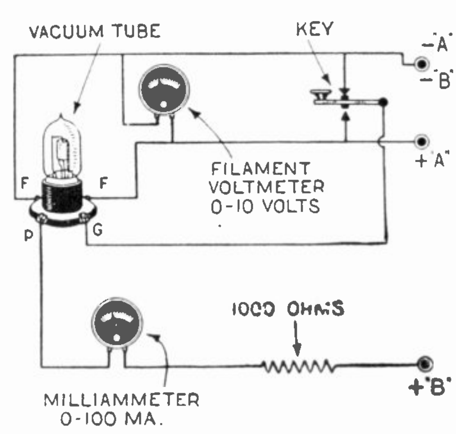


Fig. 203. When buying tubes be sure that they come up to highest possible standard. In order to ascertain this, construct a vacuum tube tester as shown above.

Amplifiers

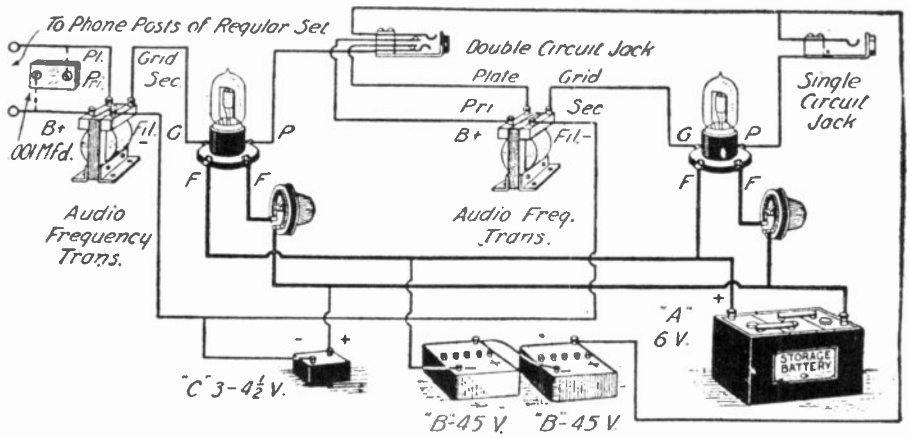


Fig. 212A. If this picture diagram is followed correctly, no one should have any difficulty in adding audio-frequency amplification to any set.

RESISTANCE PUSH-BALL AMPLIFIER

(210) Mr. Loren G. Briggs, McPherson, Kan., asks:

Q. 1. I have been unsuccessful in getting five regenerative receiving sets, each of three-tube type, to function with WD-11 tubes; what would be the reason for perfect operation with UV-201A tubes and yet correct operation with WD-11 tubes for a period of only about six hours, when the signals become inaudible?

A. 1. Your trouble is tube trouble. Your "A" battery must have been too high, or the tubes were defective. The WD-11 has a terminal voltage of only 1.1 volts and if supplied with the full output of a single dry cell, or single storage cell, without a rheostat, the tubes will shortly become inoperative. Often tubes so treated can be reconditioned.

Q. 2. Having found my three-tube, untuned primary, regenerative receiver, particularly satisfactory, I would like to add a stage of push-pull audio frequency amplification, using resistance coupling, to the stage of transformer amplification now used; what would be the circuit?

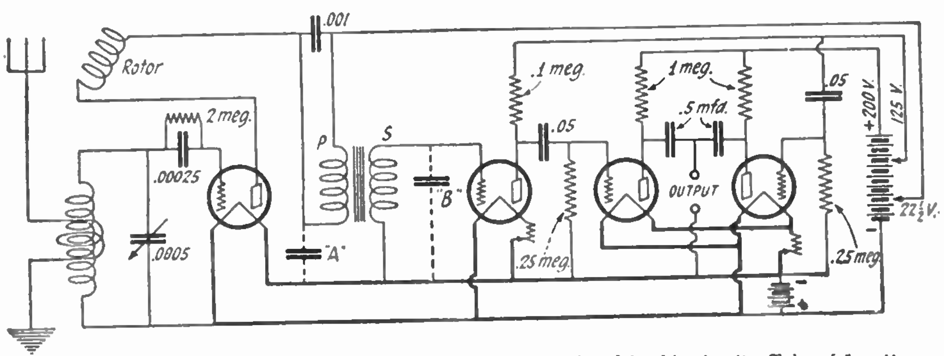


Fig. 210. Resistance Coupled Push-Pull Amplification is employed in this circuit. Tube of 5-watt size will be better than the usual type for the power tubes. Use a plate voltage of 500.

A. 2. The circuit you request will be found in Fig. 210. Condensers A and B will be found helpful for increasing the quality of reproduction from some sets. The correct values must be determined by experiment, but will probably be found to be between .002 mfd. and .006 mfd.

WAVE-TRAP

(211) F. E. Sturdevant, Columbus, Ohio, describes his receiving set and asks how he can place a wave-trap in the antenna circuit.

A. 1. Shunt an inductance coil of the required size across a variable condenser in series with the antenna.

SPECIAL PUSH-PULL CIRCUIT

(212) Mr. Lawrence Fazzano, Dumont, N. J., asks:

Q. 1. Please show a picture diagram of a two-stage audio-frequency amplifier that can be added to any receiving set, preferably to the detector tube of a regular regenerative receiver.

A. 1. We are showing a picture diagram of the amplifier you mention. Fig. 212A.

If standard six-volt quarter ampere tubes are used, the rheostats may each be of 30 ohms resistance.

If the vacuum tube sockets are marked "fil.—" and "fil+," these markings may be disregarded. It is often more desirable to connect an "A" battery negative or positive wire to a tube socket binding post marked just the opposite. Although sockets usually have polarity markings on the filament posts, as mentioned above, such markings are quite unnecessary in practical use.

The ratio of the audio-frequency transformers should not be too high, otherwise distortion may be too great. A ratio of about 4:1 for the first transformer and about 3:1 for the second transformer is usually a good combination. However, individual transformers vary greatly in their characteristics and in consequence it is often possible to use altogether different ratios, with very satisfactory results.

It is occasionally desirable to use a variable resistance connected across the secondary of the first and second audio-frequency transformers to improve the quality.

Also, a fixed condenser of one or two mfds. sometimes assists greatly to reduce battery noises, when connected from "B" plus to "B" minus.

Whether a fixed condenser (usually of about .001 mfd.) is required across the primary of the first audio-frequency transformer (as shown by the dotted lines) will be governed by the particular conditions of your receiving circuit and first audio-frequency stage equipment.

Q. 2. Please show a picture diagram of an amplifier having two stages of audio frequency amplification, both of the push-pull type.

A. 2. For such a circuit it is necessary to use a special coupling transformer having a center tap on both the primary and secondary windings.

A push-pull amplifier of two stages will require four tubes. An amplifier of the usual type, consisting of two stages, would require only two tubes. However, by using the system shown in Fig. 212B one is assured of extreme quality and high amplification. Still greater volume is obtained by using a "B" battery potential as high as 150 volts, with a "C" battery voltage of nine to twelve volts.

Q. 3. Is it necessary to use this type of amplification after one stage of the usual audio frequency amplification?

A. 3. The special push-pull amplifier connection shown in the picture diagram can be used to **amplify directly the output of the detector tube** of a set. However, unless this detector tube is preceded by one or more stages of radio frequency amplification, it will be more economical to use one stage of regular transformer coupled audio frequency amplification and then one stage of the push-pull type.

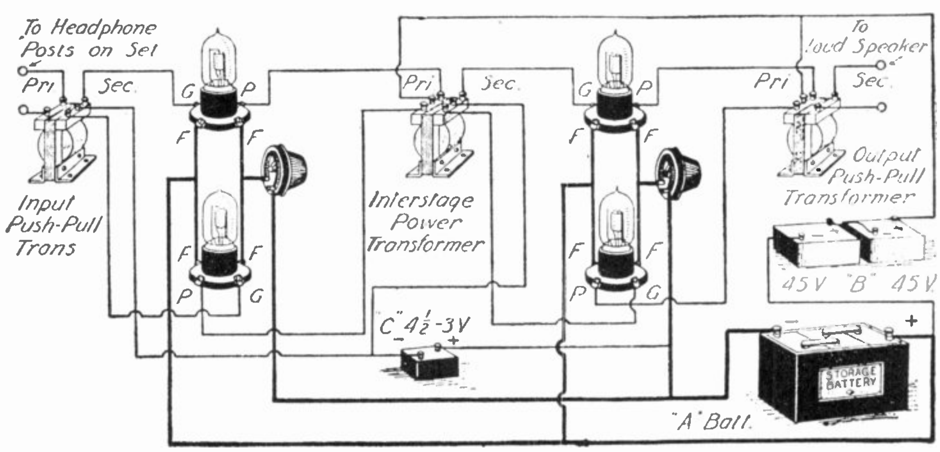


Fig. 212B. This circuit shows how to connect two stages of audio-frequency amplification, both of the push-pull type. A special "interstage" transformer is required.

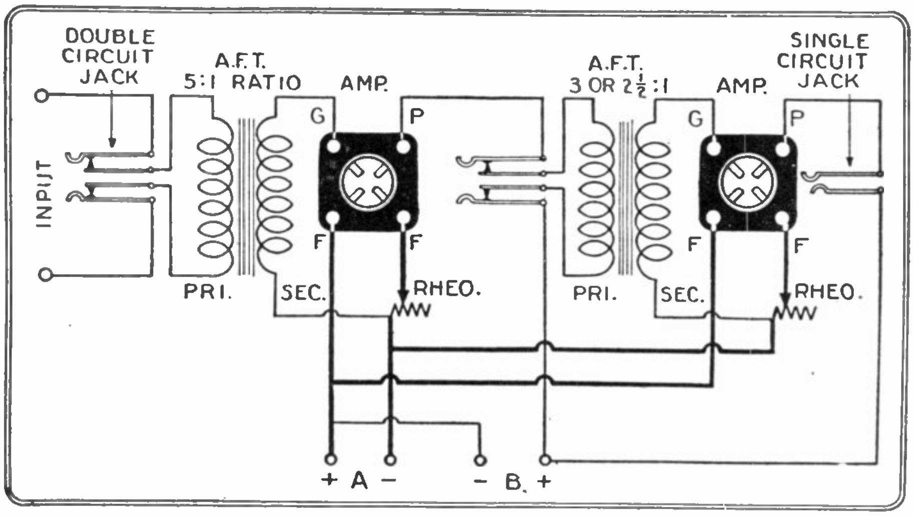


Fig. 214. The circuit diagram of a conventional two-stage audio amplifier, with jack connections after each stage. This amplifier may be added to a one-tube receiver, or any other type in which audio-frequency amplification is desired after a detector tube.

IMPROVING THE AUDIO UNIT

(213) Mr. Dale Kelly, Pelham Manor, N. Y., asks:

Q. 1. I have a very efficient modified Reinartz set but have no success with the one stage audio-frequency amplifier I have added to it. The signal strength is exactly the same as with the detector alone. Am using UV-199 tubes, 67 volts "B" potential and a 3:1 ratio audio-frequency transformer. What can I do to get increased signal strength?

A. 1. Remove batteries before making any tests not requiring the "A" and "B" potentials.

You may have a poor amplifier tube; test your amplifier tube in another set. The lead from the tube grid to the audio-frequency transformer secondary is called the grid lead; the remaining secondary connection post connects to the "A" battery and the connecting wire is called the grid return lead. This grid return lead may be connected, in your receiver, to "A" plus. This will give the effect you mention. The grid return lead should be connected to "A" minus. If a "C" battery is used the grid return lead should connect to "C" minus (negative).

Try removing the fixed condenser you now have connected across the primary of your audio-frequency transformer.

If convenient, try another audio-frequency transformer. The one you now have may be open-circuited, short circuited or grounded. To test for an open circuit, connect either post of a dry cell to one cord tip of a pair of head-phones. There now remains one cord tip and one dry cell post unconnected. It may be advisable to remove the set wires from the primary and secondary. Connecting the free phone tip to one end of the primary and the free dry cell tip to the other end should result in a click of considerable strength. This shows the primary circuit is not broken. It may be short-circuited but this requires a different test, and is not a usual fault with defective transformers. This test for open circuit may now be applied to the secondary. Occasionally, some transformers will give a click, even though there is a break in the winding, but this click is so slight that it is not easily heard.

To test for a ground, remove all wires from the transformer and connect one free end of the test set to either primary connection, and the remaining end to either secondary connection. If a strong click is heard, the windings are connected, which should not be the case. If a very slight click is heard it may be regarded as the natural charge and discharge click of the condenser formed by these two windings. This does not denote a fault. Either the primary or secondary may be grounded to the metal casing of the transformer and this is readily tested by touching the casing with on free end of the test set, and first one then the other winding, with the remaining test set end. Only an extremely slight click should be heard. Use a detector plate circuit R. F. choke.

To test for a short circuit it is necessary to connect the transformer into the set. If, now, the two primary binding posts are tightly pressed with the fingers, the signal strength should be considerably reduced. The result should be similar when testing the secondary in this manner. If there is no noticeable difference then there must be a leakage having a resistance of the value developed by the pressure of your fingers, or even less. Such a resistance usually takes the form of partly conducting binding post panels. A fibre strip for these binding posts is often the cause of trouble, although good fibre is satisfactory for the purpose mentioned above.

A jack partly shorted by soldering flux will give you the same result.

Be sure the tube prongs are making good connection to the socket springs.

The jack spring may be making poor contact.

Q. 2. May dry "B" batteries be connected in series with storage "B" batteries?

A. 2. Yes. It is not advisable unless a high resistance voltmeter is used for checking battery voltages. The potential of a 32-volt or 110-volt D. C. lighting current may be increased by connecting a "B" battery in series, where the drain is slight, as when supplying plate current for a receiving set.

Q. 3. Why is a one-wire aerial better than a two-, three- or four-wire aerial?

A. 3. For transmission, the four-wire aerial is better. For reception, there is very little difference in the result and the one-wire aerial is cheaper and easier to install and maintain.

TWO-STAGE AUDIO-FREQUENCY AMPLIFIER CIRCUIT

(214) Mr. J. L. Sherman, Logan, Ohio, asks:

Q. 1. I have at present a one-tube regenerative receiver which operates remarkably well. I would like to add a two-stage amplifier to it so that a loud speaker may be used. Can you supply me with a diagram showing the method of connecting the various instruments together?

A. 1. The diagram you request is shown in Fig. 214. Jacks are used after the detector, first, and second stages, so that any number of tubes within the receiver may be used.

Q. 2. Would it be advisable to add a stage of radio frequency amplification so that greater distance may be obtained, or would you advise constructing an entirely different receiver? The present receiver's range is limited to approximately 1,000 miles, varying with conditions. Would like something more consistent.

A. 2. Radio frequency amplification will enable your receiver to obtain stations that are far distant, its range being dependent upon the number of stages of this type of amplification that are employed, besides several other minor factors. We refer you to the Browning-Drake receiver published in the February, 1926, issue of Radio News, which incorporates a stage of neutralized radio frequency amplification along with a regenerative detector, and two stages of audio frequency amplification. Perhaps you can rebuild your present receiver into this type which is unusually efficient and popular. We cannot advise exactly, since you do not state the particular circuit characteristics of your set.

NOISES

(215) Q. 1. Mr. A. Keil, New Orleans, La. How may the noises which occur in an audio frequency amplifier be reduced?

A. 1. It is possible to reduce to some extent the noises from an audio frequency amplifier by connecting a .001 mf. condenser across the primary of the first audio frequency transformer, by connecting a small by-pass condenser of about the same capacity across the secondary of the second audio frequency transformer, or by placing a variable resistance across the secondary of the first audio frequency transformer. This resistance should be of the order of 5,000 to 25,000 or 30,000 ohms.

CHOKE COIL COUPLED AMPLIFIER

(216) Q. 1. Wm. Stone, Mansfield, Ohio, requests a circuit diagram of a three-stage, choke coil coupled amplifier to be added to standard one-tube circuit.

A. 1 We are giving in Fig. 216 the circuit of a three-stage choke coil amplifier which can be added to your particular type of set or any other standard receiving set. Be sure that your battery polarities are correct.

RADIO-FREQUENCY TRANSFORMERS

(217) Q. 1. R. Benson, Union City, N. J., wants to do some experimental work with radio-frequency transformers, particularly toward the determination of the most efficient number of turns for a given band of wave-lengths. He asks what type of form to use for this work.

A. 1. While an ordinary insulating tube may be used for this purpose, a more compact form, and one which is easier to wind, may be made as shown in diagram marked Fig. 217. This may be turned on a lathe from 2-inch stock or may consist of seven discs of ⅜-inch thick wood bolted together as shown. In the latter case, four of the discs will be 2 inches in diameter and three of them will be 1¼ inches in diameter.

For experimental use, wind the primary in the center slot and the secondary in two halves, each half in a slot on opposite sides of the primary. With a form of this kind you can experiment with the number of turns to your heart's content.

INPUT TRANSFORMER

(218) Q. 1. L. M. Whaley, Augusta, Ga., wants some information for the assembling of an input transformer of the tuned type which will match intermediate frequency transformers that he has on hand. This is for use in a superheterodyne.

A. 1. We would suggest that you use two honeycomb coils. They may be of 600 turns and 1,000 turns for the primary and secondary, respectively. The primary is shunted by a variable condenser of .0005 mf. capacity. The secondary is shunted by a very small condenser of less than .00025 mf. capacity. We would suggest a capacity of .00015 mf. This condenser may be fixed.

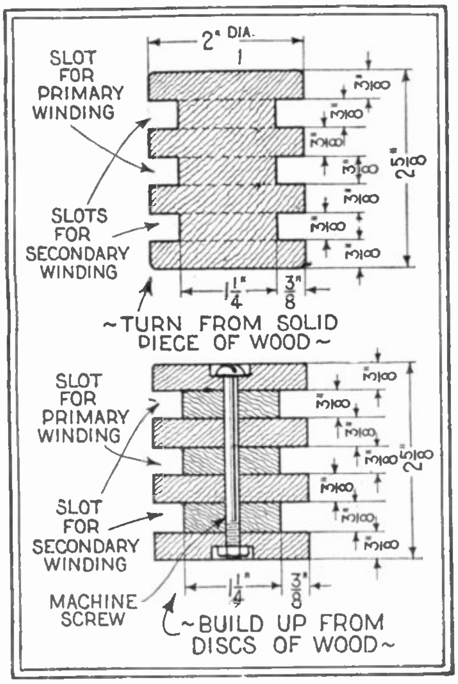


Fig. 217. The experimenter will find much of interest in constructing various sizes of radio-frequency transformers. A form such as the one illustrated will aid materially in this work.

AMPLIFIER TROUBLE

(219) Q. 1. Aaron L. Abel, New London, Wis., says that his radio receiving set works very nicely on the detector alone, but that his amplifier will not work at all. He says that his circuit is hooked up correctly and that all wiring is perfect. He asks our opinion as to his trouble.

A. 1. If your circuit is hooked up exactly right and your tube lights, we would say that one of your transformers is burned out, or that a connection is broken inside the same. We would suggest that you test all the transformer windings for continuity by means of a dry cell and a pair of phones, after removing the exterior connections to the transformer. Also look over your wiring again and test each instrument in the circuit. It may be that loose contacts are present in the bases of your tubes or that good contact is not being made between your prongs and the springs of your sockets. Look in all these places for the trouble and we are sure that you will locate it. In some cases a by-pass condenser of .001 to .006 mf. connected across the primary of the first audio-frequency transformer will spell success instead of failure.

VOLUME CONTROL

(220) Q. 1. D. B. Browilow, Middletown, Conn., asks: What value of variable resistance should be used for controlling the volume of a second stage amplifier, when it is connected across the primary or the secondary of the second audio-frequency transformer?

A. 1. The The resistance you mention should have a variable value of from 10,000 to 100,000 ohms.

PUSH-PULL RESISTANCE COUPLED AMPLIFIER

(221) Q. 1. Alexander Stuart, New York City, has been experimenting with push-pull amplifiers employing resistance coupling, but does not seem to get any particular results. He asks us to publish what we consider to be the best circuit for this work.

A. 1. The requested circuit diagram will be found in Fig. 221. We know an ordinary three-circuit coupler used for tuning and one stage of audio-frequency amplification, transformer coupled, between the detector and the first resistance-coupled amplifier. All of the values for the resistances and condensers in the push-pull circuit are given on the drawing. It is preferable to use power tubes in the last two sockets and employ up to 425 volts to the plates. This will give great volume with little distortion.

RESISTANCE COUPLED AMPLIFIER

(222) Q. 1. Frank Staats, LaCrosse, Wis., asks: Can such an arrangement as a two-stage resistance coupled amplifier be made up and if so, please show a diagram of the same, giving all the constants for the various parts.

A. 1. It is entirely possible to make up an amplifier of this nature, although it will not give as much reproduced volume as a standard two-stage transformer

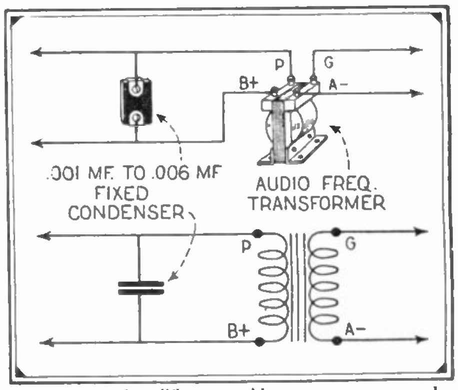


Fig. 219. Amplifier troubles are many and varied, but some of them can be alleviated by the addition shown above.

coupled amplifier. However, the reproduced music and voice will be somewhat clearer with this type of amplifier. You will find the required diagram in Fig. 222 and the constants are given here. We have shown the diagram with all the binding posts indicated that will be necessary to use in order to make up a two-stage unit to be added to any type of radio receiving set. The resistors, R1 and R2, should have an average value of 100,000 ohms each. The condensers, C, and C1, should have a capacity of .006 mf. each. The resistor, R1, should be a 1-megohm grid leak and the resistor R3 should have a resistance of ¼ of a megohm. These values are given for standard UV-201A or UX-201A tubes. With such tubes, the "B" battery voltage applied to the audio amplifiers should be on the order of 135 volts. The detector voltage may be determined by experiment and should be between 22½ and 45 volts.

T. R. F.

(223) Q. 1. George Rayner, Newark, N. J., wants to know: Do you consider a variometer to be superior to an inductance coil and variable condenser for use in a tuned radio frequency receiver, where one or the other of the instruments are to

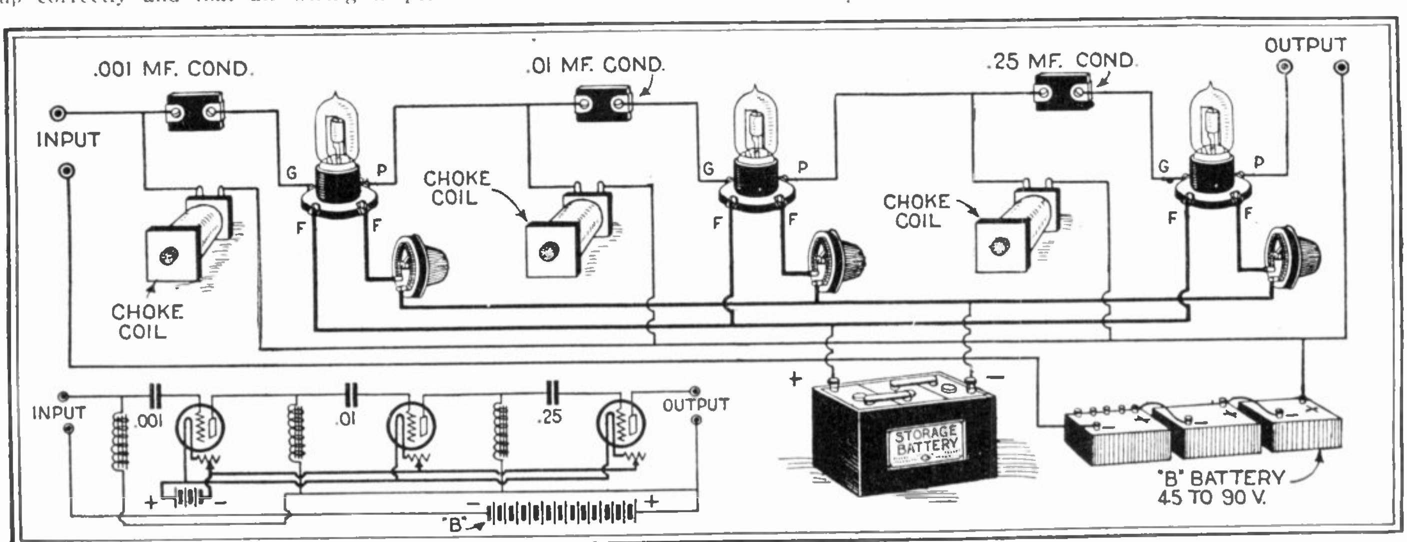


Fig. 216 The choke coils in the above circuit may consist of approximately 10,000 turns of No. 36 enameled wire, wound on a 1/2-inch iron wire core 3 inches long. Suitable end plates should be provided. If desired, the secondaries of small spark coils may be used as the chokes.

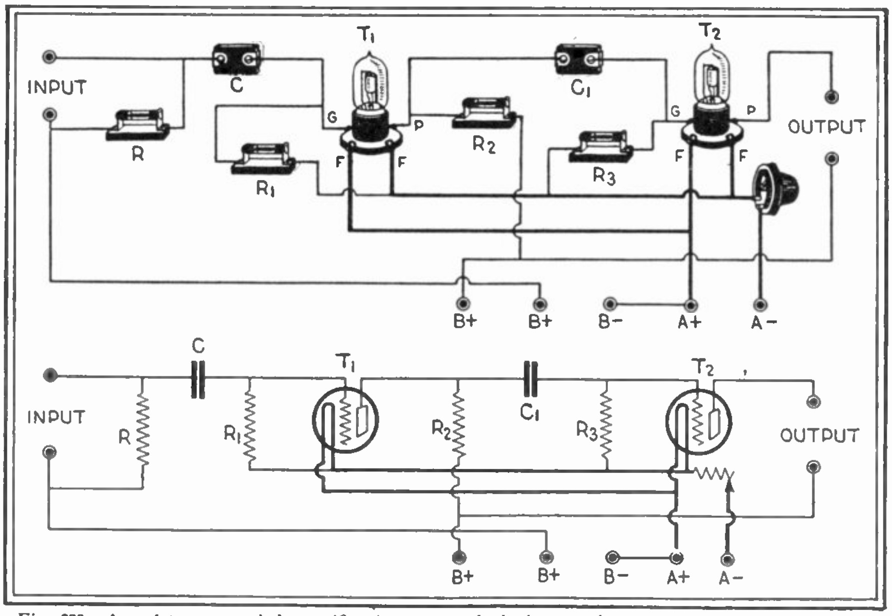


Fig. 222. A resistance-coupled amplifier is comparatively inexpensive to construct and two stages will give fair volume although not as much as a two-stage transformer-coupled amplifier. The above diagram shows a standard two-stage resistance-coupled amplifier.

be used as the tuned radio-frequency transformer?

A. 1. No, we do not. A tuned radio-frequency receiver employing single layer inductance coils and variable condensers for tuning them will usually be found far superior in many ways to a similar type of receiver using variometers for the variable tuning units. The variometer set will be found to be much broader in tuning than the other type.

RESISTANCE VERSUS TRANSFORMER

(224) Q. 1. F. G. Nicholas, McCleary, Wash., asks us to compare a three-stage resistance coupled audio-frequency amplifier with a two-stage transformer coupled unit.

A. 1. While a three-stage resistance coupled amplifier will give clarity far excelling the ordinary two-stage transformer coupled audio-frequency amplifier, their volumes will be about equal one to the other.

EFFICIENT VOICE AMPLIFIER

(225) Q. 1. G. Dusson, Cincinnati, Ohio, wants to know how to amplify the sound picked up by a Skinderviken or similar microphone transmitter button.

A. 1. The diagram given in Fig. 225 has been found very effective for all types of amplification at voice frequencies, particularly in the case being considered, where the current to be amplified originates in a microphone circuit. The amplification is sufficiently great to make it possible to use the apparatus in many interesting experiments.

INTERMEDIATE FREQUENCY TRANSFORMERS

(226) Q. 1. Mr. H. R. Lash, Sault Ste. Marie, Ont., writes us concerning intermediate frequency transformers in his superheterodyne.

A. 1. If you find that you hear stations at more than two points on the oscillator dial, it would seem to indicate that the various intermediate frequency transformers are not tuned alike. You should be able to get some radio expert in your city to check these up for you.

In the first place you require an accurately calibrated wavemeter and the wave-length to which the transformer is tuned is to be adjusted by varying the capacity of the condenser shunted across it.

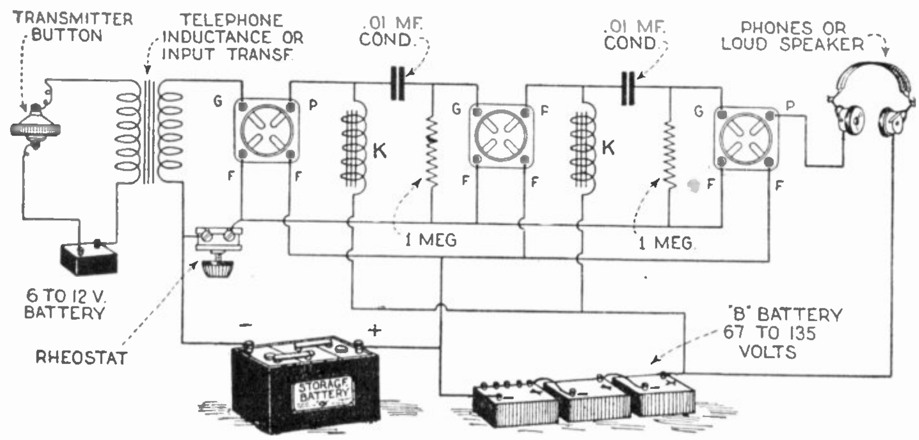


Fig. 225. The amplifier shown here is designed to build up the sound picked up by a microphone so that it will operate a loud speaker. Impedance coupling is used to reduce distortion, and the amplification obtained is about equivalent to two stages of transformer-coupled amplification.

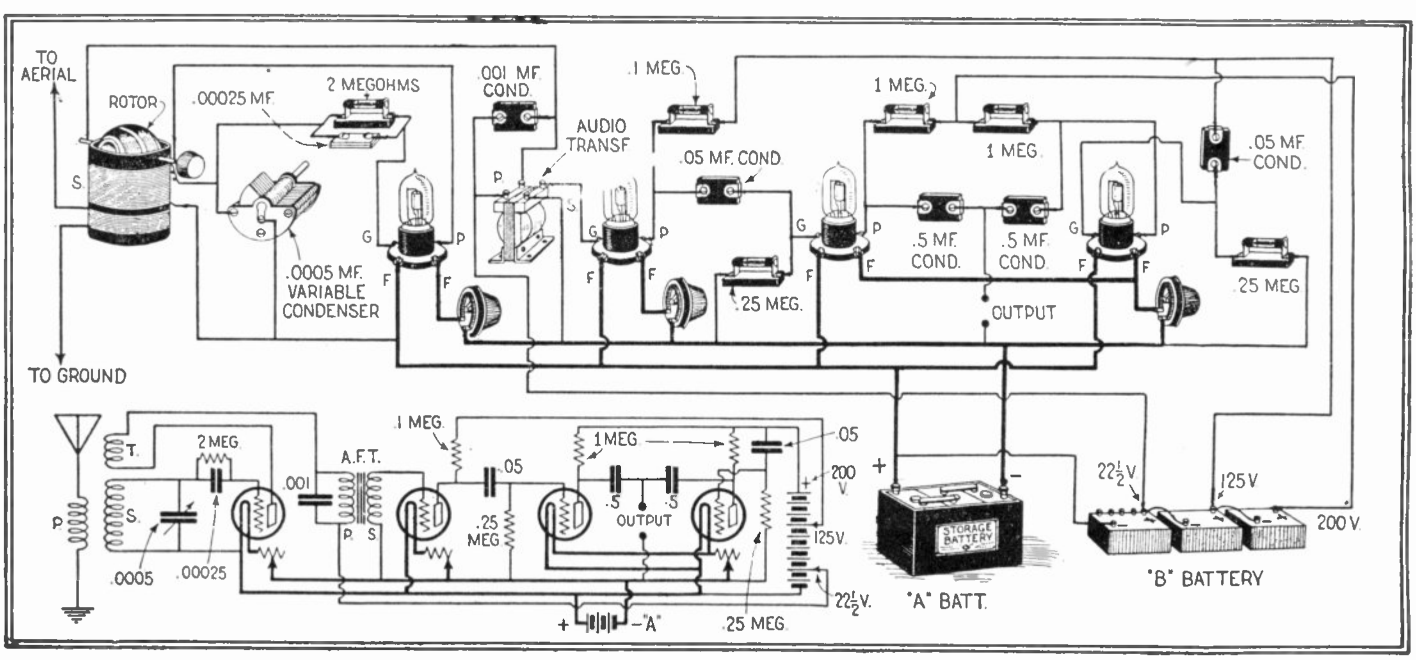


Fig. 221 Resistance-coupled audio-frequency amplification is claiming quite a bit of attention in the radio world today, and above we show a very unusual circuit employing resistances for coupling vacuum tubes together in a push-pull audio-frequency amplifier circuit. Since all of the values are given in the schematic and pictorial circuits, the interested experimenter should find no trouble in trying out this circuit.

Miscellaneous Apparatus

VARIABLE CONDENSERS

(227) Mr. Fred Klug, Jr., Boonville, Mo., asks:

Q. 1. Why does the tuning sharpen considerably when 43-plate condenser is substituted for the 23-plate condenser in my set?

A. 1. This is because a change of one degree in the position of the rotor plates moves twice the number of plates as before. Having twice the surface, it will cover twice as wide a wave-length band as previously. In other words, you will be able to tune to any station previously heard, as well as those in an additional wave-length band nearly equal to the original band. We wish to mention that there is a possibility of your not being able to receive all the stations at the very lowest setting of the 43-plate condenser. This is explained by the fact that the minimum capacity has been increased by the greater number of plates in relation at the lowest capacity setting. If desired, a very small fixed condenser may be inserted in series with the variable condenser. It will reduce both the minimum and maximum capacity obtainable from the 43-plate condenser.

Q. 2. What plate voltage is required for the oscillator of Super-Heterodyne?

A. 2. It is seldom that more than 45 volts are required. Often 20 to 25 volts are sufficient.

Q. 3. What are the "boiling" and "baking" methods for tube reactivation?

A. 3. In the boiling method a voltage of approximately 10 per cent. in excess of the terminal voltage of the tube is applied to the tube filament for a period of from two to 15 hours, without the plate potential being applied. It is no longer necessary to continue the process if after a period of a few hours the tube is found to function satisfactorily when the plate potential is applied, with the tube placed in the regular receiving set.

In the "baking" method the tubes are placed on their sides in a granite-ware dish in an oven hot enough for baking bread. After 30 minutes they are taken out and allowed to cool off, then placed in the set and filaments lighted for 15 minutes with the "B" battery disconnected. At the end of this time the filament current should be suddenly cut off. This heating and cooling will repair many tubes. This is the oven treatment.

FILTER AND TESTING CIRCUIT

228 Mr. Herbert Chamberlain, Plainfield, N. J., writes:

Q. 1. I understand there is a special filter circuit for sharp tuning. Kindly show this diagram.

A. 1. The filter circuit you mention will be found in Fig. 228. Vernier condensers or attachments will probably be found necessary with this arrangement. The amount of energy transferred is controlled by the variable resistance. The inductive relation must be as shown in the diagram. One is assured of an exceptionally selective regenerative receiver, if this construction is followed.

Q. 2. Why does my potentiometer smoke (two of them have burned out) when connected up?

A. 2. You may have an imperfect instrument. Usually, though, it is an entirely different cause. If the potentiometer arm and one end of the potentiometer winding are connected across the "A" battery and the switch arm placed so that only a few turns are included in the circuit, the fine wire, unable to carry the current, will fuse (burn out). Only the two outside ends of the potentiometer winding should be connected across the battery, (switch arm going only to the grid return lead). The total resistance of the entire winding is so high that it cannot fuse or melt under this, the correct, connection.

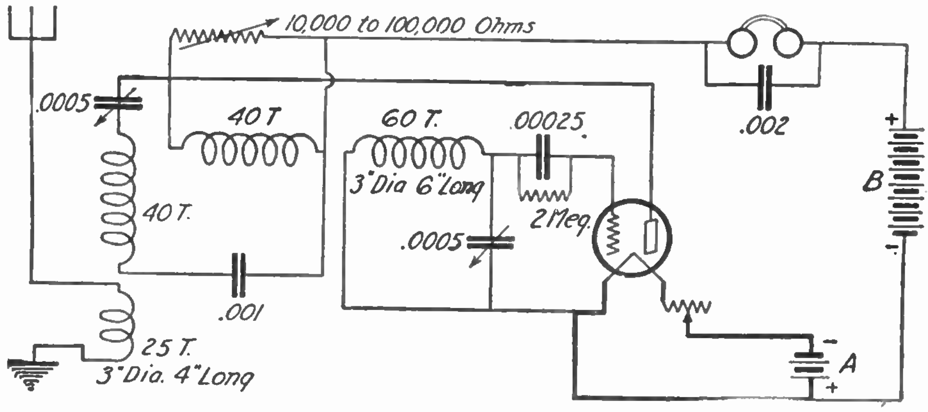


Fig. 228 The increasingly popular Filter Circuit is seen to be that of an exceptionally sharp-tuning, complete receiver. Careful instrument layout, careful construction and good apparatus will be required for best results.

CRYSTAL DETECTORS

(229) Mr. D. G. Burnside, Detroit, Mich., asks:

Q. 1. It seems very difficult to get the 4 mfd. condensers required for the A.C. adapter described by Mr. Florian J. Fox, in the Stptember, 1924, issue of RADIO NEWS.

A. 1. Two 2-mfd., or four 1-mfd. condensers, connected in parallel will have the same capacity.

Q. 2. What type of resistance should the 5,000 ohm resistance be?

A. 2. A Lavite resistance should prove satisfactory in this position.

Q. 3. Is is true that the buzzer test is not always the best way of locating a sensitive spot on a detector crystal?

A. 3. Many times the test buzzer signals will be received clearly, while station signals cannot be received satisfactorily without a readjustment of the detector.

Also, a station may be heard very satisfactorily and yet the test buzzer may not be heard with maximum intensity.

Sometimes different stations will be received best at different points on the crystal.

CONSTRUCTION OF CONDENSERS

(230) Mr. Rofier G. Cooper, Fredericton, N. B., Can., asks:

Q. 1. Can radio frequency amplification be added to a Flewelling receiver?

A. 1. It has not been successfully accomplished as yet. It may be physically possible to do so.

Q. 2. Does the filament of the UV-200 tube consume 5 watts in one second, one minute, or one hour?

A. 2. Time is not a factor in this case.

Q. 3. Would there be any saving over the list price of a ½ mfd. condenser, if same was constructed?

A. 3. These condensers are now manufactured in such an efficient manner that production costs are very low, resulting in a low retail price. We would not advise you to construct a condenser of this size under these conditions.

SOLDERING

(231) Mr. LeRoy Johnson, Aberdeen, N. C., asks:

Q. 1. Can the use of acid-core solder be the cause of a set not functioning properly?

A. 1. Possibly. It depends somewhat upon what is being soldered and the way in which the soldering is done. In general it is very inadvisable to use acid flux for any kind of soldering in connection with radio apparatus.

Q. 2. What would be a satisfactory method for soldering radio instruments and wiring?

A. 2. First, have a real hot soldering copper (called a soldering "iron"). This "iron" should not be allowed to turn red, as this causes the "tin" to burn off. To make a satisfactory connection the hot iron should be applied to the work, so as to heat the work before the solder is applied. When the solder on the iron seems to be taking hold of the surface to be soldered, the solder can be applied. If a resin core flux is used, no other flux is usually necessary to make the solder stick.

In order for the iron to work properly it is necessary that it be well "tinned." The simplest way to make sure of this is to have a large sheet of tin handy, also a jelly glass of muriatic acid which has been "killed" by the addition of sufficient scrapings of zinc to prevent the further formation of bubbles when more zinc is added. By heating the iron to almost a red heat, then quickly dipping it into the acid, the iron will readily become coated with a film of solder, when the iron is rubbed around on the sheet of tin, on which are pieces of solder. A file sometimes assists the process. No flux is used in this operation, the acid treatment being sufficient for the purpose. When all sides of the iron have become coated with a film of bright solder, the iron is "tinned" and is ready for use; without the tinning, solder will not stick to the soldering copper and the soldering copper will not heat the work.

Beware of soldering "pastes." They sometimes cause more harm than good. There are several good soldering pastes on the market, but they must be used judiciously. An excess may form a leakage path just where it is not wanted. A little care and thought will be all that is necessary. Capilliary attraction sometimes causes conducting fluxes to creep into undesirable places. Sometimes, too, it will spatter into the wrong spot.

Acid flux, even though "killed" in the manner described above, is not desirable because it often causes poor connections to develop, due to a slow corrosion. On small work, such as soldering wires, smaller than size 30 B. & S., it often eats entirely through, causing an open circuit.

Salammoniac strongly attacks the soldering iron, quickly rendering it unfit for use.

The best flux, resin, may be used as the core of the solder, as mentioned in the first paragraph, or it may be made into a convenient solution, as desired. The solution is made by dissolving resin in alcohol until the desired density is secured. It is applied with a brush and the soldering is done immediately. In either case, excess resin should be removed with alcohol and a brush or cloth, after the soldering is completed.

If the work to be soldered is easily movable, see that no motion takes place until a few seconds after the solder has clouded. If thick metals are being soldered, the pieces should be held immovable until the solder has thoroughly hardened.

When the job is done, move the pieces to see if the union is perfect. A juncture seemingly perfect can cause much inconvenience if it is not so.

Keep the iron clean and have a cloth handy for this use.

Q. 3. What are the characteristics of the Magnavox Type A tube?

A. 3. Filament voltage, 5; amperage, .20 to .25 amp. Plate volts, 60 to 120. Amplification constant, 8 to 12. Mutual conductance, 800 to 1,200 micromhos. Standard base. It is a three-element tube with an unusual design of grid.

CONDENSER DATA

(232) Mr. G. H. Lynch, Plano, Texas, asks:

Q. 1. What is a "grounded frame" condenser?

A. 1. A condenser having both movable and fixed plates entirely insulated from the frame. The frame may thus be grounded, without materially affecting the operating characteristics of the condenser. If the frame is connected to the point of lowest potential, no capacity effect is possible.

Q. 2. What is a "grounded rotor" condenser?

A. 2. A condenser whose movable plates are connected to the frame. The capacity effect possible is governed by the circuit, since it is not possible to place the frame at a potential lower than the potential of the movable plates.

Q. 3. What is the "square law" of variable condensers?

A. 3. That the change in capacity is directly proportional to the change in the relation of the movable and stator plates.

HARD RUBBER DATA

(223) Mr. John Knox, Bensonhurst, Brooklyn, N. Y., asks:

Q. 1. What are considerations to be observed in the drilling and sawing of hard rubber?

A. 1. When drilling hard rubber, use drills of the best, high carbon steel variety. Grind the drills frequently. Drill ends should be at an angle of 45 degrees. Use a drill speed of 1,500 r.p.m. for holes under 3/8-inch size. Use a speed of 800 r.p.m. for sizes up to 3/4-inch and a speed of about 300 r.p.m., depending upon the size, for holes larger than this. A very satisfactory lubricant, to prevent over-heating, is soda and water. When sawing this material for small work, use a hack saw having 24 teeth per inch. For large work a circular saw is not as satisfactory as most people would suppose. A cutting wheel is much more satisfactory. If quantity work is to be done, we would advise you to communicate with the manufacturer whose material you intend to use.

Q. 2. While operating the radio set owned by a friend, a very peculiar effect was observed. When receiving the signals from a given station, the signals are clear and loud. Now, it is not possible to rapidly change the dial settings and hear other stations; the dials must be adjusted slowly. If the dials are turned quickly to a setting upon which a station is heard broadcasting it will be several seconds before the station is heard and gradually reaches maximum.

A. 2. One of your tubes is blocking. If you have any grid leaks in the set, such as a detector leak, try others in place of the one now in use. Look your connections over very carefully to make sure that every tube is connecting to the socket springs and that the grid and grid return leads are connecting to their respective points in the set. Some one of the tubes in your set has an open grid circuit. The grid inside the tube is continually receiving a charge of negative electricity from the negative electrons leaving the heated filament. This charge would ordinarily leak off, through the circuit, to the filament from which it started, if the circuit was complete, but it is prevented from so doing if the circuit is open. A normal, slow leakage would take place, but this would delay the amplifying action of the tube, resulting in the effect you name. This "blocking" action often takes place at a more rapid rate, producing a slow or fast clicking.

Q. 3. How many kilocycles are allowed to a broadcast station, to include every audible frequency transmitted?

A. 3. A frequency band 10 kilocycles wide is required to include all the audible frequencies.

If the carrier wave of one broadcast station is less than 10 kilocycles from the carrier wave of another station, the high audio notes, first, of the one station, will overlap the high audio notes of the other station.

BUS BAR WIRE

(234) Miss Ann Sempere, New York City, asks:

Q. 1. Is square or round bus wire best for wiring up a set?

A. 1. It makes no practical difference whether one or the other is used.

Q. 2. Can an indoor aerial be used with a Neutrodyne receiver?

A. 2. Excellent reports have been received from radio fans who have used indoor aerials, not only with Neutrodyne sets, but with other types of sets as well.

Q. 3. What is the need for insulators in mast guy wires?

A. 3. The need for guy wire insulators is greatest when the aerial is being used for transmission. The guy wires absorb a certain amount of energy radiated from the aerial, and this absorption is quite considerable when the guy wires approach resonance with the aerial circuit. Breaking the guy wires up into short lengths greatly reduces this absorption.

Q. 4. What are the symptoms of too much grid leak resistance and insufficient grid leak resistance?

A. 4. Too much grid leak resistance insulates the grid from the filament and the result is a slow or fast clicking sound. Received signals are broken up a few, or sometimes several thousand, times a second.

Insufficient grid leak resistance results in reduced signal strength. If the resistance is too low the tube will not work.

For weak signals, the grid leak resistance must be higher than when strong signals are being received. If the grid leads will not be too long thereby, it is almost always of advantage to use a variable grid leak arranged to be controlled from the panel.

NEUTRODYNES

(235) Mr. N. J. King, Boston, Mass., says:

Q. 1. Please list the trade names of the Neutrodynes licensed under the Hazeltine patents.

A. 1. The following 14 Neutrodyne receivers are licensed under these patents:

Amrad	Howard
Carloyd	King-Hinners
Eagle	Murdock
Fada	Stromberg-Carlson
Freed-Eisemann	R. E. Thompson
Garod	Ware
Gilfillan	Workrite

Further information relating to these receivers may be obtained by writing to the Advertising Department of Radio News.

Q. 2. How can my Neutrodyne be adjusted so as to shift the dial readings further forward? KSD is received at about 120 on the dial. Would like to receive this station at about 195 on the dial.

A. 2. Changing the capacity or changing the inductance will control the wavelength. If it is not convenient to change the variable condensers to others having a lower maximum capacity, you may reduce the number of turns of the secondaries of the neutroformers. If the secondary windings are changed and difficulty is experienced in neutralizing the set, it may be necessary to reduce the number of turns in the neutroformer primaries.

Since you do not state the capacities of the variable condensers used, or the constants of the neutroformers, we cannot furnish specific information.

Q. 3. Why is it that a Neutrodyne constructed with standard parts does not neutralize when using UV-199 tubes? The neutrodons have no effect and the circuit will not oscillate.

A. 3. The neutroformers you are using were designed to operate best when standard six-volt storage battery tubes are used. Since the circuit will not oscillate when dry cell tubes are used, on account of the low internal capacity of these tubes, it becomes necessary either to increase the number of turns in the primaries of the neutroformers or else to connect a very small condenser across the grid and plate terminals of the radio-frequency tubes. Neutrodons will probably be found satisfactory in this capacity. Do not forget to install the detector plate circuit by-pass condenser that connects across the head-phones, or across head-phones and "B" battery; it causes a big increase in signal strength and the circuit will oscillate more easily.

MICROPHONES

(236) Mr. Eugene Moussean, Basin, Wyo., asks:

Q. 1. What is the highest radio station in the world?

A. 1. We understand the recently opened station on the Pic-du-Midi Mountain, in the Upper Pyrenees, near the Spanish border, is the highest station in the world. It is located 9,439 feet above sea level.

Q. 2. Can the very small "B" batteries of the size called "Signal Corps" be used in a superheterodyne?

A. 2. These batteries have such a short life that they should be used in a portable receiver only. Larger batteries should be used in permanent installations.

Q. 3. How can microphone currents be amplified by a vacuum tube?

A. 3. Picture diagram numbered Fig. 236 shows how this is done. The microphone requires a high current at a very low voltage. The vacuum tube requires a high voltage but a very low current. The "modulation transformer" serves to adapt the microphone circuit to the requirements of the vacuum tube circuit.

Any firm selling transmitting apparatus will have this form of transformer, which has a low resistance primary (about 25 ohms) and a high resistance secondary (about 1,000 ohms). An ordinary Ford spark-coil is often quite suitable.

A regular telephone transmitter may be used instead of the microphone, but it will not be as sensitive. Several telephone companies manufacture hand transmitters and microphones.

While the regular "A" battery used to supply the tube is shown as supplying the necessary microphone current, it may be necessary to have a different microphone current supply, depending upon the constants of the microphone used.

The regular 2-stage audio-frequency amplifier of your radio set may be used. The modulation transformer may be used in place of the first audio-frequency transformer; or the set may be left connected up in the regular way and then the microphone made up as a separate unit. When it is desired to use the microphone, it is only necessary to connect the secondary of the modulation transformer to the secondary of the first audio-frequency transformer. Since one side of the modulation transformer and one side (the filament side) of the audio transformer may always be connected, it then becomes necessary only to have a regular push-pull switch to connect the remaining two transformer posts, in order to use the microphone. The microphone may also be connected directly across the primary of the first audio-frequency transformer.

Those who are hard of hearing will find the system explained in the diagram marked Fig. 236 a great improvement over a microphone used alone, in the customary manner. The ordinary microphone connection uses only a small battery, the receiver and the microphone. It is usual for this combination to be very noisy, particularly when the battery is new. This is due to an overloading of the microphone. This overloading is prevented by using the tube amplifier shown. The microphone is operated with much less battery current, eliminating the loud, rushing sound usually present. In addition, quality is very greatly improved and greater volume is obtainable.

If the microphone is used with the 2-stage amplifier of a regular set, as described above, the exceptionally high amplification resulting may cause the loud speaker output to lead into the microphone, resulting in a "reflexing" of the audio sounds that builds up until a loud, continuous howl is heard. This may be prevented or reduced in one or more of several ways. The howl will stop if the microphone is moved to another room. Try reducing the tube filament current. Mount the microphone in a framework in such a way that the entire "mike" is suspended by springs. Rubber bands fastened to the "mike" and to the framework will afford the necessary spring suspension. The microphone may be suspended in a metal box open at one end, the box being grounded. This is an improvement over the plain framework mounting mentioned above. The microphone should not touch the metal at any point.

TUBE DATA

(237) Mr. Alan Henry Edmonton, Altoona, Can., says:

Q. 1. Please state the temperatures at which the standard vacuum tube filaments operate.

A. 1. The heat of standard tube filaments when operated at the normal, rated value, is shown in the following table:

UV-199	—1950°	absolute Centigrade
UV-201A	—1950°	absolute Centigrade
UV-200	—2450°	absolute Centigrade
UV-201	—2450°	absolute Centigrade
UV-202	—2600°	absolute Centigrade
WD-11	—1098°	absolute Centigrade
WD-12	—1098°	absolute Centigrade

To reduce the temperatures from absolute Centigrade to Centigrade, subtract 273°.

Q. 2. What are the constants of the Cunningham 250-watt tube with the "A" filament?

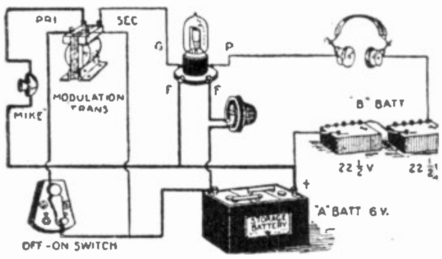


Fig. 236. Amplifying voice currents. This illustrates the principle involved in telephone "repeaters."

A. 2. The same as the 250-watt, C-304 tube, execept for the filament consumption. The constants of the C-304A tube are:

- Filament Terminal Voltage....11 volts
- Filament Supply Voltage.......12 volts
- Filament Current ....3.85 amperes (As against 14.75 amperes for the C-304 tube.)
- Normal Plate Voltage.......2,000 volts
- Normal Plate Current..200 milliamperes (2,000 volts, zero grid.)
- Amplification Constant 25
- Mutual Conductance ....5,000 mhos.

Conductance is the reciprocal of resistance. Its unit is the mho. or "reciprocal ohm."

WHAT FARADS AND HENRYS ARE

(238) Mr. F. C. Bossert, Houston, Texas, asks:

Q. 1. Among the various and numerous technical terms used in radio are the expressions microfarad and microhenry. I have referred to numerous books on these two terms and cannot seem to get a clear definition or conception of these two terms. I would be very grateful if you could explain them, possibly illustrate in some way, so that these two terms may become clear to me.

A. 1. Just as the gallon, pint, or gill is a unit of measurement to compare or measure liquids, and the inch, foot or yard a unit of measurement to compare or measure size or length, so the henry and farad are the units of measurement to compare various sizes of coils and condensers, respectively.

The unit of capacity is the farad. How large this unit is may be somewhat vaguely suggested to our imagination by the fact that if everybody in the United States had 18 each of the so-called .0005-mfd. condensers (usually equal to 18 plates), the total capacity of the whole lot, connected in parallel, would be one farad. The question naturally arises in everybody's mind, why such a huge unit was ever chosen to begin with? A volt, the unit of potential, is a convenient size. An ampere, the unit of current, is convenient. An ohm is an easily-obtained quantity of resistance. These three are the basic units. Starting with these three, such a unit as a farad is a derived unit; that is, it follows as a matter of definition.

A condenser is fundamentally a dielectric with a conductive plate on each side of it. Connected to an electric source, the condenser is charged. The larger the charge, the greater the difference of potential between the two conductive plates; and the equation is that Q equals E times C, when Q is the charge, E is the potential, and C is a constant for any particular dielectric and arrangement of parts. C is a ratio of Q to E, and we call it the capacity.

The unit of capacity is the capacity of a condenser charged to a potential of one volt by a unit quantity of electricity. The name of a unit quantity of electricity is a coulomb, which is the charge transmitted in one second by a current of one ampere. Really, therefore, the farad is the ratio of the unit of charge to the unit of potential.

Like the unit of capacity, the unit of inductance is a tremendous unit. It is the henry. While in capacity we usually deal with the millionth part of a farad, in inductance we usually deal with the thousandth part of a henry, the millihenry; although in radio work the microhenry is not uncommon, because air-cored coils are much used.

The henry is also a derived unit and its size is due, not to design, but to force of circumstances. It is the inductance in a circuit when the electro-motive force induced in the circuit is one volt, and the inducing current varies at the rate of one ampere per second. It, therefore, is derived from the unit of voltage and the unit of current.

Unfortunately, the formulas for inductances are subject to many correction factors, and are very elaborate. It is almost impossible to figure accurately the inductance of a coil without consideration of a multitude of factors, some of which cannot be known with accuracy. In general, the inductance is directly proportional to the length of the coil, the square of the mean diameter, and the square of the number of turns per unit of length; and in each case the inductance depends on the material of the core.

A core of iron gives much greater inductance than one of any other substance. Air and non-magnetic materials give minimum inductance.

A 4-inch coil diameter gives 16 times the inductance of a 1-inch coil. The number of turns per inch of length determines the inductance largely. Double the number of turns per inch, as by using finer wire, and you will get four times the inductance. The longer the coil the greater the inductance.

Various interesting and technical data and explanations may be obtained from the book "Morecroft's Principles of Radio"; and from the data sheets published in the various radio departments of **Science and Invention, Radio Listeners' Guide and Call Book, and Radio Review.**

HONEYCOMB COIL DATA

(239) Q. 1. Can you furnish me with some sort of chart in which is given the various characteristics of honeycomb coils in the sizes that may be purchased. The essential characteristics that I refer to are: each coil's approximate inductance valve in millihenries, and the minimum wavelength that may be covered, when shunted by an ordinary .001-uf. variable condenser.

A. 1. The following is the data you desire:

Size	Approx. Induc. in Millihenries	Max. & Min. W. L. with .001-mf. Var. Con.
L— 25	.040	130— 375
L— 35	.075	180— 515
L— 50	.15	240— 730
L— 75	.3	330— 1,030
L— 100	.6	450— 1,460
L— 150	1.3	660— 2,200
L— 200	2.3	930— 2,850
L— 250	4.5	1,300— 4,000
L— 300	6.5	1,550— 4,800
L— 400	11.	2,050— 6,300
L— 500	20.	3,000— 8,500
L— 600	40.	4,000—12,000
L— 750	65.	5,000—15,000
L—1,000	100.	6,200—19,000
L—1,250	125.	7,000—21,000
L—1,500	175.	8,200—25,000

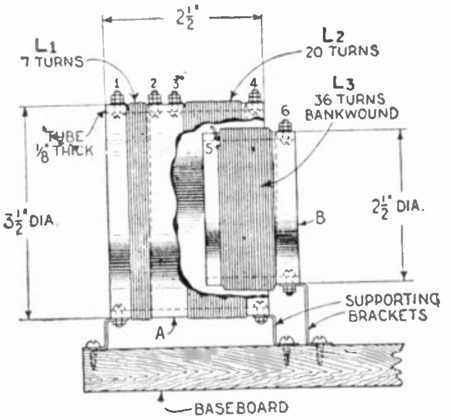


Fig. 240B. The design of an oscillator coil to operate in conjunction with a .001-mfd. variable condenser for a 10,000-meter type superheterodyne receiver.

INTERMEDIATE-FREQUENCY TRANSFORMER DATA

(240) Mr. R. Contini, Niagara Falls, N. Y., asks:

Q. 1. Due to present legal entanglements and injunction suits restraining the manufacturers from commercially producing Super-Heterodyne material, I am having difficulty in obtaining an efficient Super-Heterodyne kit, or at least the intermediate and filter transformers. Don't you think it would be a good idea to publish constructional data of various types of intermediate transformers and filters designed to operate in conjuction with them? Many constructors who "roll their own" would be glad to obtain this data; I for one would. In fact the information that you will publish, I hope, contains the constructional data of the transformer I am going to use in my Super-Heterodyne receiver.

A. 1. The following are the constructional data for various types of intermediate transformers and filters. We are also including oscillator-coil design, thus making the necessary information complete; with the source of the information, so that more complete data and illustration may be obtained by referring to the original article.

The following are constructional data for an efficient 10,000-meter intermediate transformer, filter transformer and oscillator coupler, obtained from "The Radio Constructor" series of blueprints; the title of this particular one being "A Genuine Standard Super-Heterodyne." Incidentally, this blueprint is no longer being published, though it is possible that copies are obtainable from some dealers.

The Tuned Filter

A great important part of the Super-Heterodyne is the tuned-filter coupler. This coupler is very simple and yet must be accorded much care in construction. Practically all filters for this purpose consist of two coils placed close together. Each coil is tuned by a condenser, either fixed or variable, and is arranged to have a certain "tune" or wave-length which, once adjusted, is not touched again after the set is in operation.

The tuned-filter coupler determines the "intermediate frequency." One of the simplest and most convenient forms for this purpose will be two standard "duo-lateral" or honeycomb coils, each having 750 turns. The wave-length advocated is 10,000 meters: and, in order to bring the coil up to this level, two fixed mica condensers, each of .0005-mf. capacity, are connected across the terminals of both coils.

As a great deal of the selective quality of the set depends on the filter, it will be necessary to arrange it so that the coupling between these two coils can be varied to the best position. The best efficiency will be obtained only if the intermediate-frequency transformers give maximum amplification at the particular wave-length for which the filter is designed. Therefore, when using the two duo-lateral coils as explained above, it will be a good plan to purchase or construct three intermediate-frequency transformers that will give best amplification at about 10,000 meters. There are several types on the market which will give excellent results. If the builder desires to construct a special filter it can be made according to the following plans. Fig. 240A shows details of the disks and cores necessary.

First assemble the disks on the cores and

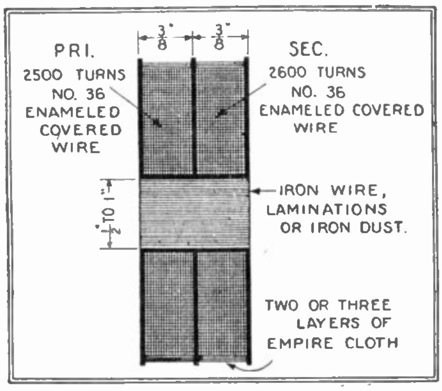


Fig. 240C. Design of an intermediate transformer which operates with maximum efficiency at 50 to 60 K.C. The correct amount of iron core must be determined experimentally.

glue them fast, as indicated in the illustration. Now wind on each form 950 turns of No. 32 D.C.C. copper wire. Have these windings as near uniform as possible; that is, wind in layers from one side to the other. The windings are insulated from the core, as shown, by means of a strip of empire cloth or insulating tape.

The aligning pin shown in the illustration, Fig. 240A of the complete coupler, is merely a piece of wood driven into the first core. A hole about twice as large as the pin may be drilled in the other core to offer a recess in which the pin is to fit as shown.

The ends of each coil are brought out, as shown, connected to small machine screw terminals fastened to the disks. This furnishes a convenient means of connecting to the coupler when wiring the set. In assembling the coupler a brass screw (do not use iron) about 2¾ inches long and just large enough in diameter to fit the holes drilled in the cores, is used. This screw should be of the flat-head variety, and fits through a hole in the panel. It is then pushed through the hole in the core of the first coil unit of the filter coupler and a nut adjusted to hold it tight to the panel.

In placing the second coil on the shaft or screw remember that the windings on both coils must be in the same direction. This is a most important feature, and must be taken into careful consideration when making the coupler. The second coil can now be fitted. Place another nut on the shaft and leave it about half an inch from the other. Then place the second coil in position, by adjusting the core so that the aligning pin fits the hole and the core can be forced up to the second nut. The final nut for clamping may now be put on, and the coupler is finished except for adjusting of coupling.

It is apparent that by turning the second nut on the shaft the second coil can be placed nearer to the first coil. The best operating position, that is, the proper coupling, will be found by test, as described later, and the second coil can then be clamped permanently in place.

Both primary and secondary coils are brought up to proper wave-length by placing .00025-mf. mica fixed condensers across the terminals of both coils.

Building the Oscillator Coupler

Fig. 240B shows the constructional details of the oscillator coupler and it will be noted that, in effect, it consists of a primary, secondary and also a coupling coil. The coupling coil is used to pick up the necessary energy from the oscillator: it is what is usually known as a "pick-up" coil. This entire circuit is tuned by the .001-mf. condenser.

The illustration, Fig. 240B, shows a bakelite or fiber tube 3½ inches in diameter, 2½ inches long and ⅛ inch thick. A hole is drilled about 3/16 of an inch from one end and the brass-angle supporting-bracket mounted as shown. Directly above this mounting screw hole, another small hole is drilled to hold a small round-head machine screw and nut, terminal No. 1. Now take a spool of No. 20 or 22 double covered copper wire and

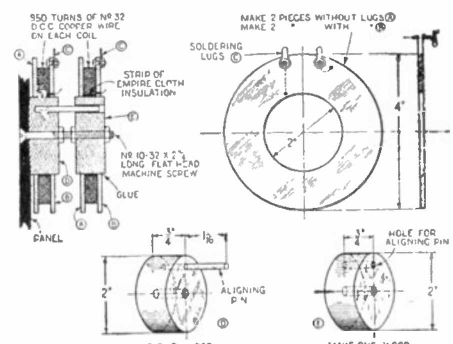


Fig. 240A. The design and constructional data including all necessary dimensions of an intermediate-frequency transformer, air core type, having an amplification peak at 10,000 meters.

wind 7 turns as close as possible. The end of this coil is then connected to a screw terminal, 2, in the tube in the same manner as done at the beginning. This is coil L1.

Use the same size wire to wind a second coil on the tube. Wind 20 turns, fastening both ends to screws, terminals 3 and 4, as shown. To each of these screw terminals a lug can be attached if desired. These will serve for making permanent connections. This will be coil L2.

Coil L3 is wound on a separate form. For this purpose a bakelite or fiber tube, 2½ inches in diameter by 1¾ inches long and ⅛ inch thick, is used. Use the same size wire and wind 36 turns in what is known as "bank winding." This coil must be wound in the same direction as coil L2 in order to form a continuous winding through the fixed condenser.

One end of this bank winding can be connected to a screw terminal, shown as terminal 6 in Fig. 244B, and the other end fastened by threading it through two small holes drilled close to the other end of the tube. This coil is then fastened to the baseboard by means of an angle supporting-bracket as shown. Fig. 244B also shows the method of placing coil L3 in proper relation to coils L1 and L2. The distance between coil L1 and L2 is not a very critical detail and the windings may be placed about ½-inch apart.

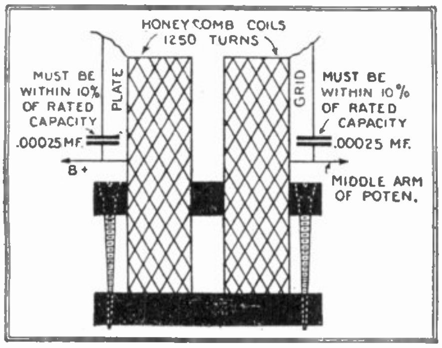


Fig. 244D. The design of the filter or imput transformer. Although these coils may be wound similarly to ordinary transformers, ordinary honeycomb coils may be used with the same efficiency.

The relation of coil L3 to L2 is best determined after the set has been placed in operation. Fig. 240B shows the smaller form on which coil L3 is wound, mounted only temporarily on the baseboard.

50 to 60 K.C. Filter and Intermediate Transformers

Fig. 240C shows the design of an efficient intermediate-frequency transformer which operates very efficiently at a peaked efficiency of between 50 and 60 kilocycles (6,000 to 5,000 meters). The correct amount of iron core to be used must be determined experimentally.

Fig. 240F shows the design of a filter transformer which may be very easily constructed and designed to operate in conjunction with the above mentioned intermediate-frequency transformer. The coil consists of two ordinary 1250-turn honeycomb coils mounted as illustrated.

Fig. 240DO shows the construction and details of an oscillator coil for the above-mentioned.

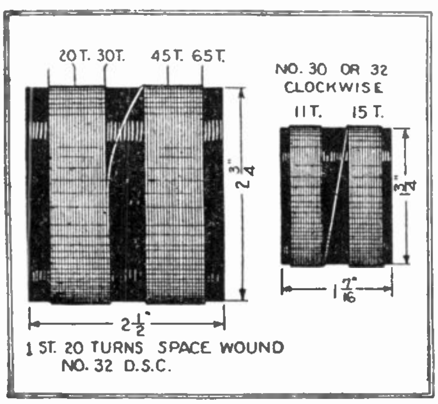


Fig. 244F. The design of an oscillator and an oscillator coil in conjunction with a .0005-mf. condenser, in a super-heterodyne receiver employing 50 to 60 KC type intermediate-frequency transformer.

Tropaformer

The tropaformer is an efficient tuned intermediate-frequency transformer; its amplification peak may be varied between 2,000 and 7,000 meters (150 to 43 kilocycles).

The complete details of this transformer are shown in the illustration, Fig. 240E. It will be noted that a variable condenser is permanently mounted on each transformer. The condenser is connected across the secondary winding; and in this way each transformer may be accurately tuned, making the intermediate-frequency amplifier very selective and efficient. Mica-insulated variable condensers are used because they occupy less space than those employing air as the dielectric. These condensers have a maximum capacity of .0005-mf. and, in connection with the coils used, the transformers may be tuned to any wave-length ranging from 2,000 to 7,000 meters. Although the coils used in these transformers were wound by machine, they may easily be wound by hand, haphazardly, on a suitable form, or spool. The number of turns, which in this case is 440 in each coil, is not critical. Two coils connected in series form a secondary, and one coil forms a primary. It is important to separate the coils at least a quarter inch. The core iron used is exceptionally thin, japanned, silicon steel. This steel, which may be obtained from manufacturers of iron-core radio-freqency transformers, is not the same as that used in the construction of audio-frequency transformers. When constructing these transformers, it is important that all coils be wound in the same direction and placed on the core, as shown in the illustration. The leads are lettered to correspond to the vacuum tube connection.

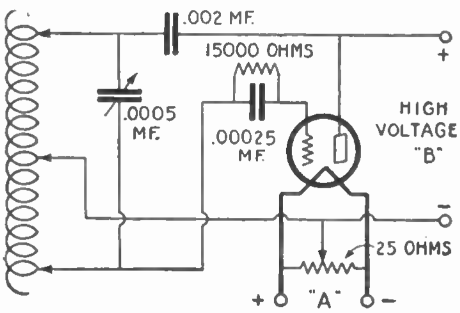


Fig. 241, Schematic circuit diagram of a laboratory type oscillator. This instrument is employed extensively for measurement and calculation work of radio apparatus. It can also be calibrated and used as a wave meter.

The design for an oscillator coil to operate in conjunction with the above-mentioned intermediate-frequency transformer, and which combination may be used for the construction of the popular tropadyne receiver, is as follows:

The two windings (plate and grid) are wound in the same direction on a tube 3 inches in diameter and 4 inches in length. The plate winding consists of 24 turns of No. 20 S.S.C., whereas the grid coil consists of 29 turns of No. 20 S.S.C., and has a center tap (14½ turns). For exact specifications and details refer to Fig. 240F.

RADIO OSCILLATOR FOR MEASUREMENT WORK

(241) Mr. Barratt, Brookville, Ind., wants to know:

Q. 1. I would like some information relative to the construction of a radio-frequency oscillator to be used for calculation work, measuring of transformer curves, amplification peaks, etc. The conventional radio-frequency oscillator emtories, as I assume yours must be a simplified affair, from what I read of it in your articles dealing with your calculation work?

A. 1. A circuit diagram of a radio-frequency oscillator, similar to that used in the Radio News Laboratories is published in Fig. 241. But one tuning control is used for changing the frequency generated by the oscillator, unless an extremely radical change of 300 or 400 meters is desired; in which case the position of the switches on the various taps leading to the coils, should be changed. The variable condenser is of .0005-mf. capacity. The inductance coil's size is dependent upon the frequency range to be covered. For ordinary purposes, (coinciding with present broadcast range) a 44-turn winding, on a 3-inch tube with No. 22 DCC wire, and tapped every fourth turn, will be entirely satisfactory.

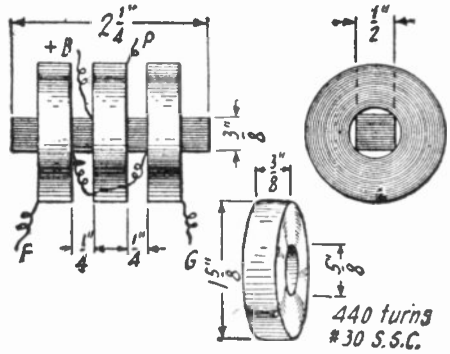


Fig. 244E. The design of a tuned intermediate-frequency transformer, employing an iron core. A small variable condenser, approximately .00025-mf., is connected across the secondary and varies the wave-length range from approximately 2,000 to 7,000 meters.

Q. 2. Can you furnish me with the formula for determining the capacity of parallel-plate condensers, also recommend some particularly good book which deals with radio principles and calculation work?

A. 2. A very good book in which radio principles and calculations are thoroughly dealt with is "Principles of Radio Communication" by J. H. Morecroft.

The formula for determining the capacity of parallel-plate condensers is:

$$C = 2.246K\frac{S(N-1)}{D}\times 10^{-7}\text{mf.}$$

S is the area of one plate; N, the number of plates; D, the distance between them; K, the dielectric constant of the material between the plates. S is in square inches and D in inches.

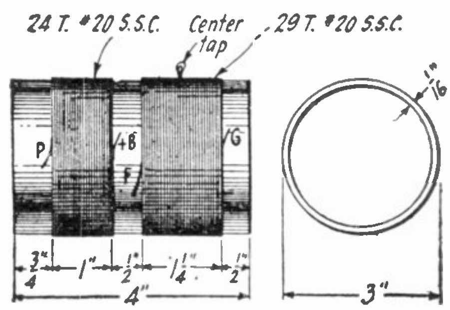


Fig. 244DO. Constructional data of an oscillator coil to operate in conjunction with the tuned intermediate-frequency transformer; designed so that it may be used in the Tropadyne, which receiver incorporates both detector and oscillator in one tube.

Values of K (Dielectric Constant)

Air	1.0
Glass	4 to 10.
Mica	4 " 8
Hard rubber	2 " 4
Paraffin	4 " 3
Paper	1.5" 3
Sulphur	3 " 4.2
Shellac	3 " 3.7
Wood, maple, dry	3 " 4.5

Wood, oak, dry	3 "	6
Molded insulating material, shellac base	4 "	7
Molded insulating material, phenolic base ("Bakelite")	5 "	7.5
Vulcanized fiber	5 "	8
Castor oil		4.7

The maximum capacity of a variable condenser of semi-circular plates is given below; in which R_1 in the outside radius and R_2 is the inner radius of the plates. The other symbols are as in the formula above. (R_1, R_2, and D in inches).

$$C = 3.53K \frac{(N-1)\ (R_1^2 - R_2^2)}{D} \times 10^{-7} \text{mf.}$$

GHIRARD VIII OSCILLATOR-COUPLER

(242) Mr. S. R. Kehrer, Woodbury, N. J., asks as follows:

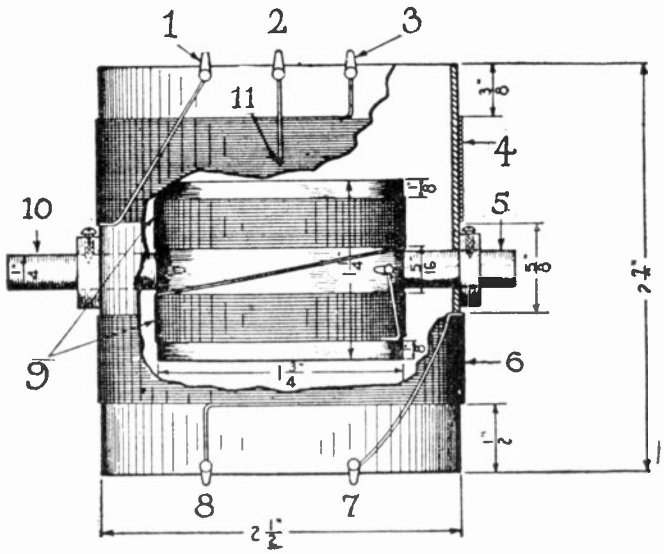


Fig. 242. Constructional and winding details of the Ghirard oscillator-coupler. This instrument may be employed as an oscillator coil in any other similar super-heterodyne circuit whose intermediate-frequency transformers have a characteristic peak of 5,000 meters (60 kc.)

Q. 1. Can you furnish me with complete construction data of the oscillator employed in the Ghirard VIII super-heterodyne receiver, described in the April, 1926, issue of RADIO NEWS? I was successful in obtaining the Sampson Electric Company's 60-kc. intermediate-frequency transformers, which are employed in this set, but was not very successful in constructing an efficient oscillator coupler to operate in conjunction with the above mentioned.

A. 1. This department has received numerous questions for the design data on this particular instrument; and we therefore print the complete details in these columns. (See Fig. 242).

SOLENOID COIL DATA

(243) Mr. J. B. Watson, Springfield, Mass., asks as follows:

Q. 1. Have you any data or information available relative to various size coils of the solenoid type (number of turns, diameter, etc.) and the wave-length range that they are capable of covering? Any information or chart data that you could furnish or refer me to would be entirely satisfactory.

A. 1. The most complete compilation of coil sizes and their wave-length ranges including number of turns, size of wire, etc., that we have available is reproduced in these columns.

These tables will enable the amateur experimenter to wind cylindrical coil inductances on any of the sizes of tubes in common use. It should be noted that the number of turns given, in each case, will bring in the wave-length without a condenser. That is, the inductance will act as though it were a coil tapped in tens and units, in which every single turn can be varied. With a condenser added in parallel, the wave-length will be greater, but as such a coil is tapped in fives or in tens the taps will compensate. Enamelled wire has been specified, but only for convenience; and if wires with other coverings are used the inductance of the coil will be slightly less but not sufficiently to make any material difference. The number of turns per inch, however, will vary with the kind of insulation used.

Note, however, that the SWG gauge is used in the following chart. The difference between this and the B. & S. gauge is very slight and the sizes can be said to be practically similar (i.e., 22 SWG gauge practically the same as 22 B. & S. gauge). However, for those who are somewhat critical and more exacting we are reprinting a "conversion table," which appeared in the Correspondence columns of the February, 1926, issue of RADIO NEWS.

The following tables give diameters in millimeters corresponding to the Brown & Sharpe gauge, standard in America, and the S.W.G., standard in Great Britain.

Numbers	Brown & Sharpe	S.W.G.
000.000	....	11.785
00.000	....	10.972
0.000	11.683	10.16
000	10.404	9.448
00	9.266	8.839
0	8.251	8.229
1	7.348	7.62
2	6.544	7.01
3	5.827	6.401
4	5.19	5.893
5	4.621	5.385
6	4.115	4.877
7	3.665	4.47
8	3.263	4.064
9	2.906	3.657
10	2.588	3.251
11	2.305	2.947
12	2.052	2.641
13	1.828	2.337
14	1.628	2.032
15	1.449	1,829
16	1,291	1.626
17	1.15	1.422
18	1.024	1.219
19	.911 6	1.016
20	.811 8	.914 4
21	.722 9	.812 4
22	.643 8	.711 2
23	.573 3	.609 6
24	.510 5	.558 8
25	.454 6	.508
26	.404 9	.457 2
27	.360 5	.416 6
28	.321 1	.375 9
29	.285 9	.345 4
30	.254 5	.315
31	.226 7	.294 6
32	.201 9	.274 3
33	.179 8	.254
34	.160 1	.233 7
35	.142 6	.213 4
36	.127	.193

MAXIMUM WAVE-LENGTH OF COIL IN METERS

No. Turns	Size Wire	Length Winding Inches	Diameter of Form. 2	2 ½	3	3 ½	4
	20	0.75	165	185	205	225	240
	22	0.56	175	195	210	230	245
20	24	0.44	180	200	215	235	250
	26	0.36	185	205	220	240	255
	28	0.3	190	210	225	245	260
	30	0.25	195	215	230	250	265
	20	1.1	205	235	265	290	315
	22	0.84	215	245	275	305	330
30	24	0.66	230	260	290	320	345
	26	0.54	240	270	295	325	350
	28	0.45	245	280	305	335	360
	30	0.37	260	290	325	350	370
	20	1.5	240	280	320	355	390
	22	1 1	255	295	335	370	405
40	24	0.88	270	310	355	395	430
	26	0.72	285	330	370	405	440
	28	0.6	300	345	385	420	455
	30	0.5	305	350	390	430	465
	20	1.8	275	325	365	410	450
	22	1.4	295	345	390	435	475
50	24	1.1	315	360	410	455	505
	26	0.9	335	385	435	480	530
	28	0.75	345	395	450	495	545
	30	0.62	360	415	470	515	565
	20	2.2	310	355	410	460	515
	22	1.7	335	385	440	495	550
60	24	1.3	355	410	470	525	580
	26	1.1	370	430	495	555	610
	'8	0.9	390	455	520	580	635
	30	0.75	405	475	540	600	655
	20	2.5	335	395	455	515	575
	22	2.0	365	425	490	550	605
70	24	1.5	390	455	520	585	645
	26	1.25	415	480	550	615	680
	28	1.0	435	510	580	650	715
	30	0.87	455	530	605	675	740
	20	2.9	365	425	495	565	630
	22	2.0	395	465	540	605	665
80	24	1.8	430	500	575	645	710

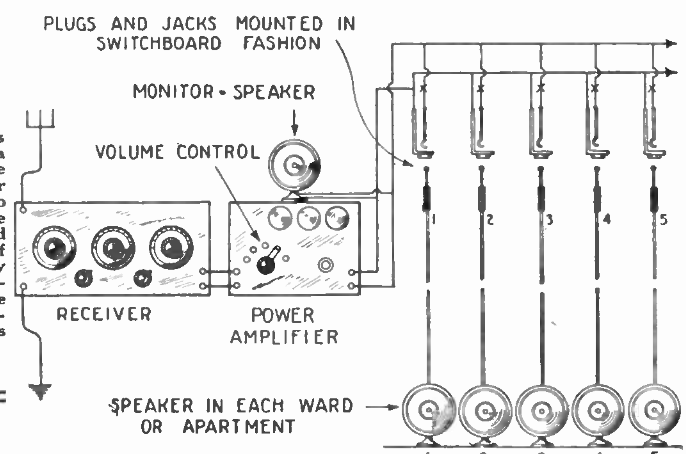


Fig. 244. This diagram shows the circuit used where a number of loud speakers are employed. A Hospital or Apartment multiple radio installation, illustrating the method of using plugs and jacks so that any number of wards or apartments may be supplied with entertainment when desired. The method for obtaining multiple radio program service is explained in the text.

MAXIMUM WAVE-LENGTH OF COIL IN METERS

No. Turns	Size Wire	Length Winding Inches	Diameter of Form. 2	2½	3	3½	4
	26	1.5	450	525	605	680	750
	28	1.2	475	555	640	720	790
	30	1.0	500	580	665	745	815
	20	3.2	390	455	535	605	680
	22	2.5	425	500	580	655	730
90	24	2.0	465	540	620	700	775
	26	1.6	490	575	655	745	820
	28	1.3	520	605	695	785	865
	30	1.1	540	630	720	810	895
	20	3.6	415	485	575	650	730
	22	2.8	450	530	620	700	806
100	24	2.2	490	575	670	750	835
	26	1.8	525	615	710	795	885
	28	1.5	560	650	750	840	930
	30	1.25	585	685	785	880	970
	20	4.3	460	540	640	735	825
	22	3.4	500	595	695	790	880
120	24	2.7	555	655	760	860	950
	26	2.2	590	700	805	905	1000
	28	1.8	630	745	855	960	1060
	30	1.5	660	775	895	1000	1110
	20	5.0	495	590	705	805	910
	22	3.9	550	655	770	875	980
140	24	3.1	605	720	840	955	1060
	26	2.5	650	770	895	1010	1125
	28	2.1	695	825	955	1070	1185
	30	1.75	740	870	1000	1125	1245
	20	5.8	535	640	760	870	985
	22	4.5	595	715	835	955	1070
160	24	3.5	655	785	915	1040	1155
	26	2.9	705	840	970	1110	1225
	28	2.4	755	905	1050	1190	1305
	30	2.0	800	955	1100	1245	1370
	20	6.5	575	680	810	935	1060
	22	5.0	635	745	895	1025	1150
180	24	4.0	700	835	985	1120	1255
	26	3.2	755	905	1060	1200	1340
	28	2.7	820	980	1140	1280	1420
	20	7.2	605	725	865	995	1125
	22	5.6	670	810	955	1090	1230
200	24	4.4	745	895	1050	1200	1350
	26	3.6	805	970	1130	1290	1440
	28	3.0	870	1050	1215	1380	1535
	30	2.5	925	1100	1285	1450	1610
	20	7.9	635	760	915	1050	1190
	22	6.2	705	855	1010	1155	1300
220	24	4.9	785	945	1110	1275	1430
	26	4.0	855	1025	1200	1370	1535
	28	3.3	925	1110	1310	1470	1640
	30	2.75	985	1175	1380	1555	1725
	20	8.7	675	800	960	1105	1250
	22	6.7	740	895	1060	1210	1375
	24	5.3	825	995	1175	1345	1510
240	26	4.3	895	1080	1270	1450	1625
	28	3.6	975	1170	1370	1560	1740
	30	3.0	1040	1240	1450	1650	1830
	20	9.4	695	835	1000	1145	1310
	22	7.3	775	940	1110	1280	1445
260	24	5.7	865	1040	1230	1415	1585
	26	4.7	940	1130	1330	1525	1710
	28	3.9	1020	1225	1440	1640	1835
	30	3.25	1090	1310	1530	1740	1935
	20	10.0	725	870	1045	1210	1370
	22	7.8	810	980	1160	1330	1505
280	24	6.2	900	1090	1285	1480	1660
	26	5.0	980	1180	1390	1595	1790
	28	4.2	1065	1280	1505	1720	1930
	30	3.5	1140	1370	1605	1820	2040
	20	10.8	750	900	1080	1250	1430
	22	8.4	835	1015	1200	1390	1570
300	24	6.6	935	1120	1340	1540	1735
	26	5.4	1020	1230	1450	1665	1870
	28	4.5	1110	1340	1570	1800	2015
	30	3.75	1190	1430	1680	1915	2135
	20	11.5	775	935	1125	1300	1480
	22	9.0	865	1050	1250	1440	1630
320	24	7.1	970	1175	1390	1595	1800
	26	5.8	1055	1275	1505	1730	1950
	28	4.8	1150	1390	1640	1880	2105
	30	4.0	1230	1485	1740	1990	2225
	20	12.2	800	965	1160	1340	1530
	22	9.5	895	1090	1290	1485	1680
340	24	7.5	1000	1215	1440	1655	1870
	26	6.1	1090	1325	1560	1790	2025
	28	5.0	1195	1440	1695	1930	2185
	30	4.25	1280	1540	1810	2070	2320
	20	13.0	825	995	1200	1385	1580
	22	10.0	920	1120	1340	1540	1740
360	24	7.9	1030	1255	1490	1710	1930
	26	6.5	1130	1365	1615	1860	2095
	28	5.3	1230	1490	1760	2010	2265
	30	4.5	1320	1595	1880	2145	2410
	20	13.7	850	1020	1230	1430	1630
	22	10.6	950	1160	1375	1580	1790
380	24	8.4	1060	1290	1530	1765	1995
	26	6.9	1160	1410	1670	1920	2160
	28	5.6	1270	1540	1810	2080	2345
	30	4.75	1365	1650	1950	2225	2500
	20	14.5	875	1050	1270	1470	1675
	22	11.2	975	1190	1410	1630	1840
400	24	8.8	1095	1330	1575	1820	2060
	26	7.2	1200	1455	1720	1980	2235
	28	5.9	1320	1590	1880	2160	2435
	30	5.0	1420	1700	2000	2290	2575
	20	16.2	925	1115	1350	1570	1790
	22	12.6	1040	1270	1505	1740	1980
450	24	9.9	1165	1420	1685	1950	2210
	26	8.1	1275	1550	1840	2120	2395
	28	6.7	1400	1695	2005	2300	2600
	30	5.6	1505	1840	2150	2465	2770
	20	18.0	970	1200	1430	1655	1895
	22	14.0	1100	1340	1595	1845	2100
500	24	11.1	1230	1505	1785	2065	2340
	26	9.0	1350	1640	1955	2250	2550
	28	7.4	1480	1795	2130	2455	2770
	30	6.2	1595	1940	2290	2630	2960

MULTIPLE RADIO INSTALLATION

(244) Mr. D. Wilkerson, Norwood, N. J., asks:

Q. 1. I wish to make a multiple radio installation in an apartment building. Can you furnish me with any data or diagram of the method of procedure?

A. 1. The system employed for making a radio installation where a number of outlets or loud-speakers are to be used, as in hospitals, hotels or apartments, has often puzzled a good many constructors and radio-set builders. The I Want to Know Department of RADIO NEWS has received numerous letters which show interest in this subject. We here present a diagram of a simple installation which, when completed, is a neat and interesting affair. (See Fig. 244).

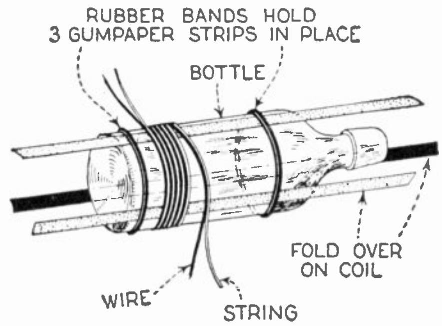


Fig. 246. The novel method employed in winding the low-loss coil is shown above.

It is essential that a power amplifier be employed where three or more outlets are concerned. The power amplifier should incorporate a volume control, which must be turned more and more towards the maximum setting, as the number of loud-speakers to be used is increased. The jacks and plugs may be mounted in switch-board fashion, the plugs on the horizontal board, the jacks on a vertical one. The plugs should be numbered corresponding to the apartment or ward number in which the loud-speaker is placed; thus, if radio reception is desired in apartment 13, plug 13 is placed within the jack. The constructor may also incorporate a volume control in each separate output; so that if apartment 13 complains that the volume is too great, the operator may easily reduce the volume for that particular line, without in any way decreasing the signal strength to any other outlet. The volume control should be connected to the leads marked "X", and consists of an ordinary variable resistance, 0 to 25,000 ohms.

The scheme as illustrated can of course be improved upon; for instance, three or four lines of jacks can be employed, each line running to a different receiver, each obtaining different stations, should one apartment desire to listen to some other program. Also, a common connection might be used for the installation of the loud-speaker, instead of two separate wires for each outlet, which is a somewhat tedious and laborious installation.

RULES FOR RADIO INSTALLATIONS

(245) Mr. D. S. Spiegel, Batavia, N. Y., asks as follows:

Q. 1. Will you please state the requirements (fire insurance companies, or Bureau of Standards, etc.), for the correct installation of an antenna and ground system? I am in the radio retail end of this game and do a lot of set installing. Installations of antennae are quite numerous and I desire to keep up-to-date with the new legal requirements.

A. 1. The following are among the safety rules for radio installations issued by the Bureau of Standards, which are given in full in its new Handbook No. 9, "Safety Rules for Radio Installations."

In erecting antennae and guy wires for your radio sets, see that you do not attach them to telegraph or electric light poles, do not carry your wires over streets or tracks and avoid crossing electrical conductors of all kinds. Antenna supports must be sufficiently rigid and of such size as to withstand any load which may come on them. Attachment to chimneys should be avoided. Metal poles, or masts extending more than ten feet above the supporting building, must be permanently and effectively grounded.

The bureau recommends that locations involving crossings over railroads, supply lines, etc., be avoided; but where no other location is possible, special rules are given for the installation.

In the case of receiving sets, lead-in conductors shall be not less than No. 14 wire (0.064-inch in diameter) if of copper, nor less than No. 17 (0.045-inch) if made of bronze or copper-covered steel. Clearances are given between lead-in wires and other conductors on the building, and it is recommended that lead-in conductors be "securely fastened in a workmanlike manner." The code also requires that the lead-in wire shall enter the building "through a rigid non-combustible, non-absorptive, insulating tube or bushing, or through a drilled window pane."

For receiving sets, grounds must not be made to gas pipes, but should be made to cold-water pipes, if these are connected to a street main. An outlet pipe from a water tank fed by a street main or a well may be used, provided this outlet pipe is adequately bonded to the inlet pipe connected to the street main or well. Where the wire is attached suitable clamps must be used.

Rules for the application of protective devices, such as lightning arresters and antenna-grounding switches, are also given. Each lead-in conductor for a receiving set must be provided with a lightning arrester, whether or not an antenna-grounding switch is used. The arrester may be either outside the building or inside if away from combustible materials.

If your set is connected to a power supply-line, the device used and methods of wiring must be in accordance with the rules covering permanent or portable fixtures, devices and appliances, as given in Section 37 of the National Electrical Safety Code. The wiring of storage batteries must also conform to these rules; and such batteries must be placed where there is adequate ventilation.

Copies of this handbook may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents each.

A LOW-LOSS SPACE-WOUND COIL

(246) Mr. J. MacDonald, Little Falls, N. Y., asks:

Q. 1. Please give me the necessary information for winding coils of the low-loss space-wound type.

A. 1. The following is a description of a coil having very low electrical losses, and sufficient mechanical strength to enable it to be used under the most exacting conditions. This coil eliminates two undesirable features found in other low-loss coils, viz., the danger of short-circuiting turns, as in "basket-weave" type, and the high distributed capacity, as in the "pickle-bottle" type.

Any size of wire between Nos. 12 and 20

will be satisfactory for winding the coil. However, it is recommended that No. 16 or 18 be used if possible. Obtain a bottle whose diameter is equal to that of the coil to be constructed. From a piece of gum-paper tape cut out three strips, 5/16-inch wide and approximately three times as long as the finished coil is to be. Several

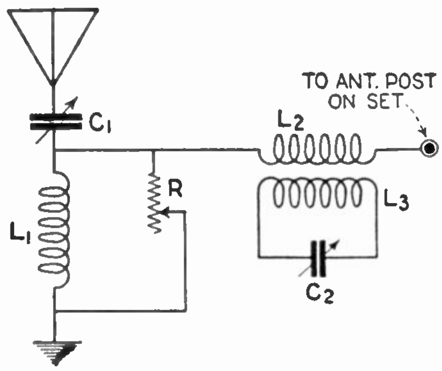


Fig. 247. A very efficient wave trap which can be constructed at a very low cost. It will be found of great benefit by those located in the vicinity of a broadcast transmitter.

rubber bands will come in handy here, to hold the tape strips on the bottle while the wire is being wound on. The turns should be spaced by a string which is wound on along with the wire. Ordinary wrapping twice will be satisfactory for the smaller wire, but something bigger should be used for the larger sizes. When the correct number of turns have been wound on, fasten the end of the wire by another rubber band and remove the string. Apply a thick coat of collodion on the wire over the tap strip. Allow this to dry and put on a second thin coat. Moisten the tape not covered by the wire and collodion and press down while it is still sticky. When this dries, break the bottle and remove the completed coil.

ELIMINATING STATION INTERFERENCE

(247) Mr. D. Walker, Norwood, N. J., asks:

Q. 1. I am bothered by constant interference from one particular local station which transmits with 1,500 watts of power. The transmitting station is in the immediate vicinity. Is there any selector of wave-trap circuit that you can give me, which will eliminate this interferennce? I am positive that the trouble is not in the receiving set, as neighboring friends with radio sets are experiencing the same difficulty.

A. 1. A filter, or wave trap, which will eliminate the trouble you mention is shown in Fig. 247. Its construction is fairly simple, there being only two parts, although the adjustment of this filter is somewhat complicated. However, once adjusted, it needs no further handling or dial twisting.

The parts necessary for this wave filter are as follows:

1 variable condenser, .001-mf. low-loss type:
1 variable condenser, 0005-mf. low-loss type;
1 variable resistance, .0-25,000 ohms;
2 bakelite tubes, 3 inches in diameter, 4½ inches long;
½ pound of No. 22 D.S.C. wire.

L1 consists of 55 turns wound on one of the tubes. L3 is 45 turns wound on the remaining tube. L2 is wound on top of L3, but is separated from it by a sheet of empire cloth, or waxed paper, and has ten turns. C1 is the .001-mf. variable condenser. The theory of this wave trap is as follows:

The incoming signal flows through coils L1 and L2. The circuit comprising L1 and C1 is tuned to the frequency of the enterfering station, and the condenser is then set as that position. The circuit including C2 and L3 is what is commonly termed an absorption circuit. The condenser of this circuit is rotated until the signal of the interfering station is heard at a minimum strength. The circuit, when in resonance with the interfering station, will absorb almost all of the energy received from that station. The energy is received from coil L2, which is closely coupled to L3, and is also closely coupled to L1. In this way, signals of other stations will be allowed to pass through, but that of the interefering station is dissipated in the absorption circuit. The resistance across L1 and C1 serves as a static-leak, and is variable to obtain the best adjustment possible.

MAKESHIFT ANTENNA

(248) Mr. Clarence Seid, Brooklyn, N. Y., asks:

Q. 1. Will you kindly describe in your columns a makeshift method to be employed when the regular aerial is down?

A. 1. As an emergency measure, when the regular aerial is "down," connect the input circuit of the receiver as shown in the diagram marked Fig. 248; it may be found satisfactory for both local and distant reception.

In effect, the aerial is replaced with the ground-condenser combination shown. The ground, G1, should be one other than the regular ground to the receiver. This combination will often be found very satisfactory in apartment houses where G is the

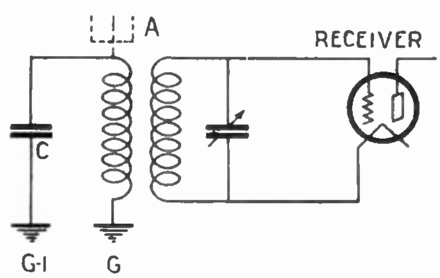


Fig. 248. This diagram illustrates the use of a separate ground connection as a temporary substitute for an aerial.

water pipe and G1 a radiator. The condenser, C, should be as large as possible. However, the lower this capacity, the less the pickup through this means and the greater the selectivity.

WAVE-LENGTH CALCULATION FORMULAS

(249) Mr. A. Cador, Ossining, N. Y., asks:

Q. 1. Could you furnish me with some simple formulas for the calculation of the wave-length of a coil and condenser combination, when the capacity and inductance are known, and the approximate inductance of a toroid coil?

A. 1. The following are several formulae from which the wave-length or frequency of a coil and condenser circuit can be determined with fair accuracy:

$$\text{Wave-length } (iv) = 1884 \sqrt{LC}$$

To find the frequency (in kilocycles) of a circuit consisting of a coil and condenser use the following formula:

$$\text{Frequency } (f) = \frac{159.2}{\sqrt{LC}}$$

In both cases L is the inductance of the coil expressed in *microhenries*, and C the capacity of the condenser in microfarads.

To find roughly the inductance of a coil of the toroid type, the following formula is employed:

$$L = .01257\, N^2 \left(R - \sqrt{R^2 - A^2}\right)$$

In this instance R is the radius of the toroid from the center of the doughnut to the center of winding, A is the radius of the turns of the winding, and N is the number of turns.

BATTERYLESS LABORATORY OSCILLATOR

(250) Mr. J. Walthier, Redlands, Calif., asks:

Q. 1. I would like to construct an oscillator for use in my experiments. I have heard that such an apparatus can be constructed without using "A," "B" or "C" batteries, using the line supply as a source of power. Could you give me a diagram and any other information relative to this device?

A. 1. The suggestion of an oscillator hook-up on a power line without "A," "B" or "C" batteries is one which will appeal to all experimenters. The added advantage of being adaptable to either A.C. or D.C. circuits makes it universal in character. Of course, A.C. has advantages, and in this case the tube is supposed to do whatever rectifying action may be necessary. With D.C. the author of the circuit relies on the commutator ripple found on any D.C. line.

The accompanying diagram Fig. 250 is self-explanatory, except that the connections of plate return and grid return are to opposite sides of the filament, on the theory that in this way the grid will be minus when the plate is positive. The resistor can be anything, but a simple 25-watt lamp is suggested where the line voltage is 110. The frequencies through which the oscillator will work are determined by the size of coils and condensers, as in any radio set. Plate and grid coils are of equal size. Coupling is kept close, by winding both coils on the same tube.

THERMAL AMMETER

(251) Stuart Thompson, Jersey City, N. J., asks:

Q. 1. What is the basic principle of operation of the thermal ammeter and how does it differ from the ordinary types of ammeters?

A. 1. The formula $P = RI^2$ represents the basic principle of the thermal ammeter where P is the power consumed as heat in the instrument. The deflection of the pointer of the instrument depends directly upon the heating effect of the current. In order that the relationship of P to I, the

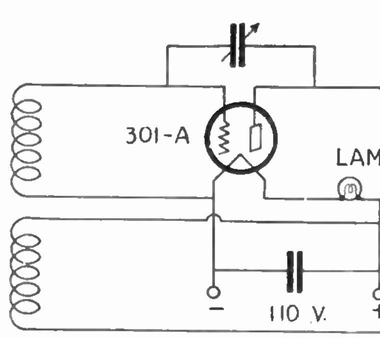


Fig. 250. An experimental oscillator utilizing the power line for its "A" and "B" supply.

current, should remain constant so that a given deflection will always correspond to the same amount of current, it is necessary that R, the resistance of the instrument should not change with the frequency. To accomplish this, the conductor must have a very small cross-section and the working element of a thermal ammeter must be a fine wire or a very thin strip of metal. An error of not more than 1% is allowed in instruments used in most ordinary radio work over any range of frequency employed. Thus for the ordinary instrument, a copper wire of 0.08 milliammeters in diameter is used. As can readily be seen, a single wire of this size can carry at best, only a few amperes, because larger currents would overheat the wire and perhaps burn it up. Contrary to general opinion, the length of the wire is not important. It is only long enough so that the current distribution within it is not appreciably altered by the terminals to which it is connected. Such instruments when properly constructed may be calibrated with direct current or low frequency alternating current and the calibration assumed to be correct at high frequency. Of course, if possible, it is always best to calibrate the ammeter by comparison with some recognized standard at the frequencies at which it will be used. At the high frequencies, it must be remembered that errors in the readings are liable to occur. Thus, not all the current traverses the wire element, but some of it is shunted through the dielectric or the material of which the case of the meter is made. However, the hot wire ammeter of the ordinary design will give fairly accurate readings. For measuring radio currents of about 0.003 to 3 amperes it must be borne in mind that it is the cheapest meter obtainable.

INTERFERENCE BY RADIATION

(252) William Shaw, Meadville, Pa., asks:

Q. 1. Kindly publish information as to which of the following sets cause interference by radiation.

*Autoplex
Neutrodyne
Ultradyne
*Single Circuit Regenerative
*Three Circuit Regenerative
*Cockaday Four Circuit
*Reinartz
Reflex
*Ultra Audion
Radio-Frequency Tuned Receiver.

Note—Those marked with an asterisk (*) radiate.

The only way to know best when a receiver is radiating is by actual test for it is not always radiating when a squeal is heard in the phones. This can best be done by arranging with a neighbor to listen in. In any case, the listener must have his set oscillating.

RADIO PHOTOGRAPHY

(253) J. H. Merwin, San Jose, Calif., asks:

Q. 1. Kindly give a brief resumé of the experimentation in radio photography since its inception of the transmission of photos by telegraphy and radio?

A. 1. With the present great strides in the transmission of photos by telegraphy and radio, and the announcement by Col. Green of the transmission of moving pictures by radio over a distance of nearly a hundred feet, it will not be surprising if in the very near future we will be sitting in our homes and listening to what the world has to say besides seeing the greatest opera performances that it has to offer.

As early as 1856, Caselli sent various designs by telegraphy using for the transmitter a tin foil-covered cylinder on which the designs were drawn in insulating compound. A needle acting very much like the stylus of a talking machine needle served the purpose of a contact pin, traveling over the surface of the revolving cylinder. Thus the circuit was made and broken as the lines passed under the contact pin, while at the receiving end, by an electro-chemical action, a cylinder which was exactly synchronized with the transmitter, reproduced the designs directly.

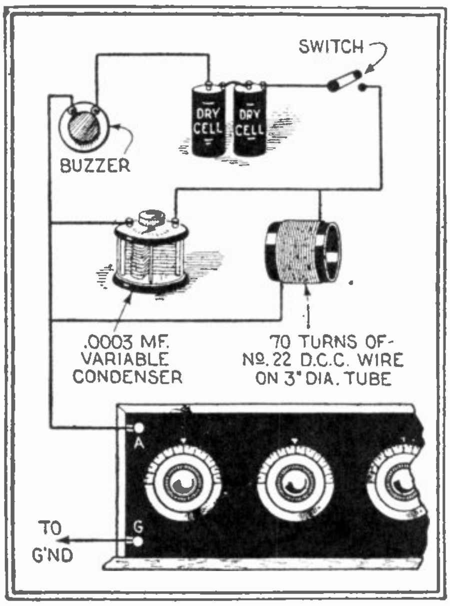


Fig. 254. Buzzer oscillator for use in adjusting neutrodyne.

The discovery of the effect of light on the electrical resistance of selenium became known in 1873 and shortly afterwards various schemes to substitute selenium for Caselli's process were tendered. The most noteworthy were those of Semlocq and Perosino in 1878. After quite a long time, Korn in 1904, employing Semlocq's plan with several modifications, put it into use and transmitted photographs several hundred miles from their destination. A negative of the picture was wound on a glass cylinder and a very narrow beam of light was used as a stylus passing through it. By reflection to a single selenium cell whose resistance varied according to the amount of light passing through the negative, the input current was modulated into the transmitting circuit. In the receiving station the current was passed through an evacuated tube which grew brighter or darker according to the pulsating incoming current. These variations in light were focused onto another cylinder covered with sensitized paper and of course after developing, reproduced the original picture in its entirety. By further experimentation, Korn was able to improve slightly on his apparatus and in 1907 made several photographic transmissions from Paris to London.

Perhaps the most original scheme was that developed by Edouard Belin. His scheme resolved itself upon the fact of his discovery that bichromated gelatin becomes insoluble under strong light. Thus he wets a film of this gelatin and places it under the negative he exposes, whereupon the portions of the gelatin exposed to light swell up more or less in proportion to the intensity of exposure, while the protected parts remain flat. This forms a sort of relief map of the negative and is wound on a cylinder over which a stylus traces its path. A microphone is attached to this stylus and by its rising and falling, the resistance of the microphone is varied which in turn controls the intensity of the current passing through it. At the receiving station an oscillograph has its mirror deflected in proportion to the current received and a light beam is reflected thereby to another cylinder. This cylinder has a sensitized paper on it and thus, providing the receiving and sending stations are in exact synchronism, the picture will be reproduced faithfully. The hardest part of the transmission of photographs lies in the synchronizing methods employed.

More recent work has been done by Jenkins, Nakken, Col. Green and others who believe that the transmission of moving pictures by radio will shortly become an accomplished fact.

BUZZER OSCILLATOR

(254) John Ballinger, Fort Worth, Texas, says he has recently completed a Neutrodyne sets and asks:

Q. 1. I am in need of a buzzer oscillator in order to help me neutralize the set. I would, therefore, appreciate it very much, if you give me complete details as to its construction.

A. 1. The buzzer oscillator often finds other uses than that for the purpose of aiding in neutralizing a set. It can be used very successfully as a wavemeter if carefully calibrated, and will afford many other uses. On a cardboard or bakelite tube, three inches in diameter and three and one-half inches long is wound 70 turns of No. 22 D.C.C. wire. Connected across this coil is a 15 plate variable condenser, having a capacity of .0003 mf. This arrangement will tune approximately from 200 to 600 meters. An ordinary dry cell buzzer is connected in the circuit in series with a key or switch and the buzzer-driven oscillator is then complete. As shown in Fig. 254, only one connection is run to the receiving set, and that is placed on the antenna post. If neutralization is desired on the shorter waves, the condenser is turned until its rotary plates are nearly all the way out and the usual method in neutralizing the set is followed. A good way to calibrate your oscillator is to place its coil near the first neutroformer of the set while listening in. Tune in a local station whose wave-length you are assured of. Then, by slowly moving the variable condenser of the oscillator until the station has completely faded out, note the reading on the dial on the oscillator. Then tune in another station on a different wave-length and again set the oscillator until the station has completely disappeared.

Thus a series of points are plotted and a very accurate graph is consummated which will come in very handy. As can readily be seen, the device lends itself very effectively to use as a wave-trap.

CRYSTAL DETECTOR

(255) Alfred O'Hara, Spokane, Wash., wishes to know:

Q. 1. The exact theory concerning the rectification property of crystal detectors.

A. 1. Although the true action of crystal detectors is a complicated matter, for practical purposes, it is sufficient to regard them as unilateral conductors. This is for the reason that they have a greater resistance to current flowing through them in one direction than to current flowing in the other. Thus, for instance, when an alternating electromotive force is impressed on a crystal detector, more current flows in one direction than in the opposite and if a direct current meter be inserted in the circuit, it will operate.

The resistance of ordinary crystal detectors is in the order of 1,000 to 10,000 ohms when current is passing in their "low-resistance" direction. The resistance in the opposite direction is about 10 times as great.

LABORATORY OSCILLATOR

(256) Harry Bertman, Bronx, N. Y., desires:

Q. 1. Information on the construction of a laboratory type oscillator, in which the radio-frequency oscillations are modulated by a 500-cycle buzzer.

A. 1. For the numerous purposes to which an oscillator of the type depicted in the diagram No. 256 can be put, we are sure that many of our readers will appreciate the constructional data so as to build one for themselves.

To contain the apparatus, a box 16 inches square and 6 inches deep, lined throughout with sheet copper or tinfoil, will suffice. Even the bakelite panel must be thoroughly shielded, provision being made to carefully insulate the wiring against short circuit. The two meters can be mounted flush with the panel or left out entirely.

The first step after the completion of the device is to calibrate it. This should be done very carefully with a standard wave-meter, using the well-known click method. It will be seen that the wave-length range is from 200 to 600 meters, using the constants given, Fig. 256A. A separate battery is required to operate the buzzer.

The oscillator can, after a fashion, be used as a small transmitter, the amateur always remembering to keep the wave-length below 200 meters. Of course, it is readily observed that the transmitted signal is of the I. C. W. type, a key being submitted for the switch in the buzzer circuit.

The real value of the oscillator lies in its adaptability as a means of aiding in the neutralizing and calibration of receiving sets. This is readily accomplished by coupling the exploring coil to the input transformer—antenna circuit—and, having adjusted the oscillator for a certain wave-length, procedure is carried on by tuning the set to resonance and adjusting it to eliminate all squealing. The outfit is known sometimes as a driver circuit.

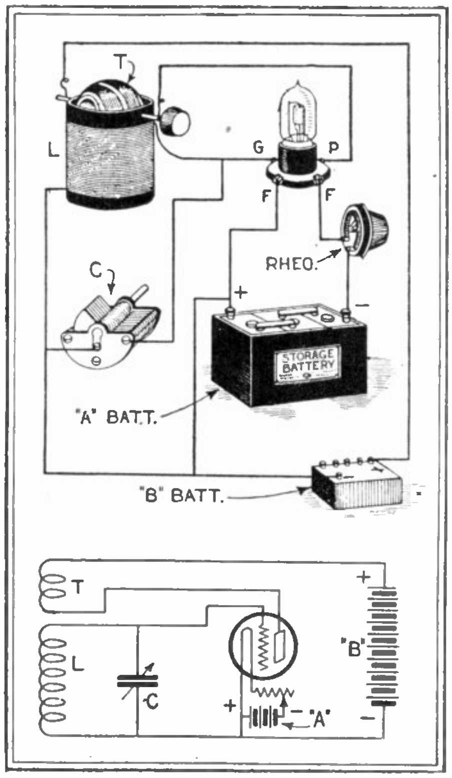


Fig. 256. Herewith is shown a fundamental oscillatory circuit.

CAPACITY

(257) Sol Kupferman, Coshockton, Ohio, asks:

Q. 1. Kindly explain as clearly as possible the action of the condenser in R.F. and D. C. circuits:

A. 1. In an arrangement known as an electrical condenser which consists of conductors and insulators, electrostatic energy may be stored up. The action is similar in analogy to that of a gas tank used for the purpose of storing gas. The amount or volume of gas which can be held by a tank is not fixed. Thus, if the pressure is doubled, twice the volume of gas can be contained within the tank. If the pressure is increased, more gas can be stored until eventually the tank bursts.

This is exactly what happens in a condenser. The amount of electrical charge given to a condenser depends on the potential difference or electric pressure, the charge being directly proportional to this potential difference. The capacity of the condenser is expressed by the constant ratio of charge to the potential difference, symbolized : Q divided by V equals C.

Besides depending upon the distance apart between its plates and the kind of dielectric between them, the capacity of the condenser varies according to the size of its plates. Radio frequency currents readily pass through condensers. As the frequency becomes lower, less and less current is allowed to go through until when a direct current is applied to its plates, no currrent whatsoever flows.

In resistance coupled amplifiers it is at once understood why blocking and by-pass condensers are used, the term by-pass being used when speaking of radio-frequency currents and the term blocking condensers used when it is necessary to keep the plate voltage from directly affecting the grid circuit.

GRID LEAK

(258) Q. 1. G. Reiser, West Hoboken, N. J., asks: What is a grid leak and what are its uses in a radio circuit?

A. 1. A grid leak is used in a radio circuit to let the radio-frequency currents leak off the grid. If these currents were allowed to accumulate they would render the vacuum tube inoperative until these charges leaked off in some manner.

Q. 2. Frequently the grid leak is placed between the grid and the filament and sometimes across the grid condenser. Which is usually the best position?

A. 2. The most generally accepted method is to place the grid leak across the grid condenser, but with some tubes the other method works out better. We would recommend that you try both methods until best results are obtained.

OSCILLATIONS

(259) Q. 1. R. Simpson, Chicago, Ill. Please explain how oscillations are produced in the circuit I am sending you.

A. 1. The phenomenon of self-oscillation is rather remarkable and is usually explained as follows:

A momentary accidental E.M.F. on the grid may cause a sudden variation of the

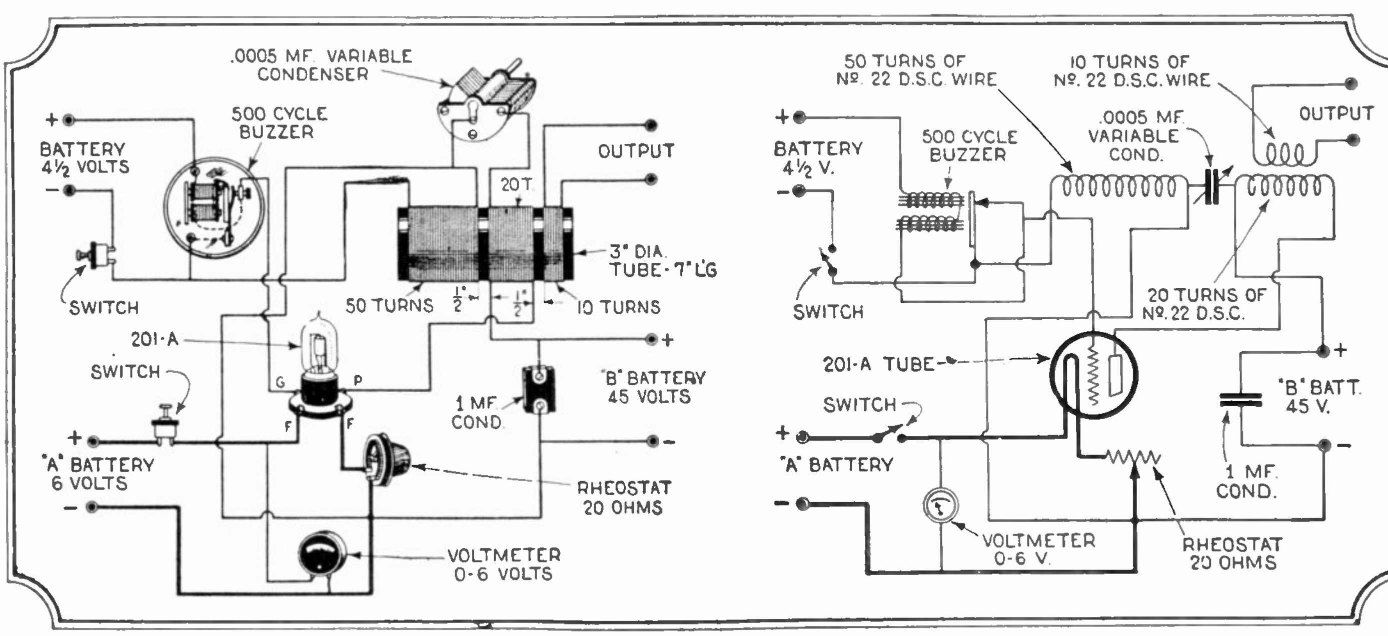


Fig. 260A. A laboratory is not complete without a calibrated oscillator. Full constructional details are given so that the experimenter can readily build one for himself. The list of materials is evident from the picture diagram, a shielded box being used to contain it.

anode current. The circuit LC consequently tends to oscillate since the condenser C becomes charged and then discharged through L. These weak oscillations in LC induce similar oscillations in R, and are then communicated to the grid of the vacuum tube. The oscillations are magnified by the amplification action of the tube and thus reinforce the oscillations already existing in circuit LC, with which they are in phase. The magnified oscillations now induced in T are magnified by the tube and so the process goes on until the oscillations in R and L are self-supporting. This, of course, takes place in a fraction of a second. The frequency of oscillations thus produced may be varied by altering the value of the variable condenser C.

TELEPHONE JACKS

(260) S. K. Pine, Waterbury, Conn., wants to know:

Q. 1. Is it necessary to use telephone jacks on a receiving set, and can I have some information concerning the same?

A. 1. The telephone jack plays an extremely important part in a radio receiver. Due to the large quantity production basis on which jacks are turned out, their cost is small and, due to this fact, it is easy to come to the false conclusion that they play but a minor part in the operation of a set.

The jack is used mainly to plug in the headphones or loud speaker on any desired stage, from detector to the output of the push-pull power amplifier, thereby enabling the operator to control the volume. Some types, known as filament control jacks, are so constructed as to light up the tubes in the receiver when the plug is inserted and to break the circuit when the plug is withdrawn. It is thus possible to automatically cut out the filament of the tubes which are not in use, with consequent saving of both "A", "B" and "C" batteries.

Thus, generally speaking, when the phone plug is inserted in the jack, the headphones are placed in series with the plate of the last tube and the positive "B" battery supply, while the rest of the circuit, through the primary of the amplifying transformer, is cut off. Again, when the plug is withdrawn, the circuit is completed through the primary of the next transformer. It is readily seen, therefore, that the jack is always in the output circuit of the tube where the most current is handled, thereby making it important that the best of insulating materials be used, that the contact points, the springs and dimensional features of the jack be as exact and perfect as possible. If the insulating material is faulty, it is evident that a serious leakage of energy will take place.

For the reason of their right-angle construction, jacks will be found very useful as supports for a sub-panel or, mounted flush against a baseboard, to act as panel brackets.

A word about materials. The frame of the jack should preferably be of nickle-plated brass, while the spring leaves should be of the same material, provided with silver contacts riveted into them. Silver will not corrode and is one of the best conductors, making it an ideal material to use for the jack spring contacts. For the insulating material, thin sheets of bakelite are preferable, with short lengths of hard rubber tubing to insulate the holding screws. It is also necessary to have the soldering contacts widely separate, so that ample room remains where heavy bus bar is to be directly soldered to the jack.

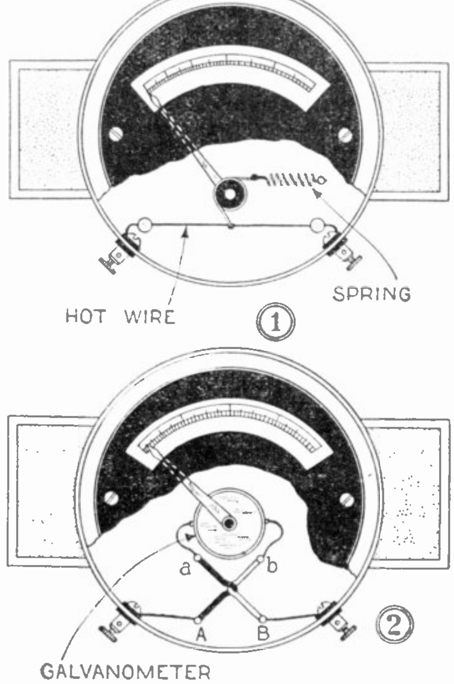


Fig. 265. A hot wire and a thermo-coupler ammeter are shown above in Figs. 1 and 2 respectively.

TOROIDAL COILS

(261) Q. 1. Mr. P. E. Butterfield, Oakland, Calif. What are the advantages of toroidal coils, and how may they be constructed?

A. 1. In the toroidal coil all inductive effects between adjacent coils is removed because the field is concentrated within the coil itself, therefore there is no stray field to induce any currents in coils near them. The easiest method of winding a toroidal coil is to obtain a circular piece of wood about one-half inch in thickness, three and one-half inches outside diameter and one and one-half inch in diameter inside. The form should look like a thick, abbreviated phonograph record with a large opening in the center to allow a spool of wire to be slipped through readily. The secondary should consist of about 200 turns of No. 24 double silk-covered or single cotton-covered wire; about 65 feet of wire is used. The primary consists of about 20 feet of the same wire wound loosely so as to extend over the entire length of the secondary.

DRILLING HARD RUBBER

(262) Q. 1. Mr. D. McCarthy, Dallas, Texas, asks what precaution should be taken in the drilling and sawing of hard rubber.

A. 1. When drilling hard rubber, use drills of the best high carbon steel variety. They should always be kept sharp so as to avoid burrs on the face of the panel. When sawing this material use a hacksaw having about 24 teeth to the inch.

LEAD-IN

(263) Q. 1. Y. Sagnotty, Toronto, Canada, wants to know if it makes any difference where the lead-in is connected to the aerial.

A. 1. If you make the inverted L type aerial, bring your lead-in off the very end of the flat top. If you make the T type, connect the lead-in exactly in the middle. Otherwise, you have an unbalanced condition, with currents bucking each other at one point or another. Surface is what you want in an antenna; therefore, we recommend that you use enameled stranded wire. If you point the lead-in end of the aerial toward the transmitter you will have more of a chance of getting the station, while in a T type antenna, the directional effect is not so noticeable.

NOISE

(264) Q. 1. J. B. Petrus, Mount, La., says that when he taps the table upon which his radio set is resting or taps the cabinet, a loud noise is heard in the receivers or loud speaker. He asks what produces this and how it can be eliminated.

A. 1. Regarding the noise which is heard when your set is tapped, we would advise that the same is caused by the vibration of the elements contained within the tubes. This can be eliminated or at least reduced to a considerable extent by suspending the sockets of the tubes on springs or rubber bands so that they will not vibrate excessively.

Q. 2. He also says that he occasionally experiences trouble in tuning out wireless stations and asks us how such trouble can be eliminated.

A. 2. Regarding the tuning out of radio telegraph transmitting stations, which we presume you mean by wireless stations, we would advise the addition of a series, inductively coupled wave-trap. We do not believe that this trouble could be eliminated by the purchase of a better vario-coupler and variable condenser. However, if the primary and secondary coupler are wound with wire any smaller than No. 20, we would advise you to rewind them with that size wire, placing thereon the same number of turns as is removed. This will make your tuning considerably sharper.

RADIO AMMETERS

(265) Q. 1. Mr. Jack Kinke, Los Angeles, Calif. Will you kindly explain the differences in operation between a hot-wire ammeter and a thermocouple ammeter?

A. 1. It will be noticed that the operating element in the hot-wire ammeter shown in Fig. 265-1 of the accompanying diagram consists of a length of expansible metal such as a thin piece of resistance wire or a length of platinum strip. One turn of thin silk thread is wound around the bearing rod and is held taut by a small spring. When an E.M.F. is applied to the binding posts, the wire becomes heated, thereby expanding and allowing the spring to take up on the thread, which sends the pointer over a graduated scale. The hot-wire ammeter operates on the principle of the expansion of metals when heated.

In Fig. 265-2 may be seen the diagram of a thermo-coupler ammeter. This instrument operates on the principle of the generation of an E.M.F. at the junction of two unlike metals which are being heated by another E.M.F. The metals most commonly used in thermo-couple elements are constantan and steel, or constantan and manganin, of about .02 millimeter in diameter and four millimeters long. When the two ends of the thermo-element, A and B, are connected to an E.M.F., the heat generated at the junction of the two elements induces another E.M.F. across a and b, which acts upon a sensitive galvanometer.

AIR HOGS

(266) Q. 1. Clair Dale Cable, Minneapolis, Minn., asks: What does air hog mean when used in connection with radio?

We take it to mean a person who would like to have the use of the air all of the time and not give anyone else a chance to use it. We have a great many of these so-called air hogs in Minneapolis who are amateurs. They commence sending code about 6:30 or 7 P. M. and keep it up until 12:30 or 1 A. M. It may be great sport for them but what about other people who have receiving sets and would like to listen to distant concerts? They may be able to get distance stations, but the concerts are always broken up by a lot of God-forsaken code.

Large broadcasting stations have certain times at which they broadcast; why should not amateurs be restricted, and not be allowed to transmit between the hours of 6 o'clock P. M. and 12:30 P. M. These are the hours during which almost all large stations are broadcasting their best programs. These programs are broadcast for the enjoyment of people who wish to listen in. They can't enjoy these programs when amateurs are always sawing and chopping them to pieces. Don't think this is meant only for Minneapolis amateurs. It is meant for amateurs from coast to coast.

A. 1. In answer to your communication regarding "amateur air hogs," we would advise you as follows. The amateur who sends "God-forsaken code" is the person that made possible your broadcast reception. If it were not for the amateurs and their work in developing radio communication to its present point, you would doubtless still be listening to your phonograph when you desired musical entertainment. There would be as yet no broadcasting stations and, therefore, of course no musical programs for you to receive.

In the majority of cases the fault of interference lies not with the amateur, but with the broadcast listener himself whose set is not selective enough to tune out the amateurs who are on a wave-length of 200 meters or less. Many of the radio receiving sets which are in use today cannot differentiate between wave-lengths 200 meters apart and everything comes through as through a sieve. This fault gives rise to many unjust complaints against the amateurs who, by the way, are barred from the air during certain hours. On the 150- to 200-meter band these hours are 7:30 to 10:30 p.m., local standard time. Possibly the interference you mention is caused by Army and Navy stations transmitting official government business. Since many receivers are not selective, it is impossible for them to separate the radio telegraph transmitting stations from the broadcasting stations.

In discussing this matter we must remember that every question has two sides and that in respect to the broadcast listener, the amateur has been limited in his hours. If you can positively ascertain that it is an amateur who is breaking up your broadcast reception, we would advise you to inform your nearest radio inspector so that steps may be taken in the matter to remove the trouble.

Every transmitting amateur is a gentleman at heart and only too glad to regulate his experiments so as not to interfere with other people's enjoyment. We are sure if you will find out who is causing the interference and approach him in the proper manner that no more trouble will be experienced. Furthermore, there have recently been formed throughout this country vigilance committees under the auspices of a nation-wide amateur organization. If you will inquire as to the members of this committee in your home town and communicate with them, they will be only too glad to investigate all your troubles.

RHEOSTAT CONNECTION

(267) Q. 1. J. C. Porter, Habana, Cuba, says that he has noticed that in different circuits the rheostats are sometimes shown in the positive filament lead, while in others these instruments are indicated as being connected in the negative lead. He asks which connection is correct.

A. 1. The exact connection of the rheostat which you inquire about causes very little difference. Usually, however, it is advised that they be placed in the negative lead of the "A" battery.

Q. 2. Are "C" batteries needed in a two-stage amplifier, and if so how should they be connected?

A. 2. In two-stage amplifiers, "C" batteries are usually desirable. To use them, connect the grid return binding posts of the audio frequency transformers together and connect the common wire to the negative of the "C" battery. Connect the positive side of the "C" battery to the negative "A."

TROUBLE

(268) Q. 1. Wm. N. Keech, York City, Pa., says that he has built a radio receiving set following the directions given in this magazine, has used all good parts and wired the set carefully. Says he cannot get any results worth while, and that the volume delivered is very small. He asks our opinion as to his trouble.

A. 1. Inasmuch as you state that you have followed directions very carefully and are unable to get results from your set, we would suggest that the trouble lies in the fact that the tickler connections are reversed. This of course will prevent regeneration, and naturally you will be unable to produce volume. The problem resolves itself simply into reversing the terminal connections to the tickler coil.

MEGOHM

(269) Q. 1. Robert H. Phelps, Kansas City, Mo., asks us whether or not 7 megohms is the same as 70,000 ohms.

A. 1. Seventy thousand ohms is not equivalent to 7 megohms. Seven megohms means 7,000,000 ohms; 1 megohm = 1 million ohms.

INTERFERENCE

(270) Q. 1. Donald Reuss, Easton, Pa., says that he is operating a radio set a very short distance away from a motion picture theatre in which the projectors are equipped with arc lights. He says that he has considerable trouble from this source as the arcs interfere with his reception. Changing the direction and length of his aerial has had little or no effect on the interference. He asks our advice.

A. 1. The only thing that we can suggest is that you install a more sensitive set and use a loop antenna. Two or three stages of radio frequency amplification with a loop will give you quite good reception and a directional effect that should enable you to practically eliminate the interference.

FIXED RESISTANCES

(270A) Q. 1. Emile Hennon, Brussels, Belgium, says that in the country where he lives he cannot buy the fixed resistances which are often recommended in the construction of radio sets. These resistances that he mentions are the ones used to control the filament current of the tubes. He asks if rheostats can be used in place of these resistances and whether or not a rheostat is necessary in the filament circuit of each tube.

A. 1. It is entirely possible to replace these fixed resistances with rheostats and the only objection is that the control of the set is thus somewhat complicated. It is not necessary to incorporate one rheostat for each tube, although it is advisable inasmuch as it gives much greater flexibility to the set and allows for the slight differences which are sometimes noticeable in the filaments of tubes.

PORTABLE RECEIVER

(271) Q. 1. Wm. Hampton, Millville, N. J., says that he has been looking for a diagram of a two-tube set that will fit in a small storage battery box. He asks us to furnish him with such a circuit.

A. 1. The size of the cabinet in which a radio set will fit does not depend at all upon the circuit, but depends upon the parts employed and the mechanical arrangement of them. Practically any two-tube set could be built so as to fit in the box you mention. The mechanical arrangement will depend upon yourself. No special hookup is necessary for such a purpose.

FRYING NOISE

(272) Q. 1. Jesse L. Fitzwater, Wabasha, Minn., says that he has considerable trouble with his five-tube set in that a continual frying noise is noticeable during reception. He asks our opinion as to the source of this noise.

A. 1. There are several sources where trouble of this nature could start. The most obvious one is a poor fixed condenser somewhere in the set. This might be the grid condenser or it might be one of the by-pass condensers. Try removing these condensers from the circuit, replacing them with others, and see if any noticeable difference is obtained. If not, try shunting the secondary of the first audio frequency transformer with a variable grid leak and then use a resistance which is variable from 10,000 to 100,000 ohms. One or the other of these resistances may clear up your trouble. Furthermore, make sure that the trouble does not originate in the loud speaker itself.

INSTRUMENT CHANGE

(273) Q. 1. Oliver Malmanger, Huxley, Iowa, says that he is plannnig on building a Neutrodyne receiver and asks whether or not a variocoupler can be used in place of the first neutroformer.

A. 1. This change is entirely possible and the only objection to it is another control will be added to the receiver. If you make this change, the primary of the variocoupler should consist of about 10 or 12 turns of comparatively heavy wire, say No. 18 D.C.C.

LOOP QUERY

(274) Roger Pryor, Union Hill, New Jersey, asks:

Q. 1. How can I make a loop to give me the best results on my Neutrodyne set?

A. 1. Twelve turns of No. 18 ordinary cotton covered paraffined bell wire, wound on a frame 3 feet square will answer. The turns should be spaced at least ¼ of an inch apart, and the loop when shunted with a .0005 variable condenser will cover between 200 and 600 meters very efficiently.

Miscellaneous Data

R. F. AND A. F. WITH STANDARD RECEIVER

(275) George Siedel, Pittsburgh, Pa., writes:

Q. 1. How can I connect one stage of radio frequency amplification with my type CR-5 receiver and place after the same one stage of audio frequency amplification?

A. 1. The diagram given in Fig. 275 shows all the necessary connections. It is imperative that the variable condenser which is connected in series with the antenna binding post on your set be short circuited or else removed from the circuit so that the aerial binding post will be connected to the grid end of the stator. If this is not done, the set will not function. It is advisable to connect this variable condenser in parallel with the stator so as to give sharper tuning although in some cases it will be found that such a procedure will raise the wave-length to a point where broadcasting stations cannot be received. Thereupon the condenser should be removed from the circuit.

STORAGE "B" BATTERY QUERY

(276) Joseph Karl, Pittsburgh, Pa., asks:

Q. 1. In making a storage "B" battery should the plates be pasted in the same manner as those in a large storage battery, such as used in automobiles?

A. 1. Yes.

Q. 2. What kind of wood should be used for separators?

A. 2. Practically any kind of wood could be used, but white pine or spruce is best. Even better than wood are perforated sheets of thin hard rubber.

MULTI-AUDI-PHONE

(277) James McCarthy, Bayonne, N. J., asks:

Q. 1. Is the apparatus known as the multi-audi-phone still on the market?

A. 1. To the best of our knowledge this apparatus is no longer manufactured.

Q. 2. What is the principle of the multi-audi-phone and how is it constructed?

A. 2. You will find in Fig. 277 a cross sectional diagram of the microphonic amplifier known as the multi-audi-phone. As will be seen, it consists of a solenoid within which is a movable core, which in turn is connected to a diaphragm. On the opposite side of the diaphragm is a projection, the end of which is cup shaped. Close to this is another cup shaped projection which can be moved closer to and further away from the former by means of a screw. Between these two surfaces and held in place by an insulating tube is found a compound which we believe is carbon in a granular form. The action of this instrument is similar to that of the microphone and becomes obvious upon studying the accompanying diagram.

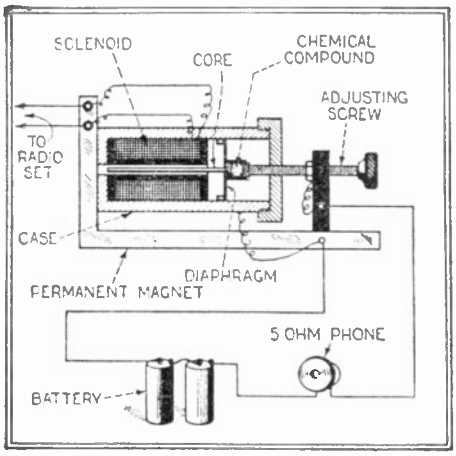


Fig. 277 One of the first successful types of microphone amplifiers is shown above. This is the cross section view.

A. F. AMPLIFICATION WITH A REINARTZ TUNER

(278) T. L. Jacoby, Detroit, Mich., wants to know:

Q. 1. Can I add four stages of audio frequency amplification to a Reinartz tuner?

A. 1. We would not advise you to use four stages of audio frequency amplification on a Reinartz or any other type of tuner. Furthermore, if you desire to use amplification with this circuit, it may be added in the standard way, no change being necessary for this particular type of set. Two, or at the most only three, stages of A. F. amplification should be used.

RADIOPHONE TRANSMITTER TUBE

(279) Gilbert Joyce, Kansas City, Mo., asks:

Q. 1. Can a U.V.201 vacuum tube be used as a radiophone transmitter?

A. 1. A U.V.201 vacuum tube with 100 to 150 volts on the plates will act as a transmitter over very short distances. Any one of the 5-watt tubes will give good results.

UNTUNED ANTENNA CIRCUIT

(280) Charles Burg, Riberside, Cal., asks:

Q. 1. How can I place one stage of radio frequency amplification in front of my single circuit tuner without an apparatus for tuning the antenna circuit?

A. 1. The diagram in Fig. 280 shows all the necessary connections for such a circuit. It is advisable to place the grid leak in the position shown rather than in the conventional place in parallel with the grid condenser. An amplifying tube is used at the extreme left and a detector tube in the other socket. The potentiometer may or may not be used as is found best by experiment.

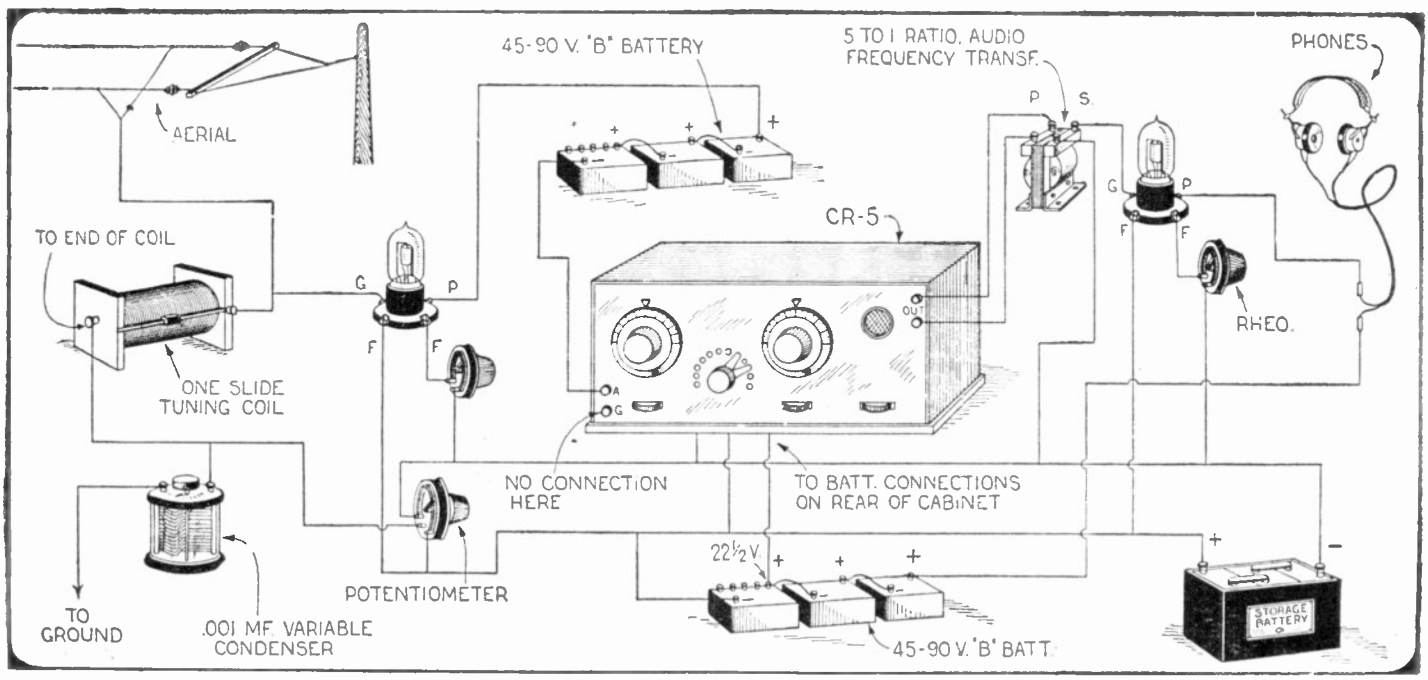


Fig. 275. To increase the receiving radius of a standard signal circuit tuner of practically any type, radio-frequency amplification may be added by following the circuit diagram given above. The remarks relative to the series antenna condenser which are given in the text should be carefully noted, as inattention to points given there will result in the set's failure to operate. If desired, a honeycomb coil may be substituted for the one slide tuner indicated in the diagram. Various coils will have to be substituted to cover the band of wave-lengths desired. The inductance used in the antenna circuit should be such that its wave-length will tune in the incoming signals.

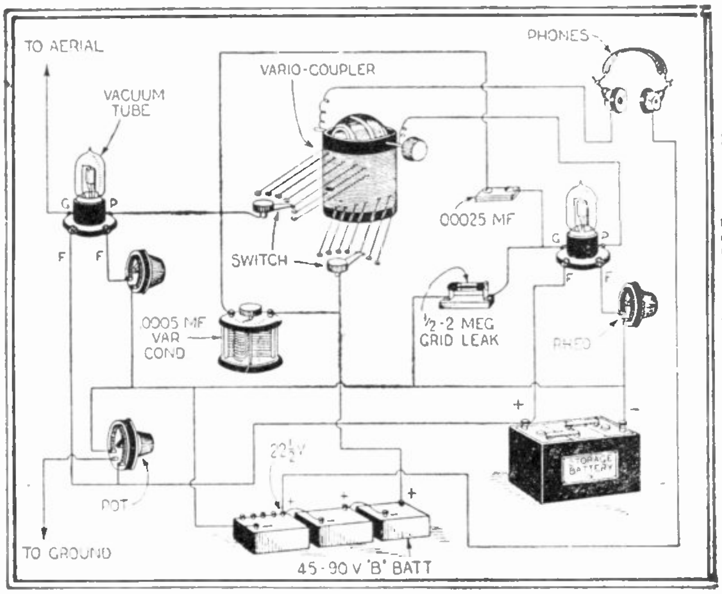


Fig. 280. In some cases it is possible to use radio-frequency amplification without any tuning arrangement between the R.F. amplifier tube and the antenna. Such a circuit diagram is shown above. At times it will be necessary, however, to place a one-slide tuning coil in series with the antenna.

SQUEALING

(281) Elmer Kayler, Dayton, Ohio, says that his set howls and squeals continuously when his hand is brought near any of the controls. He asks:

Q. 1. How can I eliminate this and will a vernier condenser be of any assistance?

A. 1. You can probably eliminate the trouble you mention by shielding the back of your panel with aluminum and grounding the shield. The trouble is due to the capacity of your body and can be eliminated as mentioned above. If this work is done a vernier condenser shunted across your antenna condenser will be of assistance in accurate tuning.

VARIOMETER WITH SINGLE CIRCUIT TUNER

(282) Robert Fitch, Lakewood, Ohio, asks:

Q. 1. How can a variometer be added to my present standard type of single circuit tuner?

A. 1. The circuit diagram in Fig. 282 shows how a variometer may be connected in series with the plate of a standard single circuit tuner. Recent experiments have shown that such an addition to a standard single circuit set makes it more selective under almost all conditions.

AMPLIFIER TROUBLE

(283) Frank Prell, Osceola, Nebraska, sends diagram of his detector and two-stage amplifier and says that he has placed his transformers quite a distance apart, but that he still gets whistling noises during reception. He asks:

Q. 1. Can you tell me what is the trouble with my circuit?

A. 1. The whistling noise is probably caused by the way you placed your transformers in an endeavor to cut it down. The long leads necessary between your transformers have a capacity effect on the circuit, thereby causing the howling. In connecting up your set, do not have the grid and plate circuits cross each other. Also try reversing the leads on the transformers, grounding the filament, and shielding all the apparatus.

Your circuit diagram is O. K., but would suggest that you connect the fixed phone condenser directly across the primary of the first amplifying transformer.

Variable grid leaks and condensers are always preferable in any type of set, and we would advise you to try various resistances and capacities until the correct value is obtained.

A. F. AMPLIFIER WITH SWITCHES

(284) G. H. Gillis, M. D., Yatesboro, Penna., asks:

Q. 1. Can you give me a circuit diagram of a detector and two stage amplifier unit used either with a single circuit tuner or a three circuit tuner and include thereon a switch for changing from detector to one or two stages of audio frequency amplification without the use of jacks?

A. 1. In the diagram in Fig. 284 we show a detector and two stages of audio frequency amplification. Two switches are indicated. When switch S is on switch point 3 and switch S1 is on switch point 2, the detector alone is being used. With switch S on point 2 and S1 on point 1, the detector and one stage of audio frequency amplification are being used. The

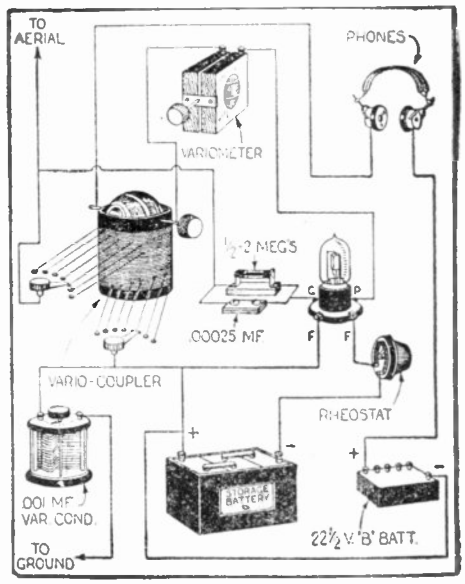


Fig. 282. If a variometer is placed in series with the plate of a vacuum tube in a standard single circuit tuner, much greater selectivity will result as a combination of the feed-back and tuned plate system.

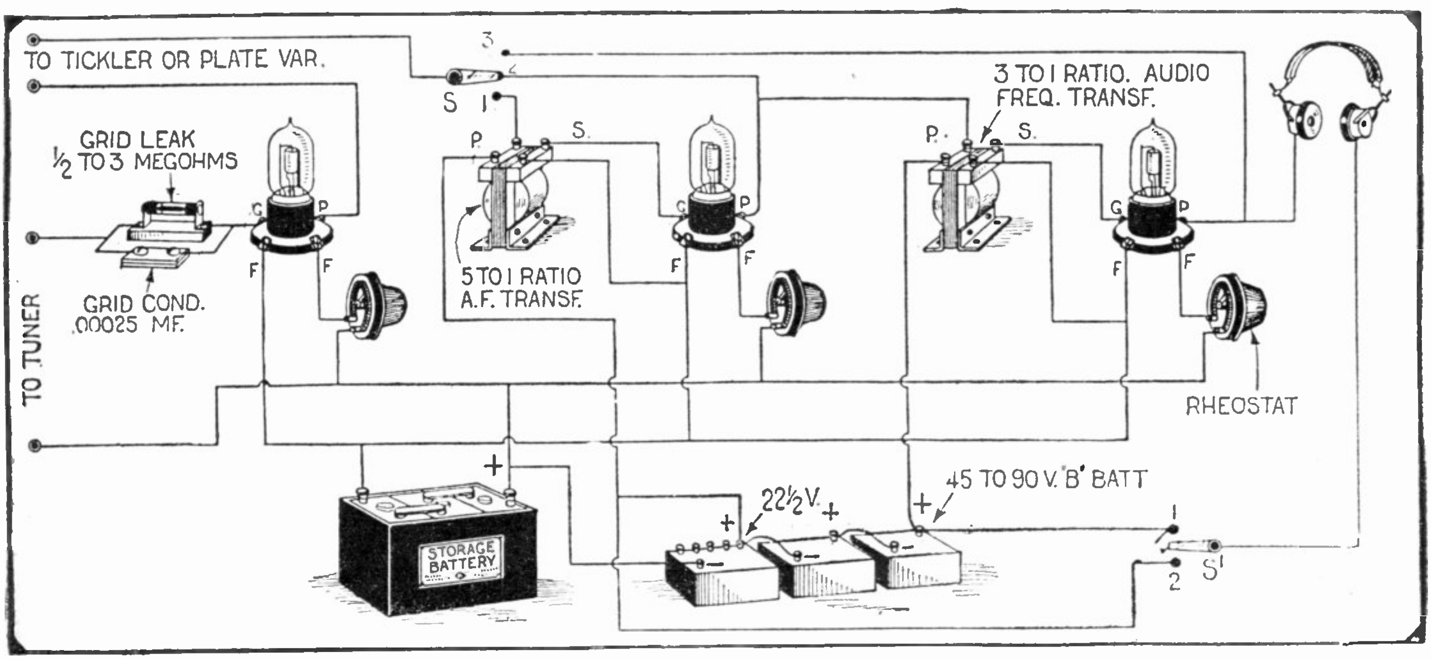


Fig. 284. Since jacks are rather inefficient instruments and often cause trouble because a slight amount of grit or dirt between the contact points causes an open circuit, they should be avoided. An efficient way of eliminating jacks is to make use of two switches, one of the three-point type and the other of the two-point type. All the necessary connections are indicated above and the manipulation of the switches is described in the text.

third tube then acts as the audio frequency amplifier. With switch S on point 1 and switch S1 on point 1, all three tubes are being used.

CHANGING TYPE OF TUBES

(285) C. O. Dieter, Rittman, Ohio, asks:

Q. 1. If I decide to substitute U.X.-199 vacuum tubes for those contained in my set at the present time, will any changes have to be made? The tubes I am using now are a U.X.-200-A detector, and U.X.-201-A amplifier.

A. 1. In regard to the use of U.X.-199 tubes in your radio set, we would say that no radical changes will be necessary. You will, however, have to either substitute sockets for these tubes as they have different bases than the standard tubes, or else obtain adapters so that the 199s can be used in standard sockets. The above mentioned sockets or adopters can be obtained from companies advertising in the current magazines. You will also have to substitute three dry cells for your present "A" battery and it is advisable to use 30 ohm rheostats.

LEAD-IN CONNECTION

(286) George Rice, Brooklyn, N. Y., asks:

Q. 1. What is the best way, mechanically and electrically, to connect a lead-in wire to a standard flat top aerial?

A. 1. We illustrate in Fig. 286 one of the best methods of making this connection. The connection between the flat top wire and the lead-in or down-lead has no mechanical strain exerted upon it and, therefore, its electrical qualities are not subject to change thereby. The joint may either be made with a copper sleeve connector or may be soldered.

INCREASING SELECTIVITY

(287) M. C. Baker, Los Angeles, Calif., asks:

Q. 1. How can I improve the selectivity of my crystal receiving set consisting of a variocoupler with ten taps and a variable condenser across the rotor?

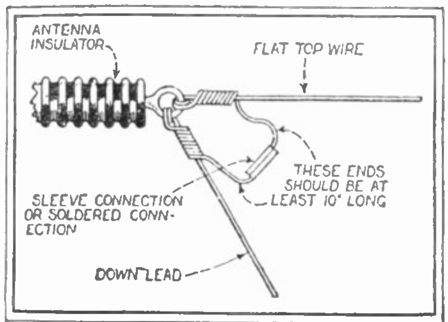


Fig. 286. Careful attention should be paid the connection of the lead-in to the aerial proper. Above is illustrated the best method for making this joint so that it will be strong and electrically perfect.

A. 1. The selectivity of your set may be increased somewhat by placing a variable condenser either in series with the antenna or across the stator as may be found best by experiment. This condenser should have a capacity of .0005 mf.

Since you do not state the length of your antenna it may be that it is too long. If such is the case, you should cut down the length so that it will be no more than 80 to 90 feet long, including the lead-in to the set.

DRY CELLS WITH CRYSTAL SET

(288) C. H. Dorman, Buchanan, Iowa, wants to know:

Q. 1. Can I connect dry cells in the circuit with my crystal receiver so as to increase the efficiency?

A. 1. We would advise you that you cannot use dry cells on this set with any increase in efficiency; in fact, it would decrease the results obtained. Only in the use of certain crystals can dry cells be used and it has been proven by experiment that such crystals do not give as loud reception and as great range of reception as galena or any one of the other crystals sold on the market today.

TROUBLE WITH CRYSTAL SET

(289) T. A. Dew, Bronx, N. Y., says that he has a crystal receiving set which does not operate properly. He states that all his instruments are in good condition and that he is using a short piece of copper wire as a cat-whisker. He asks:

Q. 1. Can you suggest some point that could be the trouble with my set?

A. 1. Since you say that your apparatus is all in good shape and tests up correctly, we would say that the trouble is probably in your crystal. Undoubtedly, the latter is not very sensitive. It may be, however, that your instruments are not connected up properly and we would advise you to send us a circuit diagram for inspection. We would further advise that you use a piece of fairly fine phosphor bronze wire as a cat-whisker, have the same coiled in a spiral.

INVERSE DUPLEX

(290) J. J. McKenzie, Ensley, Ala., asks:

Q. 1. What is the advantage of the inverse duplex type of receiver over the standard reflex circuit?

A. 1. We will take the circuit diagram shown in Fig. 290 as an example. Here we see that the first tube on the left acts as the first stage of radio frequency amplification and as the second stage of audio frequency. The center tube acts as the second stage of radio frequency and the first stage of audio frequency. Obviously, the load imposed on the tubes by causing them to act as amplifiers is more equally distributed than in the standard straight reflex. In the latter circuit, the first tube is the first stage of both radio and audio frequency and the second tube is the second stage of both types of amplification. Therefore, the second tube is severely taxed and does not function properly at all times.

Q. 2. Kindly show a circuit diagram of a three tube inverse duplex receiver using a vacuum tube detector.

A. 2. The circuit diagram will be found in these columns.

RADIO FREQUENCY AMPLIFICATION

(291) Roy L. Grant, Eureka, Kansas, asks:

Q. 1. How can I increase the receiving

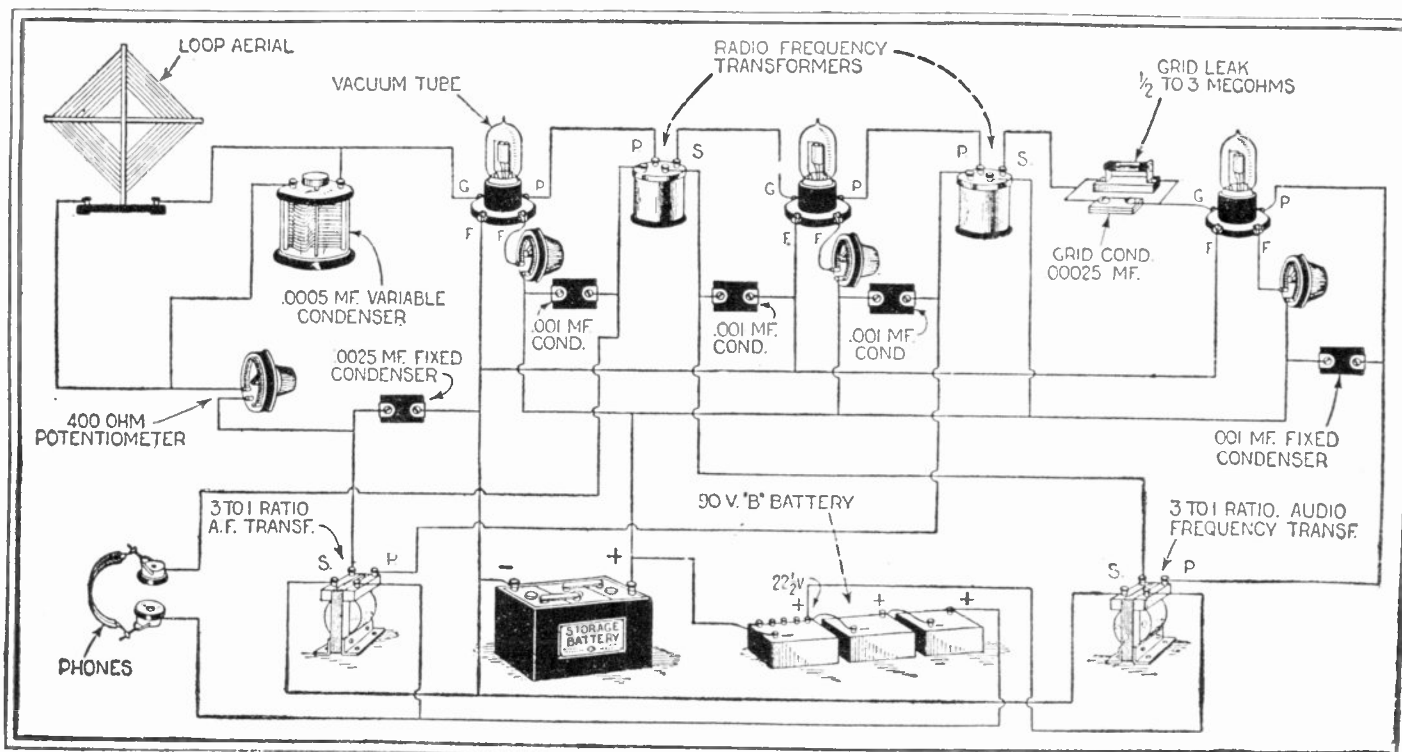


Fig. 290. The inverse duplex receiver has the advantage of not overloading the tubes and rendering them inefficient as is the case in the standard straight type of reflex circuit. The connections for a three-tube set of the inverse duplex type are given above. Two radio- and two audio-frequency transformers are used in connection with the three tubes giving practically the same form as two stages of radio-frequency, detector and two stages of audio-frequency amplification.

range of a set and can the extra instruments be added to a set comprising a tuner, detector, a two stage audio frequency amplifier, without changing the connections therein?

A. 1. The only way to increase your range to any great extent will be the addition of one or two stages of radio frequency amplification. Unless you are fairly familiar with radio work, however, we would not advise you to attempt this addition as good results would not be obtained without considerable experimental work. If, however, you desire to try such a circuit, send us a description of the tuner, enumerating all the instruments used therein and give a hook-up of the same. We will then show you how to add radio frequency amplification in front of your tuner.

RESISTANCE OF PHONES

(292) O. E. Kaufman, Plains, Kans., asks:

Q. 1. Does the actual resistance of phones have anything to do with their efficiency?

A. 1. The resistance of receivers in radio work has very little to do with the efficiency of the phones. It is the number of ampere turns on the magnets that counts. Phones might much better be rated at their impedance, as for very best results this value should be nearly equal to the internal impedance of the vacuum tube. The talking current actuating a telephone is so light that the question of ohmic resistance plays but a small part in practice. The great point is to get as many turns of wire as possible without making the receiver too clumsy. The simplest way to rate a telephone would be by its resistance except for one thing—the temptation to dishonest people of putting iron or German silver wire in the coil. This gives resistance, but reduces the ampere turns.

RADIO AND AUDIO FREQUENCY AMPLIFICATION

(293) Austin Peterson, Sheffield, Ill., asks:

Q. 1. Can you give me a circuit diagram showing how to connect up one stage of radio frequency amplification, a detector and two stages of audio frequency amplification using a loop antenna and a variometer to tune the radio frequency amplifier?

A. 1. The diagram for this arrangement will be found in Fig. 293.

JACKS IN REFLEX SET

(294) A. H. Patterson, Lynchburg, Va., asks:

Q. 1. Can I use filament control jacks in a three-tube Reflex circuit?

A. 1. It is impossible to use filament control jacks with a three-tube Reflex circuit for the simple reason that none of the filaments of the Reflex amplifiers can be out while the set is in operation. We would advise you to use a standard three-tube Reflex circuit which will be supplied upon receipt of our usual charge.

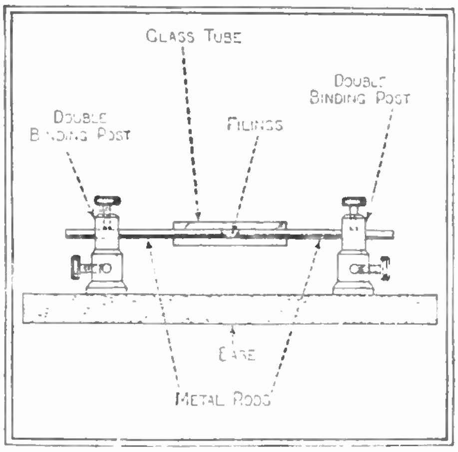


Fig. 296. The details for the construction of a coherer are given above. This type of detector is obsolete at the present date, but sometimes is used in connection with experimental radio control apparatus.

TESTING A VACUUM TUBE

(295) Homer J. Jones, Canton, Ohio, asks:

Q. 1. How can I test a vacuum tube when I purchase it so as to be sure that it is in good condition?

A. 1. The only way that you can test a vacuum tube is to see that the filament lights. If you desire a further test, it will be necessary to use it in a radio receiving set. If the tube will not pass plate current it will not work in the set.

COHERER CONSTRUCTION

(296) J. L. Jones, Beatrice, Alabama, says that he desires to do some experimental work in connection with radio control. He asks:

Q. 1. Can you give me some information on the construction of a coherer?

A. 1. The construction and the action of the coherer are fully explained in any ordinary text book on radio particularly the older ones. No exact dimensions are necessary for this instrument, a glass tube one quarter of an inch inside diameter sufficing for the supporting element. Two metallic plugs which will fit closely within this tube are used and between their ends, which are adjusted to about one quarter of an inch apart, is placed a quantity of nickel or nickel and silver filings. The construction is shown in Fig. 296. Any suitable mounting may be arranged.

TUNED RADIO FREQUENCY AMPLIFICATION

(297) Irvin F. Barutz, Freelandville, Indiana, refers to an article entitled, "A Tuned Impedance Radio Frequency Receiver," which appeared in a recent issue of the Radio News. He asks:

Q. 1. In the circuit diagram given, what is the capacity of condensers C3, C4, and C5?

A. 1. In the radio receiving set you mention, condenser C3 has a capacity of .001 mf., C4, .0005 mf., and C5, .00025 mf.

Q. 2. Could another stage of radio frequency amplification be added to this circuit using another coil and condenser?

A. 2. Another stage of radio frequency amplification could be added to this circuit, but we would not advise its use as it would be difficult to control. You would do better to use the Neutrodyne principle. The circuit of a Neutrodyne set will be found elsewhere in these columns.

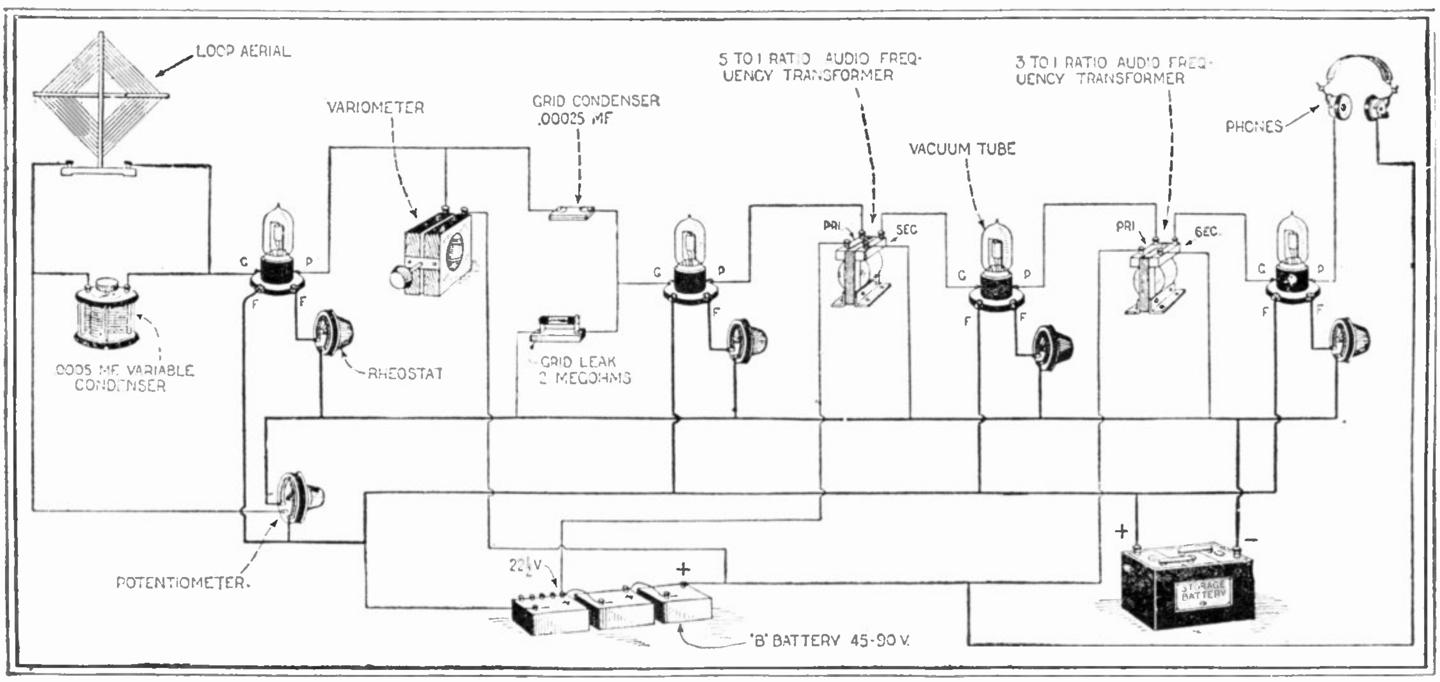


Fig. 293. A very simple and fairly efficient radio receiving circuit, consisting of one stage of radio-frequency amplification, a vacuum tube detector, and two stages of audio-frequency amplification is shown above. The controls are exceedingly simple, only one tuning control being used. A loop antenna is the collector agency. A variometer is used for coupling between the radio-frequency amplifier and the detector. Used with a loop, this form of tuned impedance amplification gives quite sharp tuning, but if an outdoor antenna is to be used, an inductance coil and a variable condenser in parallel should be connected in the circuit in place of the variometer shown herewith.

RADIO SET ON FARM LIGHTING PLANT

(298) J. J. Gloudemans, Brussels, Wis., says that he has a 32 volt direct current electric lighting plant and asks if he can use three cells of the plant to replace his "A" and Magnavox battery, using at the same time one or more lamps for equalizing the other cells.

A. 1. You can run both the vacuum tubes in your radio set and your Magnavox from three cells of your lighting plant battery, and you would not need equalizing bulbs as you suggest. Just arrange the leads from your batteries to the set, so that they can be changed from one group to another occasionally. This will prevent one set of cells from deteriorating faster than another.

SPARK COIL C.W. TRANSMITTER

(299) Robert H. Trickey, Sask., Canada, requests:

Q. 1. Can you give me a circuit diagram showing how to connect up a U. V.-201 tube with a suitable source of high voltage such as a spark coil, so that the same may be used for C.W. transmission?

A. 1. A circuit diagram for this work will be found in Fig. 299. The source of current may be a small coil capable of giving approximately a one-half inch spark. The condenser across the secondary should be of the glass plate type and must be of sufficient size to cut down the spark length so that a spark discharge will not take place within the vacuum tube.

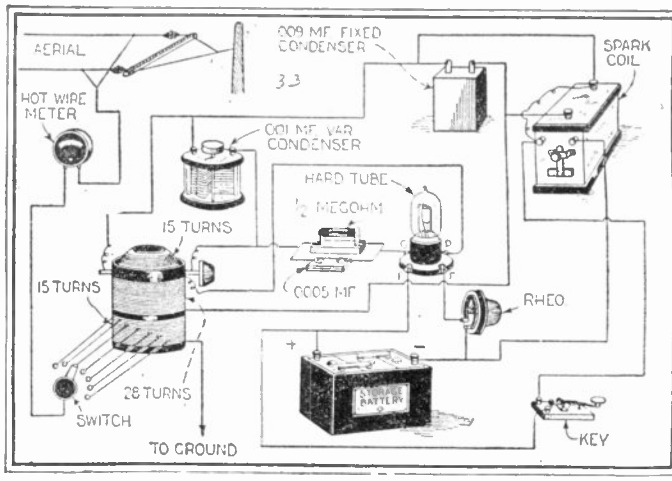


Fig. 299. Where a source of high voltage current is not available, an excellent I. C. W. transmitter can be made using a spark coil for supplying the plate voltage to an amplifying or a five-watt power tube. Do not connect this apparatus or attempt to use such a set until you have qualified for a license.

TROUBLE SHOOTING

(300) Hugh Malcolm, Oneal, Ark., says that he has a radio set consisting of a variocoupler, a variable condenser, a variometer and the usual vacuum tube detector appliances. He says that he has been working this set for quite some time, but it suddenly went dead. He asks:

Q. 1. Can you help me in this matter?

A. 1. It sounds very much to us as though a connection has broken somewhere in the set, which, of course, renders it inoperative. We would advise you to investigate each instrument thoroughly and test all the circuits for continuity. It may be that either the grid or plate connections to the elements of your vacuum tube have broken and, therefore, the circuit is incomplete within the tube itself. The best way to test for this trouble is to obtain another bulb and place it in the socket. If signals come in, you then know that your bulb is defective. We would advise you to clean all your movable contacts and as stated above, test all circuits. If you are unable to locate your trouble, do not hesitate to write to us, giving complete information on the results obtained.

SELECTIVE CRYSTAL RECEIVER

(301) Carl S. Paulson, Brooklyn, N. Y., refers to our Interference Preventer Contest and asks us to show how to connect a crystal detector with the first prize winning circuit.

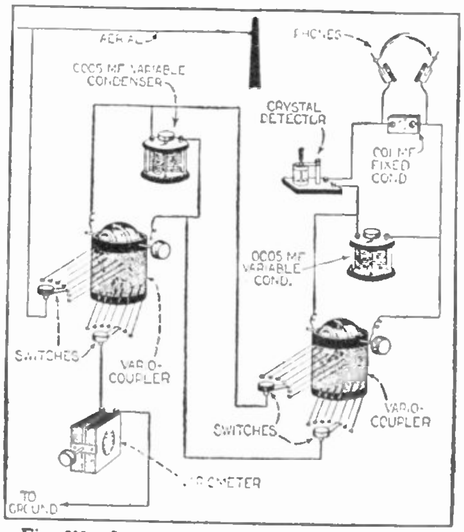


Fig. 301. In congested districts, a receiving set capable of very fine tuning is desirable. Such a tuner used in connection with a crystal detector is shown herewith.

A. 1. In Fig. 301 will be found a diagram of the necessary connections for using the selective tuner with a crystal detector. While this set will be extremely selective, still its control will be very complicated and the signals will not be very loud because of the losses found in transformation.

COMBINATION CRYSTAL AND AUDION

(302) Jack Maloney, Liberty, N. Y., says:

Q. 1. Please give a circuit diagram showing a variocoupler in connection with a crystal detector and an audion detector, so arranged by means of two jacks that either the crystal or vacuum tube may be used as desired.

A. 1. You will find in Fig. 302 a circuit diagram such as requested by you. When the plug is in jack A the filament of the vacuum tube should be extinguished and the crystal detector may be used. When the plug is in jack B, the filament of the tube is to be lighted and the set operated as a standard three-circuit regenerative tuner.

A "MIXED" CIRCUIT

(303) Benedict Massell, Allerton, Mass., submits a circuit diagram of a set consisting of two stages of radio frequency amplification, a detector and two stages of audio frequency amplification using the Reflex principle so as to obtain the above mentioned results with three tubes. In the detector circuit he proposes to use the principle of super-regeneration. He asks:

Q. 1. Do you think that this circuit is of any value?

A. 1. It is absolutely impossible for us to tell you just how your set will function without making the connections and trying it out. Frankly we do not believe it to be of any value. Super-regeneration is so critical in control that, used in connection with the reflex principle, we believe that you would get a choice selection of howls, groans, squeaks and squeals. Either of the circuits which you have attempted to combine, on paper, are hard to control. Combined they would probably be impossible to control.

NEUTRODYNE CIRCUIT

(304) Richard Jackson, New York City, asks:

Q. 1. Is it possible to make a Neutrodyne set using only three vacuum tubes?

A. 1. This is entirely possible but you will not be able to use a loud speaker on the same except possibly for the powerful local stations. Such a set, however, is an excellent "DX" receiver for use with head phones and a circuit diagram with all the data thereon is given in Fig. 304.

GROUNDED LOOP

(305) J. H. M. Beaty, Chester, S. C., asks:

Q. 1. What is meant by a grounded loop?

A. 1. A grounded loop antenna usually refers to a standard loop which is connected to a ground. By doing this, signal strength

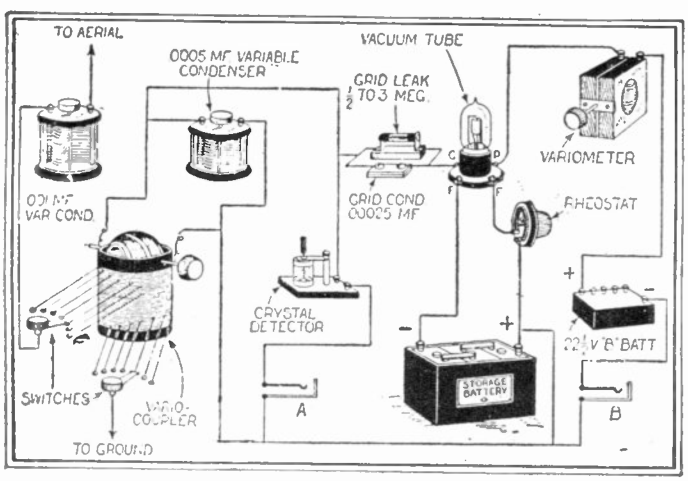


Fig. 302. Where a radio receiving set is located near several broadcast stations, a crystal detector can very readily be used for local reception, while a vacuum tube is desirable for DX work. A combination circuit which makes this possible is shown above. The telephone plug is to be placed as described in the text.

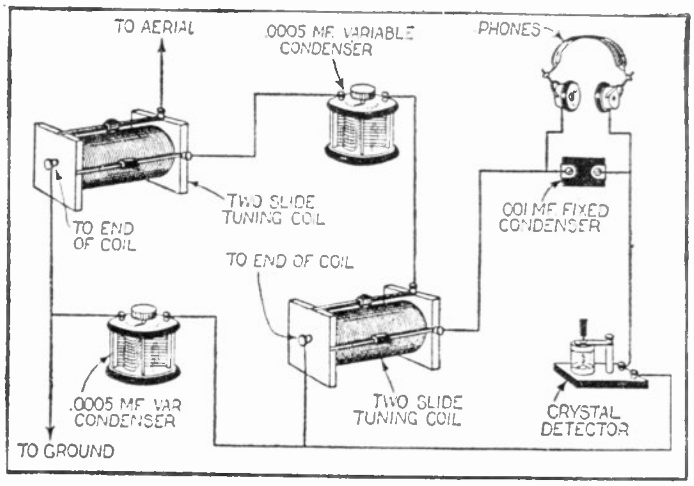


Fig. 309. The circuit diagram above shows a capacitively coupled tuner using a crystal detector for rectification. This circuit may be quite sharply tuned.

will be increased somewhat, but selectivity will be greatly reduced.

Q. 2. If I tap a coil wound on a 3½ inch tube every 10 turns, will a variable condenser with a capacity of .0005 mf. shunted across the coil take care of the tuning between these taps?

A. 2. Yes. In fact a coil consisting of 40 turns of No. 22 D. C. C. wire on a 3½ inch tube without any taps whatsoever will cover the band of broadcasting wavelengths when shunted by a .0005 mf. variable condenser.

Q. 3. When a coil is to be tuned by means of a parallel condenser, what is the highest capacity that should be used?

A. 3. In placing a condenser in parallel with an inductance coil a capacity of no more than .0005 mf. should be used so as to preserve the correct relationship between the inductance and the capacity. When it is found that a station cannot be tuned in with the .0005 mf. condenser at maximum, the amount of inductance should be increased.

MULTI-WAVE COUPLER SUPPORT

(306) Geo. A. Patterson, Wichita Falls, Texas, asks:

Q. 1. In reference to the multi-wave Reinartz receiver, what length will the sides of the metal support for the rotor have to be?

A. 1. The length of the sides of the support for the rotor and stator of the multi-wave coupler you mention will depend entirely upon the size of the coils employed. This could be very readily ascertained by obtaining your two coils, mounting the rod in the rotor and placing it in its relative position to the stator. The measurements can then be taken directly.

THE INTERIOR OF A MICROPHONE

(307) Robert Bailey, San Francisco, Calif., wants to know:

Q. 1. How is the interior of a microphone such as used in radiophone transmission arranged?

A. 1. A microphone similar in construction to an ordinary telephone transmitter may be used for this work and we illustrate in Fig. 307 a cross-section of such a transmitter showing the component parts.

A. C. HUM

(308) L. R. Forney, Fort Benning, Ga., submits a circuit diagram of his receiving set and states that it gives very good results. He says, however, that he is constantly troubled by a persistent hum which at times almost drowns out the reception. He asks:

Q. 1. Can you suggest the cause and method of eliminating this hum?

A. 1. We believe that your trouble arises not in your receiving set itself, but from induction from nearby power lines. We would suggest that you investigate this and if you find your aerial lead-in passing near a line carrying alternating current, you should cover the former with insulation, place a shield over the insulation and ground the latter. Other than this, there is practically no method of eliminating the hum without the use of quite an elaborate choke coil and condenser system.

Q. 2. I have considerable trouble with howling and squealing when the second stage of audio-frequency amplification is used. Can you help me toward eliminating this trouble?

A. 2. Regarding the howling obtained in your second stage, we would suggest that you try shunting a .0005 mf. condenser across the secondary of the second audio-frequency transformer as well as one with a capacity of .001 mf. across the primary of the first audio-frequency transformer.

Sometimes a two megohm grid leak will give better results than the small fixed condenser across the secondary of the second transformer. Both arrangements should be tried, one at a time.

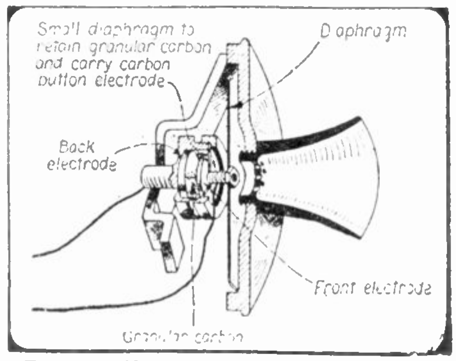


Fig. 307. Above: A cross-section view of a standard telephone microphone employing carbon granules for varying the current in accordance with the fluctuations of the voice.

CAPACITIVELY COUPLED RECEIVER

(309) Arthur Greene, Portland, Me., asks:

Q. 1. What is the simplest circuit for use with a crystal detector which will come under the head of a capacitively coupled receiving set?

A. 1. You will find in Fig. 309

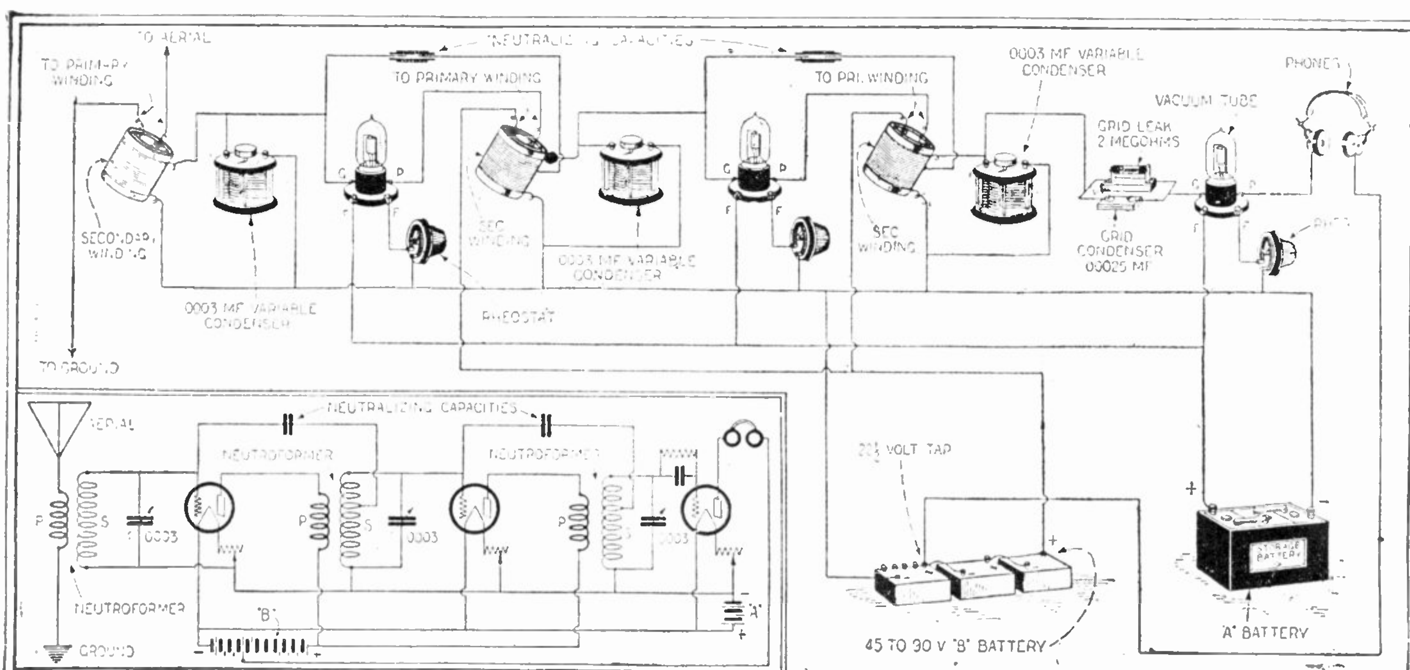


Fig. 304. The circuit diagrams above show all the necessary connections for a three-tube Neutrodyne receiver using Neutroformers with tapped secondaries. The antenna circuit is aperiodic while the secondary circuit and the secondaries of the second and third Neutroformers are tuned. The two diagrams above both show the same set.

a circuit diagram showing how two variable condensers and 2 two-slide tuning coils may be connected to give very good results as a capacitively coupled receiver.

POOR RECEPTION

(310) D. C. McBride, Winchester, Tenn., states that he has made a receiving set, but is unable to get any results from the same. He asks our advice on this subject and requests some suggestions as to know how to overcome his trouble.

A. 1. In the first place, we would suggest that you try reversing the polarity of your "A" battery. Some tubes work best with the negative side of the "B" battery to the positive side of the "A" battery, and some with negative to negative.

Another thing is that we would not advise you to use the open circuit jacks which you indicate in your diagram, because when your phone plug is in the jack for the detector tube, you will find that your phones are shunted by the entire resistance of the primary of the amplifying transformer. When the plug is in the first step jack, the phones are in series with the entire resistance of the primary of the second amplifying transformer. In either case the results obtained will be greatly inferior to those obtained when using two-circuit jacks.

In his experience, the editor has always found that when building up a new set it is much better to start with just the tuner and the detector and to add later one or two steps of amplification. We would advise that if you do not obtain the desired results otherwise, that you try this. Just hook up your variable condenser, variocoupler, variometers, and grid lead and condenser with your detector tube, "A" and "B" batteries and phones. You should not have the least trouble in making this type of set work, and you can operate it, and at the same time notice the various characteristics of your detector tube, which are shown during the operation of the set. You will also be able to learn how to tune this particular type of tuner. After you get this set working well, and have thoroughly mastered the tuning, and adjustment of the detector tube, you are ready to add one step of amplification.

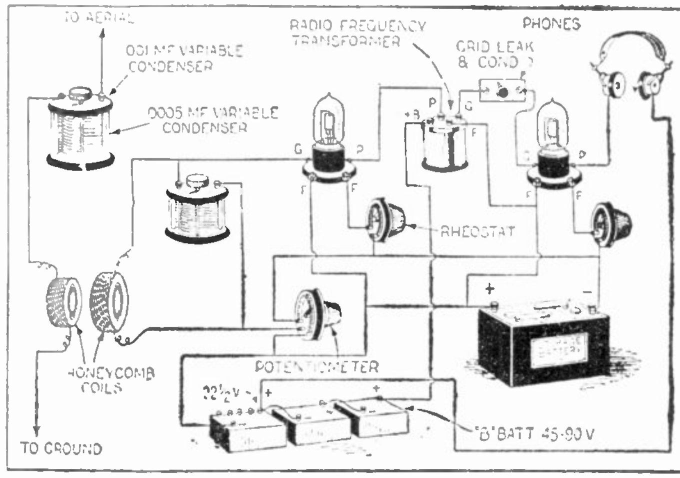


Fig. 347. A two-circuit tuner which does not employ regeneration will be made much more sensitive by adding one stage of R.F. as shown above.

Try this for a while, and then add your second step. We are sure that you will then obtain the desired results.

R. F. WITH TWO CIRCUIT TUNER

(311) Ross Kirberg, Ness City, Kansas, asks:

Q. 1. Can you give me a circuit diagram for connecting one stage of radio-frequency amplification with a two honeycomb coil tuner?

A. 1. The diagram you request is given in Fig. 311.

QUERY ON VARIO-COUPLER

(312) Alex Maderia, Erie, Penn., refers to a circuit diagram published in Radio News in which two connections were shown to the stator of a vario-coupler. He states that he has a coupler, but it is of a different style, having fourteen taps on the primary or stator. The coupler pictured in the magazine had taps every tenth turn only. He asks:

Q. 1. How can I hook up to this vario-coupler?

A. 1. The connection to your vario-coupler will depend upon the style you have on hand. In all probability, your 14-tap vario-coupler is tapped 7 times in tens, and 7 times in units. If such is the case, you will connect all the tens taps to the points of one 7-point switch, and the units to the points of the other 7-point switch. One switch arm is then connected to the aerial condenser, and the other to the ground.

R. F. WITH R. C.

(313) Jim K. O'Neill, Alta., Canada, asks:

Q. 1. Can you give me a circuit diagram for adding one stage of radio-frequency amplification to a standard R. C. tuner, detector and two-stage amplifier without changing the internal connections of the same?

A. 1. Such a diagram is given in these columns. The view of the R. C. set shown indicates all of the binding posts mounted on the rear of the same. The same "B" battery and "A" battery are used for both the radio-frequency amplifier and the set itself.

Q. 2. What is the voltage per cell of a storage "B" battery?

A. 2. Storage "B" batteries will give a voltage of approximately 2 volts from each cell. A number of cells hooked up in series will give a voltage of two times the number of cells.

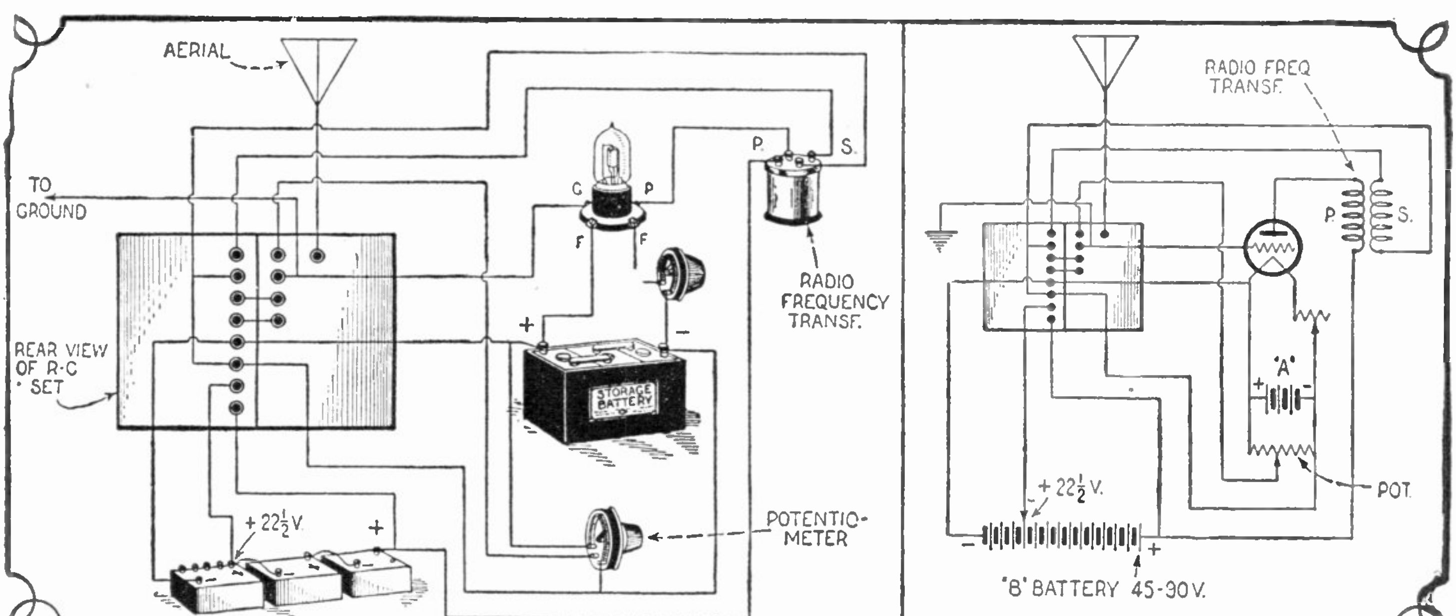


Fig. 313. Many owners whose standard R. C. tuners are designed to be used with a special detector and two-stage audio-frequency amplifier often desire to add radio-frequency amplification to the same so as to increase the receiving range. This can be accomplished, placing the radio-frequency amplification between the tuner and the detector by following the diagram given above. As shown, the tickler feed-back is retained, feeding back through the R. F. amplifier. If this is not desired, the jumpers shown may be removed and the binding posts on the detector, which formerly connected to the tickler, short-circuited. This will make a much quieter receiving set.

INDEX TO QUESTIONS

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HERE is your chance to get at no cost the new improved INKOGRAPH—a perfect writing instrument that operates like a fountain pen. The INKOGRAPH is guaranteed to give perfect satisfaction. It is a beautiful, finely shaped pen of exceptionally high standard of manufacture, strong, durable and handsome materials are used throughout. It is a pen that will stand "heavy duty service." It is a pen that anyone would be proud to own. Same size and shape as regulation $7 and $8 fountain pens.

Never before has any manufacturer of a standard writing instrument which is guaranteed to give perfect satisfaction, offered you so great a value. Remember, the Inkograph answers the purpose of both pen and pencil combined. Its point is shaped like a fine lead pencil point and writes with ink free and easy without a miss, skip or blur. The steady uniform flow of ink actually improves your handwriting. Won't blot, scratch, leak or soil hands.

You who already possess a standard fountain pen will find the Inkograph a most valuable addition to your writing equipment, for it will do everything any fountain pen can do and many very important things which it is impossible to accomplish with any fountain pen at any price.

What Users Say Counts Most

My Inkograph is the smoothest writing instrument with which I have ever written. That is saying a lot. I am a teacher by profession. I have a $7.00 pen and another that cost more than the Inkograph, but Inkograph is better than either. It is the greatest improvement in writing instruments since the Babylonians recorded their thoughts on clay tablets with a triangular pointed reed. John R. Atwell, Chadwick, N. C.

I wouldn't take $5.00 for the pen I am writing this letter with. I have a good fountain pen but don't write any more with it. I am proud of the Inkograph and that I can say this to you and mean every word of it. R. H. Wilson, Beckley, W. Va.

In making out local requisitions, it is necessary to make an original and two carbon copies on very heavy paper, and the Inkograph does this twice as well as the hardest indelible pencil, and is much neater and the original is much more legible. Wm. L. Fortney, Placerville, Ia.

It sure has improved my hand writing—I never took home any medals for penmanship but I can almost read my own writing since I got this pen. M. F. Johnson, Medina, Wis.

I want to thank you for the return of my Inkograph pen, which you repaired for me. I feel rather lost without this pen in my pocket. I prefer it to any pen I ever carried principally because of the ease with which one can write with it, not having to be careful whether you slide the pen to the North, East, South or West, it flows freely in all directions. Wm. B. Brown, New York, N. Y.

Delighted: It writes bully—you have invented a pen that is perfection. It is so much more rapid than my $9.00 fountain pen. I wish you abundant success. S. L. Carlton, Aurora, Ill.

Combines Features

of both pen and pencil, minus the weak points of both, plus improvements not found in either.

The lead pencil smudges, the point breaks and its writing soon is obliterated. Most fountain pens skip, scratch, flood, clog, leak, blot, soil hands and clothing. The old stylographic ink pencil dries up, balks, blots, writes heavy, flows unevenly and is never reliable. The Inkograph feeds as fast and uniform on the 20th page as it did on the first.

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Not the tiniest drop of ink will spill, although one filling is sufficient to write thousands of words. Will write on any quality of paper.

Makes 3 to 4 Carbon Copies

at one time with original in ink. Bear down as hard as you like without fear of bending, spreading, injuring or distorting its 14 Kt. solid gold point. Are you a salesman?—use an Inkograph, make out your orders in ink and retain a duplicate for your records. Do you wish to keep a copy of your private correspondence?—use an Inkograph. Do you do office work which requires clear carbon copies?—use an Inkograph. Do you make out bills or sales slips?—use an Inkograph and make a permanent original in ink with carbon copies. You can permit any one to write with your Inkograph, for no style of writing can affect the Inkograph point as it will a fountain pen.

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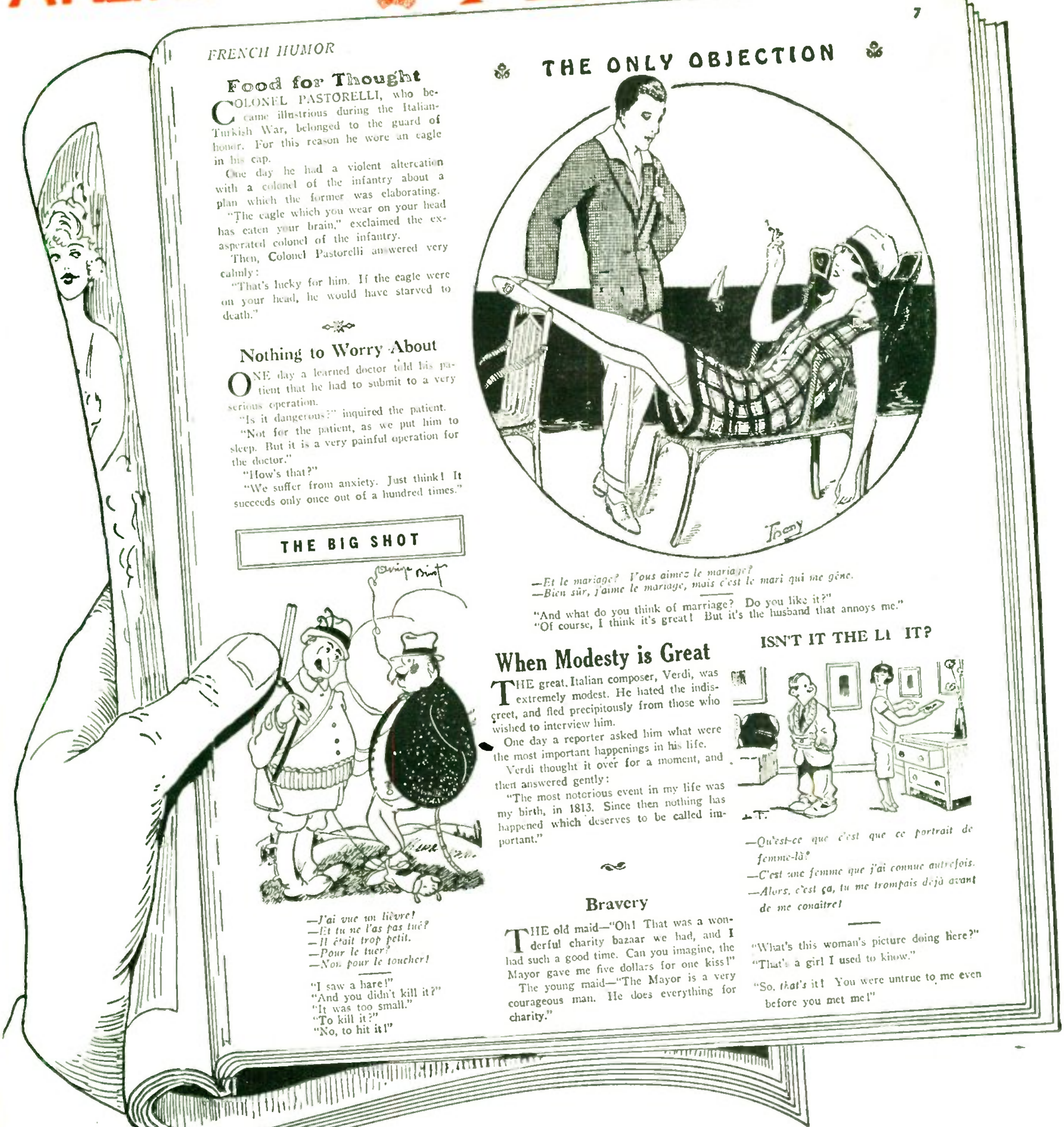

Food for Thought

COLONEL PASTORELLI, who became illustrious during the Italian-Turkish War, belonged to the guard of honor. For this reason he wore an eagle in his cap.

One day he had a violent altercation with a colonel of the infantry about a plan which the former was elaborating.

"The eagle which you wear on your head has eaten your brain," exclaimed the exasperated colonel of the infantry.

Then, Colonel Pastorelli answered very calmly:

"That's lucky for him. If the eagle were on your head, he would have starved to death."

Nothing to Worry About

ONE day a learned doctor told his patient that he had to submit to a very serious operation.

"Is it dangerous?" inquired the patient.

"Not for the patient, as we put him to sleep. But it is a very painful operation for the doctor."

"How's that?"

"We suffer from anxiety. Just think! It succeeds only once out of a hundred times."

THE BIG SHOT

—J'ai vue un lièvre!
—Et tu ne l'as pas tué?
—Il était trop petit.
—Pour le tuer?
—Non, pour le toucher!

"I saw a hare!"
"And you didn't kill it?"
"It was too small."
"To kill it?"
"No, to hit it!"

THE ONLY OBJECTION

—Et le mariage? Vous aimez le mariage?
—Bien sûr, j'aime le mariage, mais c'est le mari qui me gêne.

"And what do you think of marriage? Do you like it?"
"Of course, I think it's great! But it's the husband that annoys me."

When Modesty is Great

THE great Italian composer, Verdi, was extremely modest. He hated the indiscreet, and fled precipitously from those who wished to interview him.

One day a reporter asked him what were the most important happenings in his life.

Verdi thought it over for a moment, and then answered gently:

"The most notorious event in my life was my birth, in 1813. Since then nothing has happened which deserves to be called important."

Bravery

THE old maid—"Oh! That was a wonderful charity bazaar we had, and I had such a good time. Can you imagine, the Mayor gave me five dollars for one kiss!"

The young maid—"The Mayor is a very courageous man. He does everything for charity."

ISN'T IT THE LIMIT?

—Qu'est-ce que c'est que ce portrait de femme-là?
—C'est une femme que j'ai connue autrefois.
—Alors, c'est ça, tu me trompais déjà avant de me conaître!

"What's this woman's picture doing here?"
"That's a girl I used to know."
"So, that's it! You were untrue to me even before you met me!"

FRANCE sends its matchless wit and humor to every American Home

FRANCE, the magic land of humor, wit, and keen, knife-edged "parlay," now woffers humor-loving Americans its choicest, finest humor through the new weekly magazine, "FRENCH HUMOR."

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