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Radiotorial Comment

The A.C. Receiver

Ever since the advent of radio broadcasting there has been a strong demand for receivers which could be operated directly from the alternating current light socket. This was established as one of the major objectives to be attained by set designers. Its practical accomplishment by several different methods is greatly to the credit of those who attacked the problems.

In this issue of RADIO are presented the full details as to how a.c. operation has been perfected by various manufacturers. As an introduction to these technical details a general statement of the problem and a comparison of the several methods which have been adopted to solve it may be of interest and value to many readers.

The original vacuum tube required direct current for the proper functioning of each of its several elements. Relatively heavy current at low voltage was needed for filament supply. The plate supply called for relatively high voltage and small current drain. The grid required different voltages for different purposes but negligible current. So far as plate and grid voltages are concerned, the requirements of the newer types of tubes are the same as before. But several of them have been especially designed to use low-voltage alternating current for filament supply.

These a.c. tubes threaten to revolutionize the radio industry and have already seriously injured the business of many concerns whose products were not adapted to their use. Likewise there have been corresponding gains for those who were prepared for the change. The main point at issue, and one frequently overlooked by the layman, is that direct current is still required for plate and grid operation, even where alternating current is used for filament supply. Furthermore, except for convenience, none of the described methods for converting alternating to direct current, has any advantage over dry batteries, when all factors are taken into consideration.

That the task of converting a.c. to d.c. was first successfully accomplished for plate and grid supply was due to the small current requirements for these purposes as compared to the heavy current drain for parallel filament connections in multi-tube sets. Not only are most of the available rectifying devices limited to less than three amperes capacity, but also are most of the filters employed to remove the a.c. component from the pulsating continuous current furnished by the rectifier, except at almost prohibitive expense.

But for furnishing the required plate and grid voltages, rectified and filtered a.c. is eminently satisfactory, especially for the higher voltages needed for power tubes. While few of the commercial devices completely eliminate the a.c. hum, this is not sufficient to bother the average listener who realizes that some extraneous noises have always accompanied the mechanical reproduction of sound. Furthermore, by going to some additional expense in larger capacity condensers or push-pull audio amplification, it is possible to make this hum inaudible to the most fastidious.

Where the current drain for parallel connected filaments is not too heavy and where absolute steadiness of voltage output is not imperative, the *A* battery eliminator has recently come into successful use. Furthermore, by connecting the filaments in series instead of in parallel it is possible to secure satisfactory operation from low-current high-voltage rectifiers and filters, as has been demonstrated by several leading manufacturers.

But as neither of these useful expedients seemed to fully satisfy the public demand, the tube manufacturers liberated the a.c. filament (but d.c. plate and grid) tube from their laboratories, possibly before it had been perfected as fully as will be later models. The appearance of these tubes and of sets to use them, caused a veritable stampede from the battery-operated tubes and sets.

Today, every buyer seems to want an a.c. set, not because it gives any better selectivity, sensitivity or tone quality, but because the average user is too lazy or too ignorant to take care of a storage battery. Most of the manufacturers, jobbers and dealers are agreed that it is here to stay and are diligently trying to perfect its minor defects.

Undoubtedly new and improved types of a.c. tubes will be developed for various special purposes, just as have d.c. tubes. A shielded grid tube for a.c. filament operation is in the offing as a more efficient r.f. amplifier than the present a.c. tube used for that purpose. A new heater type designed for longer life than those first marketed will also soon be available.

The filaments of all the present power tubes used as audio amplifiers may be heated with raw a.c. with but slight hum. This can be eliminated by push-pull connection. But, contrary to generally-accepted opinion, such push-pull connection does not also double the lower output. In fact, carefully conducted tests have proved that push-pull connection of two tubes gives but 1.1 times the power output of a single tube with the same plate and grid voltage.

The availability of a.c. tubes has also created a demand for means of converting d.c. sets for a.c. operation. This may readily be done at slight expense and trouble so that old sets can thus be brought up-to-date if desired. But the wise man, in our estimation, is he who takes advantage of the present low prices of d.c. sets and accessories. A battery-powered set gives just as good results today as the latest a.c. model.

Radio—The Aladdin of The Navy

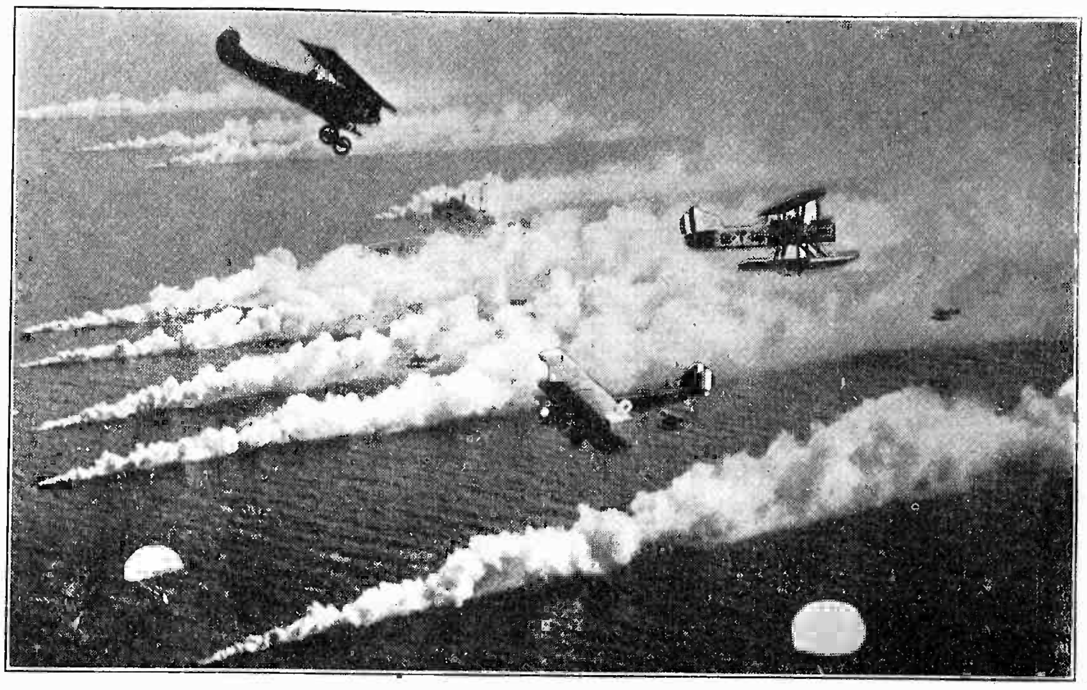
By C. K. Spencer

WITH the recent announcement that the Navy is interested in the development of a system of transferring pictures by radio from scouting aircraft direct to commanding admirals afloat, attention of radio enthusiasts again has focussed on the sea and air services. Though it is not generally known, the Navy was the prime mover in the development of the transmission of pictures by radio, as it was in the development of radio telephony and, still earlier, of radio telegraphy.

Now it is intended to use radio to convey pictures of a vast sea front, as seen from an aircraft, direct to the admiral directing the tactics. It follows, that this method will also be of extreme value to the scouting lines of surface vessels. The idea is to have the planes take, develop and print the pictures in flight, then immediately transfer them to the surface flagship. At present, they are taken and developed, but not printed. The negatives are sent to the surface either by means of small parachutes, or by the plane's alighting alongside a cruiser or battleship to transfer film.

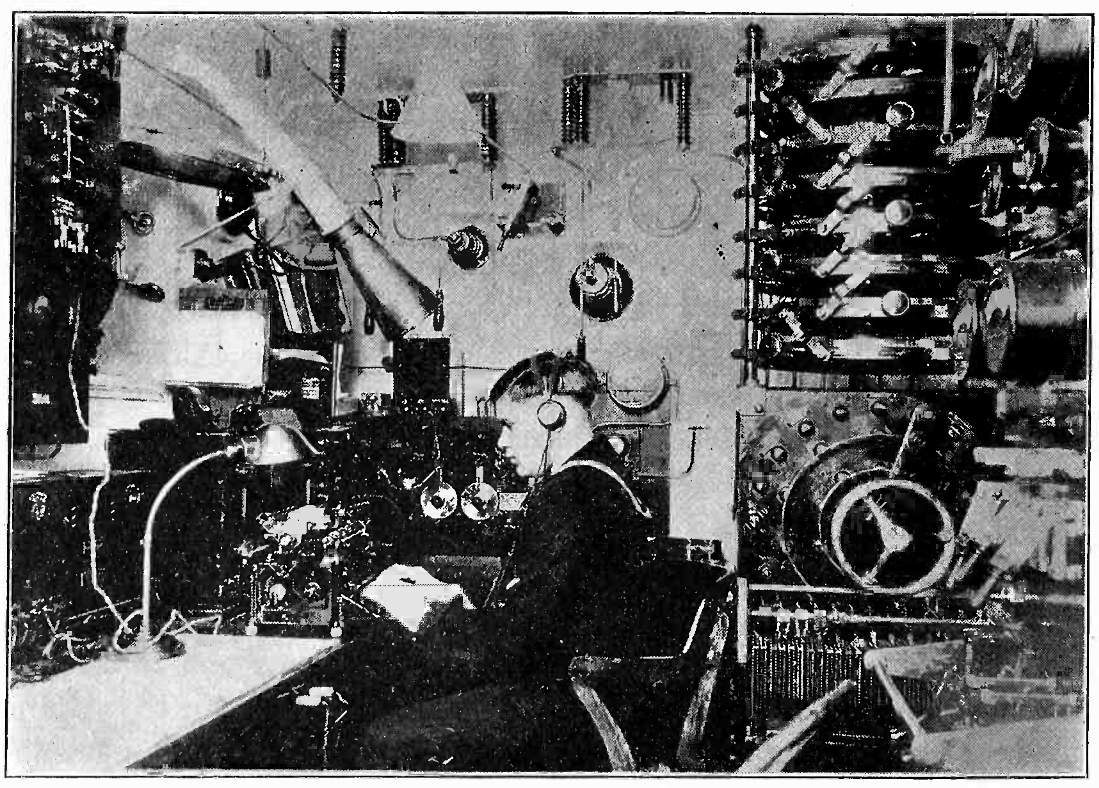
Several battleships have been equipped with picture transmission apparatus and further equipment will be added as funds become available. By this means a flagship could transmit a graphic plan of attack or a captured enemy plan could be sent in picture form.

This news, coming hard on the heels of the announcement of general Naval operations between the mainland United States and the Hawaiian Islands, to begin in early April, arouses some curiosity as to what methods are at present in use to attain speed of operation of the fleet and successfully maneuvre it so that the greatest possible advantage is to be had when it finally discloses its presence to the enemy.



Radio-Directed Attack by Torpedo Planes on Ships Concealed in Smoke. A Torpedo Plane (Right) Is Escaping a Fighter (Upper Left) Which Is About to Attack a Bomber (Lower). Two Parachutes Are Proceeding Seawards.

Efforts to lessen interference with civilian broadcasting stations led to the adoption of more selective transmitters and the more efficient operation of the forces afloat. Improvements in the land stations, with the gradual elimination of the Navy's high-power arcs in favor of the more selective tube installations, have been slow because of the difficulty in producing a tube set with all the advantages of the arc for long-distance transmission. During 1927, two engineers of the General Electric Company were at the San Diego station changing over from arc to tubes. The General Electric Company stood the expense and $25,000 in addition for new tubes. If the station is successful as a tube unit, and proves to be as selective as expected, the entire Naval arc system will go over to tube transmission. But, regardless of the arc's present disadvantages and its interference with civilian broadcasting, it is the basis of the transmission for the maneuvres of 1928.

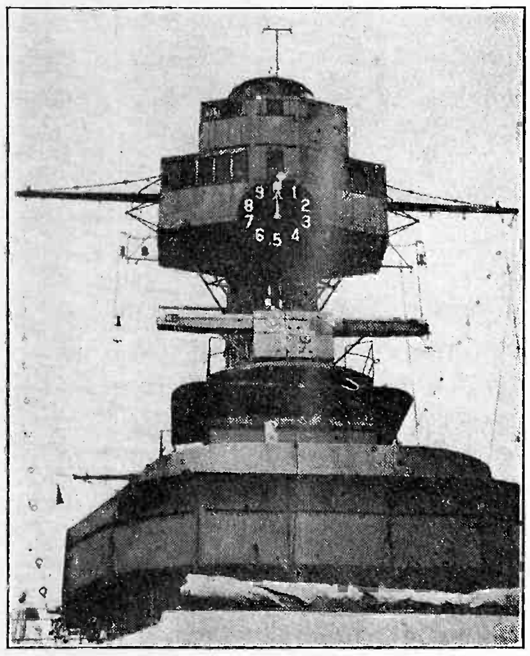


Interior of a U S. Destroyer Radio Room.

The operations between the mainland and Hawaii will be the greatest ever conducted. Over a web of radio control, the fleet of battleships, light cruisers, destroyers, submarines, aircraft carriers and aircraft squadrons, will conduct at least one scouting formation more than a thousand miles from tip to tip of the right and left wings, before the converging operation on Hawaii, for the defeat of an "enemy" fleet off the islands and the reduction of the island defenses. However, prior to the attacks on the Islands, the Hawaiian radio installation will participate with the San Francisco radio as a part of the Naval maneuvering system.

Immediately after the battle fleet receives its "state of war" orders, San Francisco "NPG" will go on a war basis, and will be under command of the senior officer until the fleet leaves San Francisco. San Diego, in the event of accident or simulated accident at San Francisco, will take over control of communications.

At prearranged hours of each day and night either San Francisco or Hawaii will begin abruptly on an interminable transmission in which will secretly appear certain sines. The fleet at sea will intercept the entire schedules, from four to six radio men taking each, and from the entire schedule the ships and officers will choose the matter of significance interspersed in secret war code. To any dispatches the fleet will make no reply. The system is known as the "no-answer" schedule, and obviates the fleet's pres-



Radio Antennas on "West Virginia."

ence becoming known through the operation of enemy direction finders.

Within the fleet itself short-wave directional radio will be used, except for the vessels on the scouting line. Only vessels in company will utilize this means of communications.

Between 800 and 500 miles from Hawaii, radio traffic to the fleet from NPG at San Francisco may continue, but Hawaii will be presumed to be in enemy hands, and the campaign for taking it will begin. The fleet will attack from an unknown direction, probably at night. To prevent this approach, a vast fan of submarine and destroyer scouts will be arranged by the defending forces on a complicated pattern of movement. They will attack with torpedoes, and immediately open their radios to warn the island defences. Aircraft on both sides will join then in attack and defence, and on no less than twelve different waves, radio battle traffic will commence, between aircraft squadrons, and between air and sea, air and land, and sea and land, as well as within all the forces of the fleet.

While the writer would like to indicate the methods used to hinder the radio operation by the "enemy," this may not be done because it is as yet of a secret nature and probably will become more so rather than less, as time goes on and radio tactics become still more vital to success.

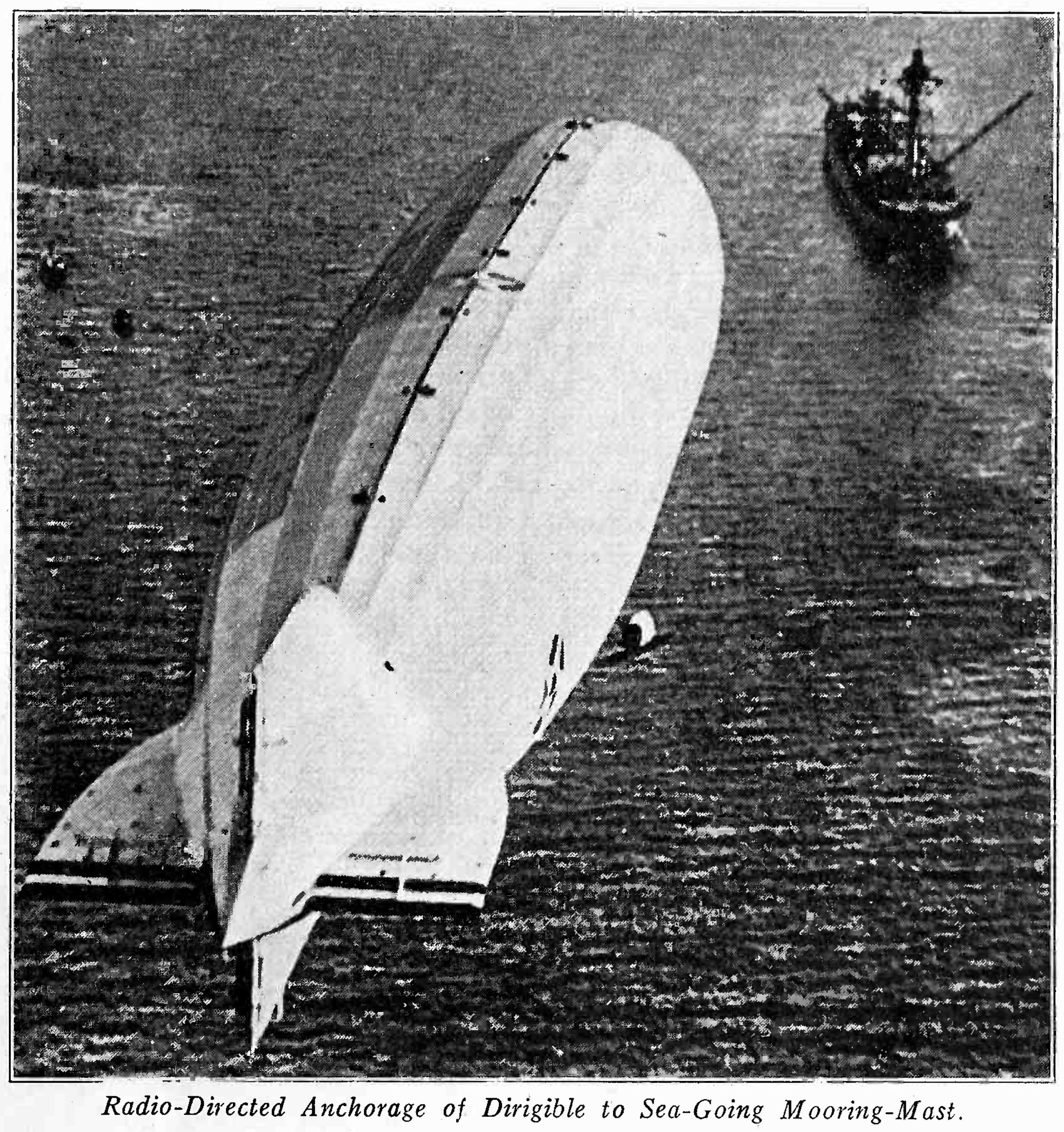
A vital factor, immediately action opens, will be the underwater communication between submarines and between submarines and surface craft. Methods for radio communication between aircraft and submarines, first successfully tested in 1920, are now ready for practical application in the operations of 1928, and American submarines may be guided to their targets by aircraft scouting high above the seas.

The entire spark equipment of 38 destroyers has been removed and tube transmitters installed instead. Ten modern light cruisers have given up their spark equipment, and the main transmitters are now all of the tube type, as likewise are those on 8 fleet auxiliaries and 4 submarines.

While the fleet radio is being developed in the direction of the tube, it might be significant to state that the naval engineers still believe enough in the arc to endeavor to save it. In many ways it is superior to tube equipment, for distance transmission. In order to preserve the arc set at Hawaii, the Pearl Harbor 350 kw. arc transmitter is being electromagnetically screened as an experiment in order to try to reduce the troublesome interference from arc "mush" and from harmonics. Unless the arc interference can be eliminated or reduced, it will have to go in favor of the tube. If the Pearl Harbor experiment proves sufficiently successful, the high-power arc installations at the other stations will be similarly screened.

An interesting radio experience which may be met by the fleet is the probable co-operative radio tests which have been urged by many radio officers for consummation while the fleet is at Hawaii, after the "battles" have been terminated. They desire a test to be made with the fleet and the island stations at Cavite, Tutuila and Pearl Harbor. Each of these latter stations has succeeded in making high-frequency equipment which has helped greatly in the increased traffic caused by the China situation. This traffic has been relayed across the Pacific without serious delays, and large volumes of routine traffic between Cavite and Pearl Harbor, heretofore relayed through Guam, has been handled direct between Cavite and Pearl Harbor, resulting in considerable savings in power costs and reducing the average time required by at least 50 per cent for trans-Pacific traffic.

Careful shielding is the secret of success in using the screen grid tube. While inter-electrode capacity is practically eliminated in this tube, interstage coupling is not. Each r.f. stage must be inclosed in completely interlocking heavy shields. Aluminum shields should be at least .08 in. thick; copper not less than .05 in. thick. The use of copper facilitates soldering of joints. Best results are secured by putting "cans" on the tubes and by inclosing the lead which connects the plate from one tube to the coil of the next in a small grounded metal covering. R.F. chokes and bypass condensers are necessary in the plate circuits to prevent coupling through the battery or eliminator circuits. For a three-stage amplifier it is also advisable to include chokes in the screen grid leads of each stage. The use of heavy shielding, solid construction and cushion sockets minimizes microphonic noises.



Radio-Directed Anchorage of Dirigible to Sea-Going Mooring-Mast.

All About Alternating Current Sets

A Complete Discussion of Every Phase of The Subject, Including Tubes, Circuits of Factory Built Models, and Conversion of D. C. Sets

By The Laboratory Staff

THE a.c. set is here to stay, and with it has come a greatly increased interest in all things concerning a.c. operation. Readers want to know how the latest factory built sets are made to operate from the power circuits without audible hum in the loud speaker; those experimentally inclined, want information so that they can build their own a.c. receivers from parts now on hand; others would like to learn of the changes necessary in the present d.c. operated sets so as to install the new a.c. tubes. Much of this information has been already published in one form or another, but not under one head where it may be readily used as a reference. So it is the purpose of this discussion to bring out the points most interesting to the average experimenter, to present the circuits of the latest factory-built sets, together with the important features of each, and to show various means by which old sets may be converted for a.c. operation.

In publishing the circuits of the factory built receivers, it is interesting to note that practically all of them were sent voluntarily by the manufacturers. It is not so long ago that obtaining authentic circuits of this type was like pulling teeth, for there seemed to be an ingrown fear on the part of the manufacturers that someone was going to steal the circuit and come out with a new set incorporating their special features. As an actual matter of fact, such circuits are an invaluable aid to service men who are called on to shoot trouble or repair factory built sets, and who are too often not equipped with the proper circuit diagrams. They are also of interest to the man who is well versed in radio circuits, and would like to know something of the actual electrical details of receivers which have been so extensively advertised.

The various definitions of the term "a.c. receiver" have led to some confusion. For clearness, it is assumed here that an "a.c. receiver" is one whose tube filaments are supplied with alternating current from the electric light mains, through a step-down transformer. Those sets having storage battery type tubes, but with the filaments lighted from rectified a.c. through the medium of an *A* battery eliminator have been aptly termed "powerized" sets, and this term will be used here. Of course there is the exception of the set using series filament wiring and obtaining its power from a rectifier, commonly called an *ABC* eliminator. This is in effect a special a.c. circuit, and such factory-built receivers as have incorporated this circuit in their models are entitled to inclusion in the classification of "a.c. receivers."

A.C. Tubes

AS HAS previously been published in more or less detail, there are five types of tubes now in general use whose filaments are operated from raw a.c. through a step-down transformer. Two of them are used for r.f., detector and first audio amplifier purposes, and the other three are used in the power amplifier stage only. The former include the UX-226, CX-326 oxide coated filament type, and the UY-227, CY-327 heater type. Destined for early use also is the UX-250, CX-350 type, concerning which details are published elsewhere in these columns. The power tubes include the type 112, UX-171, CX-371 and the UX-210, CX-310.

It is customary to light the filament of the type 26 tube from a.c. through a step-down transformer having a secondary winding of 1½ volts, and at this voltage the tube filament requires 1.05 amperes. It is similar to the type A storage battery tube in characteristics, and is used as an r.f. amplifier or as an amplifier in the first audio stage in many of the newest factory-built sets. It is not suitable for use as a detector.

The type 27 tube is generally used as a detector and differs from the type 26 in that the usual filament is replaced by an indirectly heated cathode consisting of an oxide-coated metal cylinder, inside of which is a heater element requiring 1.75 amperes at 2.25 volts a.c. The fluctuations in temperature of the filament which occur with each alternation, or at the rate of 120 times per second, are prevented from affecting the performance of the tube by the thermal inertia of the insulating material and of the cylinder. Thus the tube may be used as a detector without introducing an a.c. hum into the audio frequency amplifier.

All the power tubes listed may have their filaments operated from raw a.c. and this has been done, in the power stage, long before the other a.c. tubes were introduced. The 112 and 71 tubes are operated from a 5 volt secondary of the power transformer. The 210 and 350 tubes require a 7½ volt secondary, so that in the average a.c. receiver, the filament lighting transformer usually has three windings, 1½, 2½ and 5 volts, with occasional 7½ volt winding where the larger tubes are to be used.

Besides the tubes mentioned above, there are others, such as the Arcturus, which is a heater element type tube, with models suitable for both r.f., detector or audio stages, and which has one side of the heater element grounded to the cathode, so that only a four prong socket is required. These tubes may be used without extensive wiring or socket changes, in any of the d.c. sets now in use. The heater element requires 15 volts a.c.

Another tube of the same type is the Kellogg, which has the heater terminals brought out to the top of the tube, so that the wiring of the a.c. filament circuit can be made up separately, and any d.c. set may be changed over to a.c. without changing the sockets or old filament wiring. The heater requires 3 volts a.c., and is not connected in any way to the cathode. There are other makes of a.c. tubes besides those mentioned, but the above types are typical, and are briefly described so that the diagrams may more readily be understood.

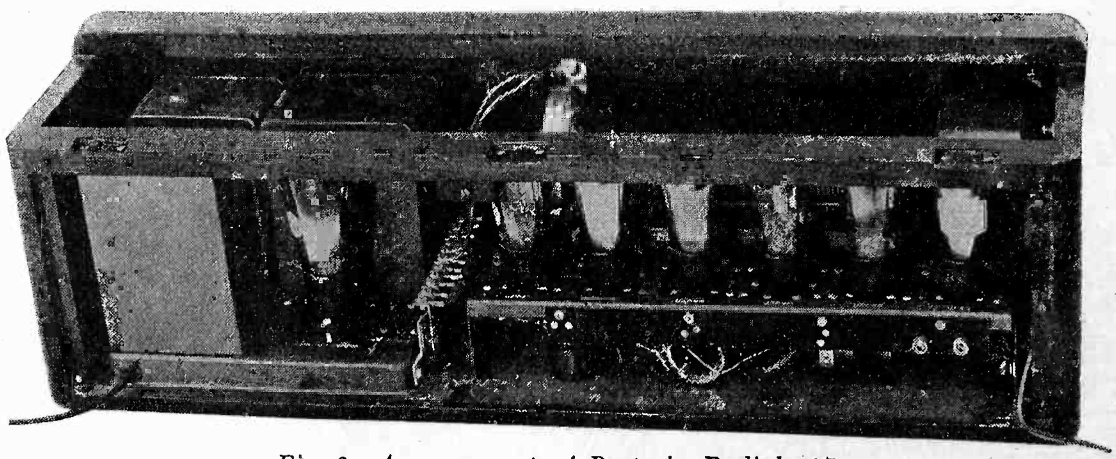


Fig. 2. Arrangement of Parts in Radiola 17.

Some of the Factory-Built Sets With A.C. Tubes

AS A typical example of a six tube factory-built a.c. receiver, the diagram of the Radiola 17 is shown in Fig. 1. This receiver is of the unit type, with the equipment required to supply the proper filament, plate and *C* voltages mounted in the back of the cabinet housing the receiver, so that no external wiring except that of the antenna, ground and 110 volt a.c. wires is required. The arrangement of parts can readily be seen in the picture, Fig. 2.

The receiver consists of three stages of tuned r.f. amplification, using type 26 a.c. tubes, a detector employing a type 27 heater tube, and two stages of audio amplification, the first audio stage being a type 26 and the power stage a type 171. The filaments of the type 26 tubes are supplied from a 1½ volt winding of the power transformer associated with the *B* power plant, while the filament of the type 27 tube and that of the power tube are lighted from separate windings on the same transformer.

The *B* voltage supply is a full wave rectifier tube of the 280 type, with the filament lighted from a separate 5 volt winding on the power transformer. The voltage delivered is approximately 180, and this is divided and reduced to the proper values by means of a tapped resistance shown in the diagram. *C* bias for the various tubes is obtained by means of the voltage drop across a set of resistances in the negative *B* circuit, This method is practically standard for all types of a.c. sets, since *C* batteries are not used.

The three r.f. transformers are tuned by a gang-condenser, while the antenna circuit, instead of being tuned, consists of a 3000 ohm potentiometer, the slider of which is connected to the grid of the first r.f. amplifier tube. This serves as a volume control, and obviates the necessity of resistances in the plate circuit, as are often used in d.c. sets.

By the use of low resistance potentiometers across the three filament secondary windings of the receiver, a condition of electrical balance is obtained whereby the a.c. hum can be eliminated or reduced to a point where it is not objectionable in the loud speaker. The fixed resistances in the grid circuits of the second and third r.f. tubes are for the purpose of eliminating tendency of the tubes to oscillate. These values of resistance are for the particular receiver illustrated. Other receivers may require different values to accomplish the same purpose.

It will be noted that the primary of the power transformer has a tap so that in case the line voltage is as high as 120 volts, extra turns can be inserted in the primary, and the correct secondary voltages obtained. It might be well to remark that, as a rule, east of the Rockies, the line voltage in the average house lighting circuit is from 105 to 115 volts, while west of the Rockies, the average line voltage is from 115 to 125 volts. Hence, it may be found that in some of the new a.c. sets, trouble is had with the type 27 heater tubes burning out in a short time. This can usually be traced to excessive secondary voltage. These tubes are rated at 2½ volts, but will actually operate very satisfactorily at voltages as low as 2.1 volts, and the tube manufacturers recommend an average of 2¼ volts. Hence, where the line voltage is high, and there are no taps on the primary of the power transformer to take care of this difficulty, a ¼ ohm fixed resistance should be inserted in the 2½ volt secondary circuit at the transformer secondary. If more than one heater type tube is connected to this winding, the value of this resistance will be lower, requiring ⅛ ohm for two tubes, and about .05 ohm for three tubes The problem of voltage regulation, where the line voltage varies considerably from time to time was taken up in an article by Clinton Osborne in March RADIO, and will not be dealt with here.

ANOTHER type of six tube set is illustrated in the diagram of the Kolster, shown in Fig. 3. This receiver is somewhat the same in circuit as the Radiola 17 although differing in mechanical design. It employs variable filament balancing resistances for adjusting the degree of a.c. hum to a minimum. If the grid return lead of any tube having its filament operated from a.c. is connected directly to one side of the filament, the fluctuations in voltage due to the use of a.c. cause a fluctuation in grid voltage which introduces an enormous amount of a.c. hum into the plate circuit. Hence the exact electrical center of the filament circuit must be selected by means of a resistance which is either accurately tapped at the center, or in which the center can be found by varying the slider of a resistance having a sliding contact arm. Individual tubes may require a variation of 5 per cent

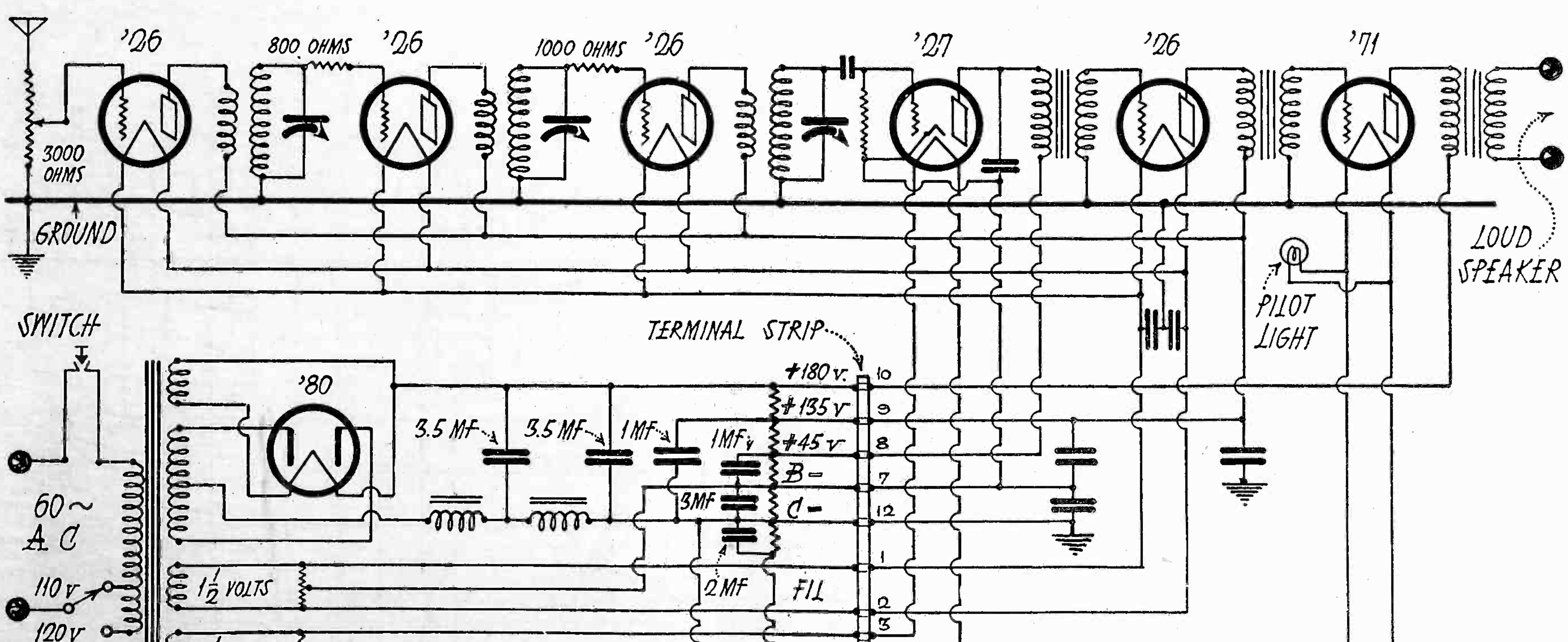


Fig. 1. Circuit of Radiola 17.

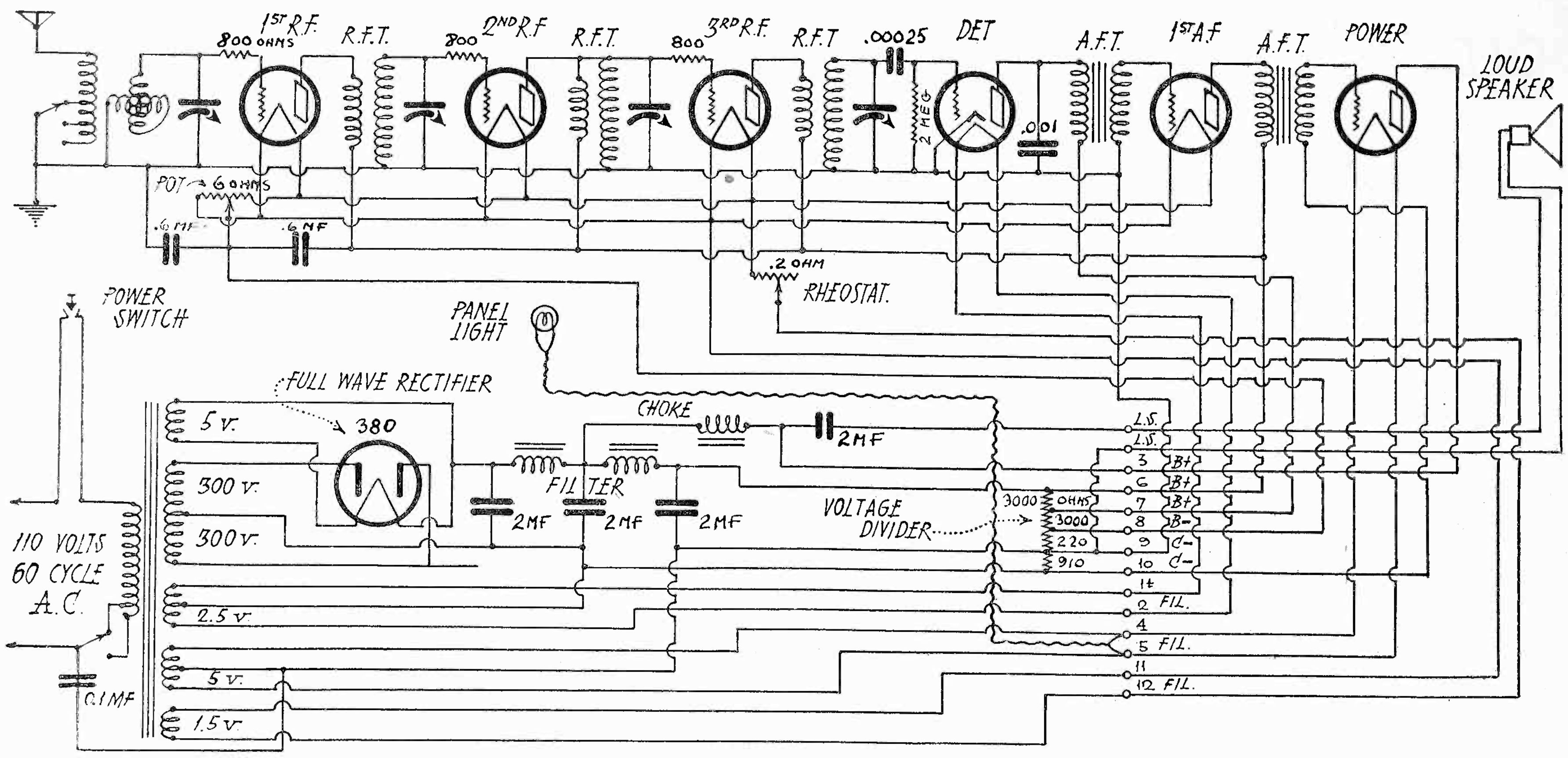


Fig. 3. Diagram of Kolster A.C. Receiver.

from the exact center setting, and line conditions may require wider variations. In practically all a.c. sets, this center tap is grounded, to further reduce the a.c. hum.

IN FIG. 4 is shown the circuit of the Gilfillan Model 60, which is a six tube neutrodyne, and employs the same number and type of tubes as in the previous receivers described. The volume control, instead of being in the antenna circuit, consists of a 2000 ohm variable resistance shunted across the primary of the last r.f. transformer, so as to control the input to the detector tube.

The detector tube is connected to the 90 volt *B* supply tap through a 75000 ohm fixed resistance, which in effect reduces the voltage to 45, without the necessity of extra shunt resistances in the power plant. Some models of this receiver are equipped with an electro-dynamic Jensen loud speaker, the field of which is used as one of the chokes in the filter of the *B* voltage rectifier. This is the system also employed in some models of the Radiola line, but involves a series-filament arrangement which will be described later.

In Fig. 4 it will be noted that a large number of 1 mfd. bypass condensers are used. These are for the purpose of providing low resistance paths for the r.f. currents so that there will be no tendency for the r.f. tubes to oscillate. These condensers are often omitted from the cheaper types of factory-built sets to save on the original cost of the set. Their use is largely dependent on the type of circuit and the elaborateness with which the set is to be designed.

FIG 5 shows the Mohawk type 226-227 receiver, which has two stages of tuned r.f. amplification, detector and three stages of transformer coupled audio frequency amplification. Volume control in this receiver is different from most of the others described, in that it is a ½ ohm rheostat placed in one side of the a.c. leads to the two type 26 r.f. amplifier tubes. By varying the filament current of these tubes, the r.f. amplification is controlled, and a system of electrical balance is obtained by placing a 20 ohm fixed resistance across the two filaments in parallel, with the volume

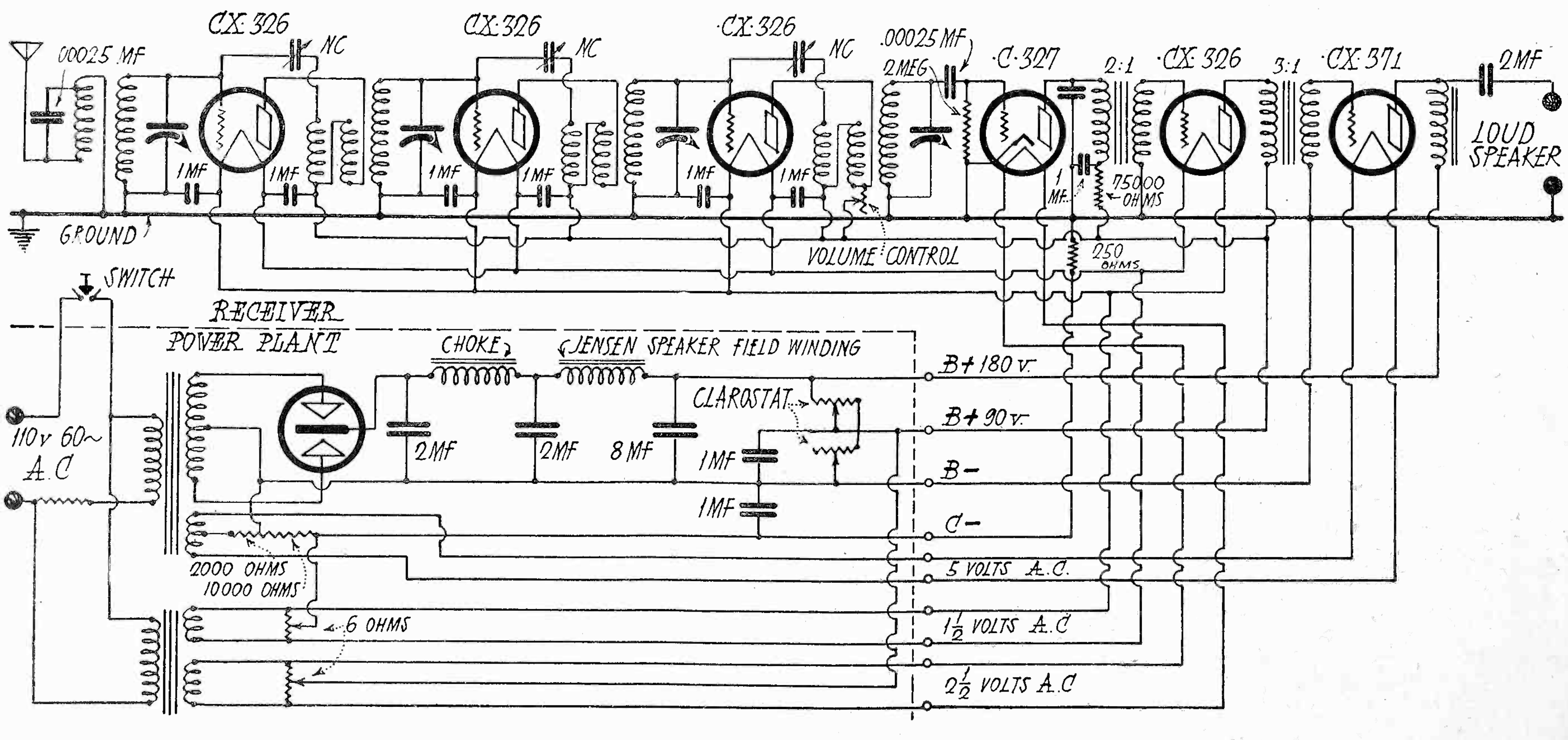
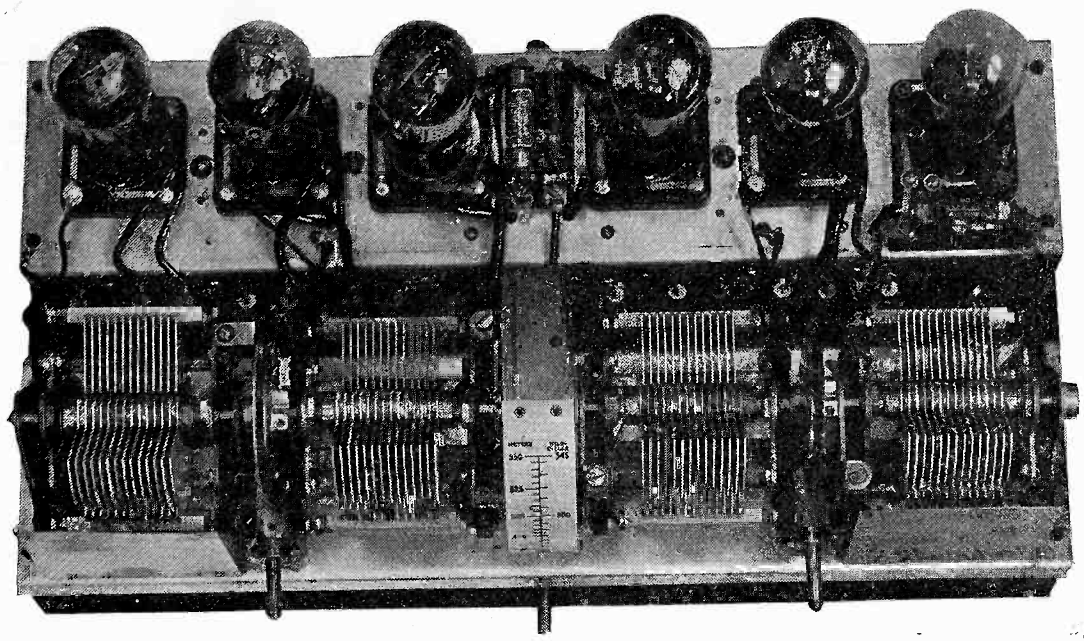


Fig. 4. Gilfillan Model 60 Circuit Diagram.

control rheostat on the transformer side of the fixed resistance. This resistance is tapped at the center, and at this point, a 1000 ohm fixed resistance shunted with a .5 mfd. fixed condenser is connected, the other terminal going to the negative *B* connection. Thus the plate current for the two r.f. tubes, in passing through the 1000 ohm resistance, provides a voltage drop which is used as *C* bias. The same method of providing bias for the first two audio amplifier tubes, which are of the type 226, is used.

The plate voltage for all four 226 tubes is 110 volts, which is 20 volts higher than that used in previously mentioned sets. The type 71 power tube has 180 volts plate and approximately 40 volts negative grid obtained by the voltage drop across a 2000 ohm fixed resistance in the negative *B* circuit. The maximum *B* voltage is 220 volts, but 40 volts is deducted for *C* bias, leaving a total of 180 volts effective on the plate of the power tube. In this receiver, a positive bias of 45 volts is placed on the heater of the 227 detector tube, a procedure which is not followed in all factory-built sets, but which is recommended by the tube manufacturers, especially for home-built sets, as the use of the bias greatly aids in eliminating any a.c. hum due to unbalance in the heater circuit. In the Mohawk, as in the Radiola 17, grid suppressor resistances are used in the r.f. amplifier circuit to prevent r.f. oscillation.



Arrangement of Parts in Gilfillan 60.

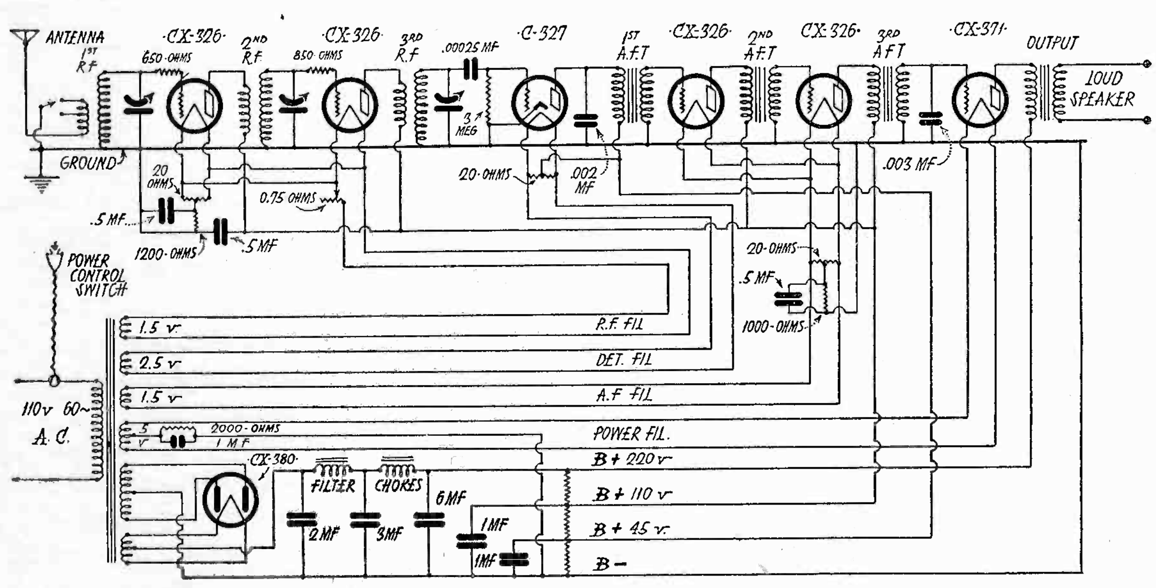


Fig. 5. Diagram of Mohawk Type 226-227 A.C. Receiver.

THE circuit of the Splitdorf receiver is shown in Fig. 6, this receiver being somewhat similar to the other sets, having three stages of tuned r.f. amplification. This set is built as a complete unit, with the *B* voltage supply and filament transformer underneath the metal chassis supporting the tuning apparatus, the bottom of the chassis acting as a shield to prevent the power transformer from introducing hum into the receiver circuit by direct induction.

THE circuit of the Stewart-Warner Model 715 one dial control receiver, in Fig. 7, is an interesting variation of the a.c. models, since it incorporates a different system of balancing the filament circuits, and has a unique r.f. amplifier system. As can be seen from the diagram, the volume control consists of a variable resistance shunted across the antenna primary coil, so that there are no variable fila-

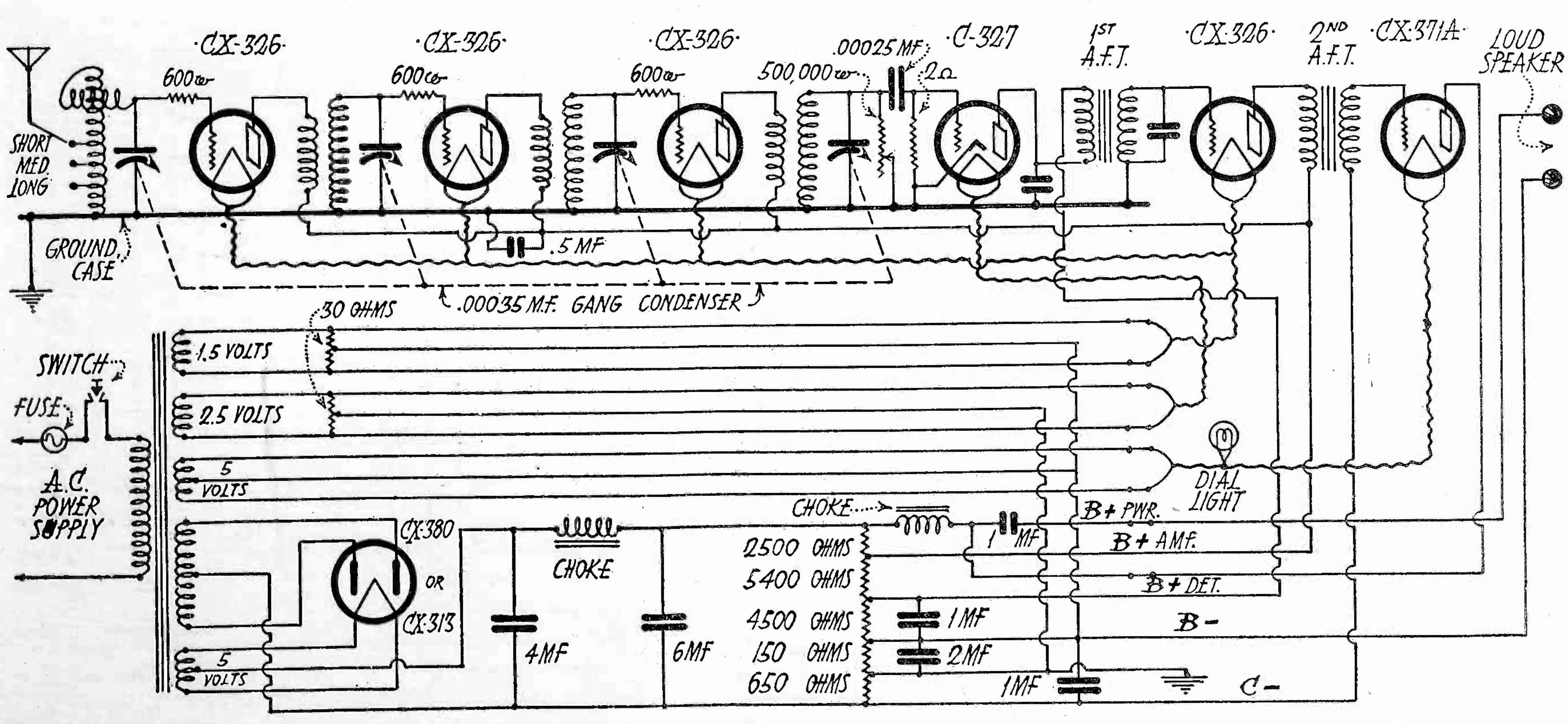


Fig. 6. Splitdorf A.C. Receiver—Wiring Diagram.

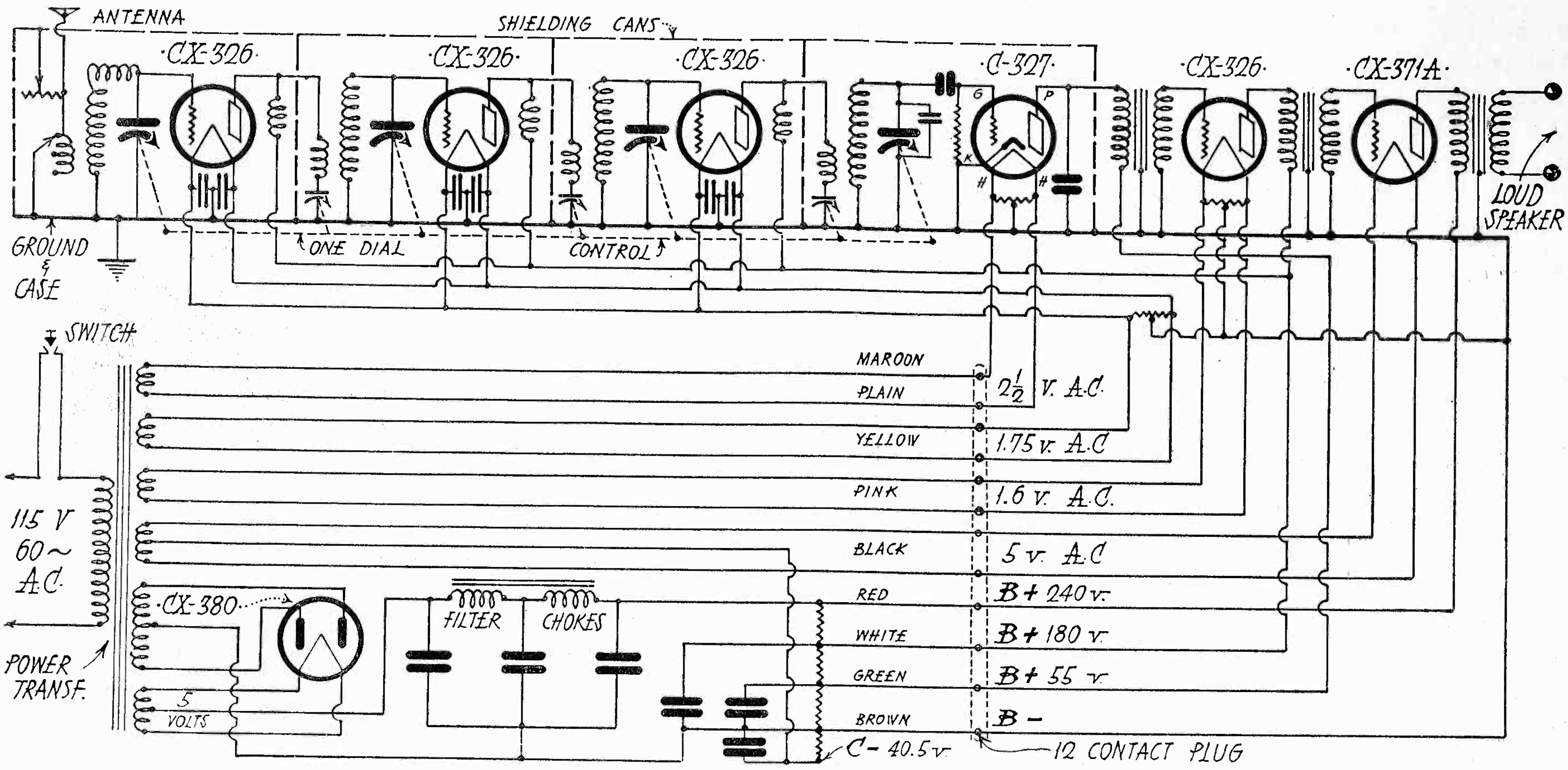


Fig. 7. Stewart-Warner Model 715 A.C. Receiver.

ment or plate controls in the r.f. amplifier.

The r.f. amplifier coupling units consist of a choke coil in the plate circuit of each r.f. tube to bypass the plate current, while the r.f. currents pass through the primary of the r.f. transformer and through a variable stopping condenser which is connected in such a manner that it is varied at the same time as is the tuning condenser associated with that particular transformer secondary. In this way, the oscillating point is set when the receiver is lined up, so that the amplifier breaks into oscillation at the same volume control setting for the entire broadcast band, and the voltage of the r.f. amplifier is adjusted at the factory so that the amplifier does not oscillate at any volume control setting, a very desirable characteristic for any set.

The three r.f. amplifier tube filaments, which are in parallel on the 1½ volt transformer winding of the power plant, have a single balancing resistor with a center tap, but a pair of small capacity mica condensers are connected across each filament circuit at the tube socket, so that the r.f. currents do not have to pass outside the shields, and reach the filament of each tube by the shortest possible path. Thus a system of r.f. balance is attained, which greatly aids in suppressing oscillation. The detector and first audio tubes have individual balancing resistors, with a *C* bias resistance in the negative *B* circuit of the first audio tube. Another resistance of the same type, but lower in value, is used to supply *C* bias for the three r.f. tubes, and the *C* voltage for the power tube is obtained by tapping the main resistor in the power plant.

IN FIG. 8 is shown the complete circuit of the Crosley Bandbox receiver, which is a six tube tuned r.f. set, with three stages of r.f. amplification, detector and two stages of transformer coupled audio amplification. Three type 326 tubes are used in the r.f. circuit, which, together with a 326 tube in the first audio stage, are operated from a single 1½ volt winding of the power transformer, with a 20 ohm center-tapped resistance for balancing the filament circuit.

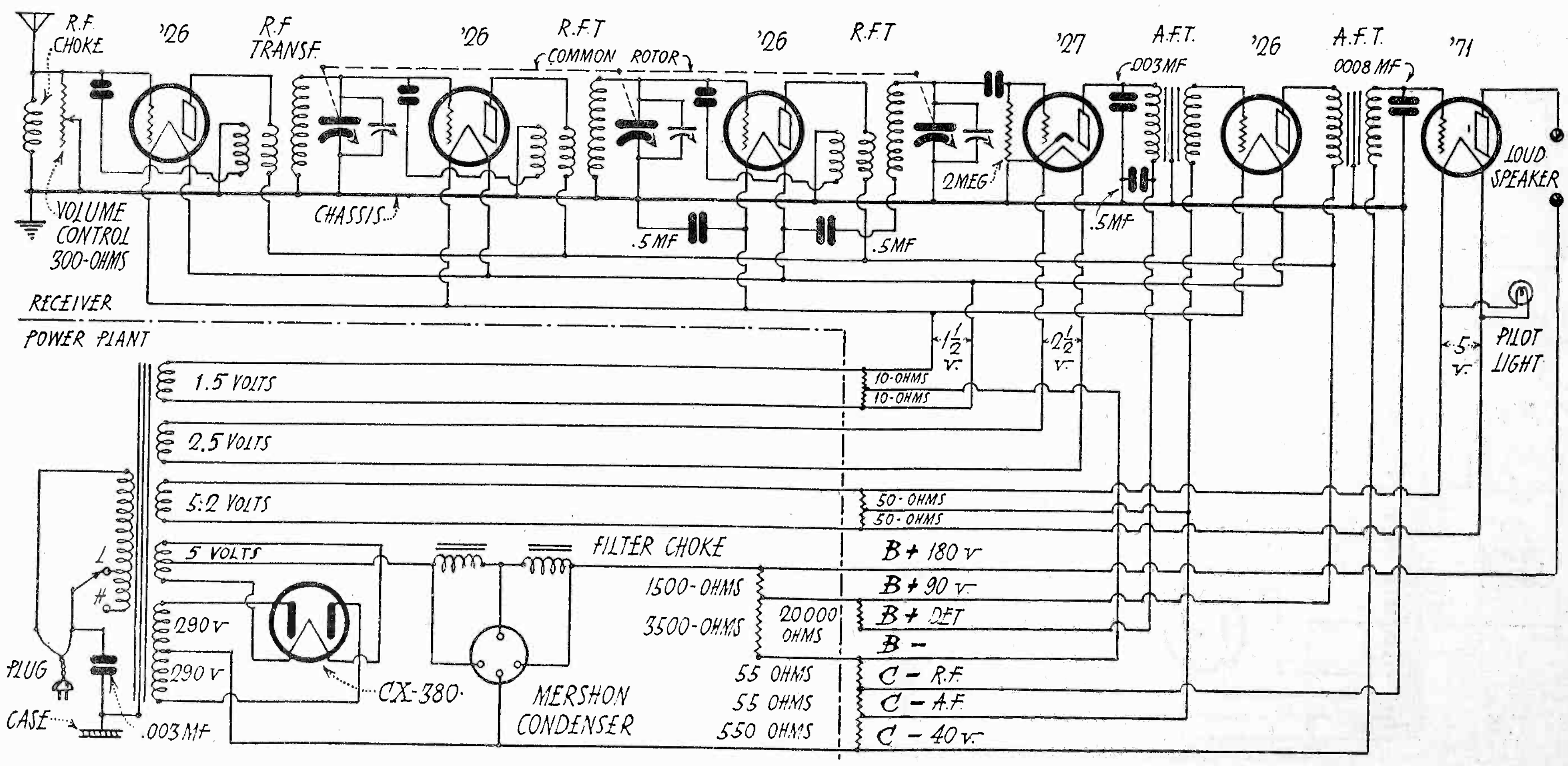


Fig. 8. Circuit of Crosley Bandbox A.C. Receiver.

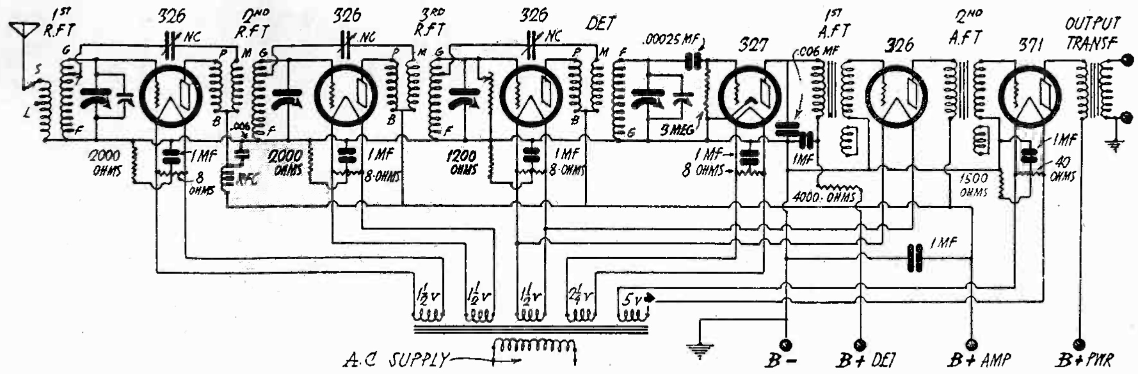


Fig. 9. *Circuit for A.C. Bremer-Tully Counterphase* 8.

Volume control is obtained by shunting the antenna circuit (which consists of a radio frequency choke, connected between the antenna and ground terminals), with a 300 ohm variable resistance. The antenna circuit is not tuned. The three-gang condenser used for the main tuning control tunes the secondaries of the three r.f. transformers. Each r.f. amplifier is balanced to prevent r.f. oscillation by means of a neutralizing condenser in series with a balancing winding of the r.f. transformer. *C* bias for the 371 power tube is obtained through voltage drop in a 550 ohm fixed resistance in the negative *B* supply circuit. The same method is used for the r.f. and first audio tubes by the voltage drop across a pair of 55 ohm resistances.

The *B* voltage supply consists of a full wave type 380 rectifier tube, with filter circuit consisting of a pair of 10 henry chokes, and a Mershon electrolytic condenser of three sections. The output voltage, as measured across the tapped resistance shunting the filter output, will be approximately 220 volts, so that 180 volts will be available for the power tube plate circuit, and voltages of 45 and 90 for the remaining tubes in the set are obtained from the taps in the resistance.

IN FIG. 9 is shown the circuit of the Bremer-Tully Counterphase 8, which is a six tube set having three stages of neutralized r.f. amplification, detector and two stages of audio: The r.f. amplifier tubes, which are type 326, are balanced individually with center-tapped 8 ohm resistances, and *C* bias for each tube is obtained by the voltage drop in the *B* negative connection to the center tap of the 8 ohm resistance. A 1 mfd. condenser is connected across the *C* biasing resistance in each stage, and in the first r.f. amplifier, a .006 mfd. fixed condenser is connected between the positive *B* terminal of the first r.f. amplifier and the center-tapped resistance. No positive bias is placed on the detector tube heater element, but a system of a.c. balance is installed, consisting of an 8 ohm center tapped resistance with a 1 mfd. condenser between the center tap and the cathode.

No circuit is shown for the *B* voltage supply, but it is practically the same as for any of the other factory built receivers. Note the individual 1½ volt windings of the power transformer for supplying each r.f. amplifier tube separately, with the first audio tube filament shunted across the supply for the third r.f. amplifier tube.

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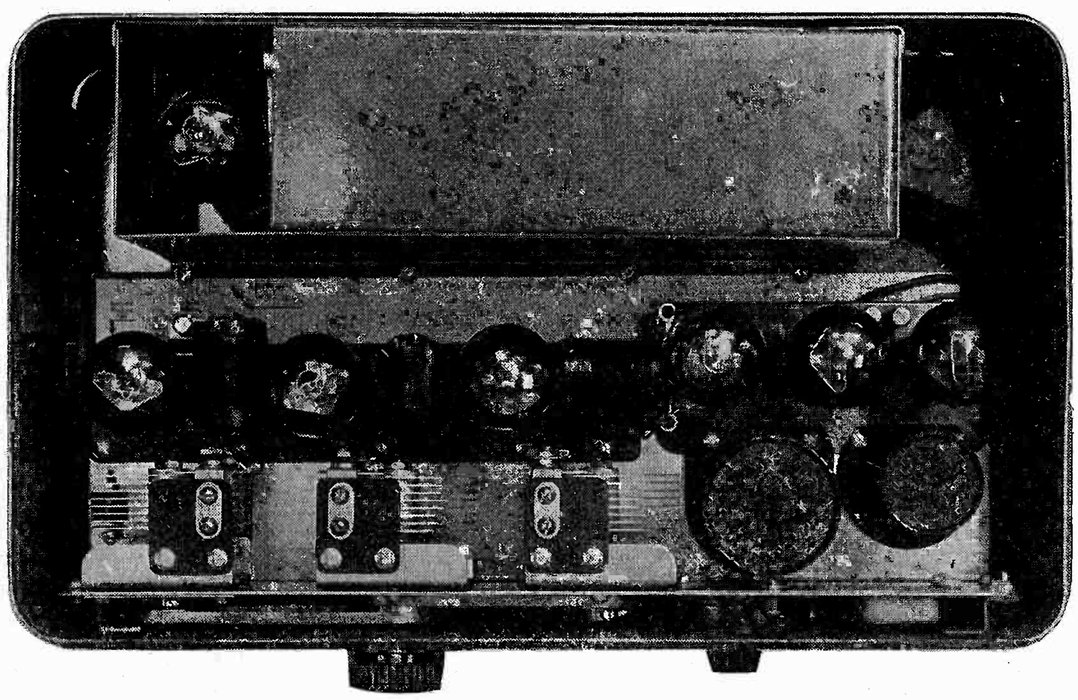

Atwater Kent Model 37 *A.C. Receiver.*

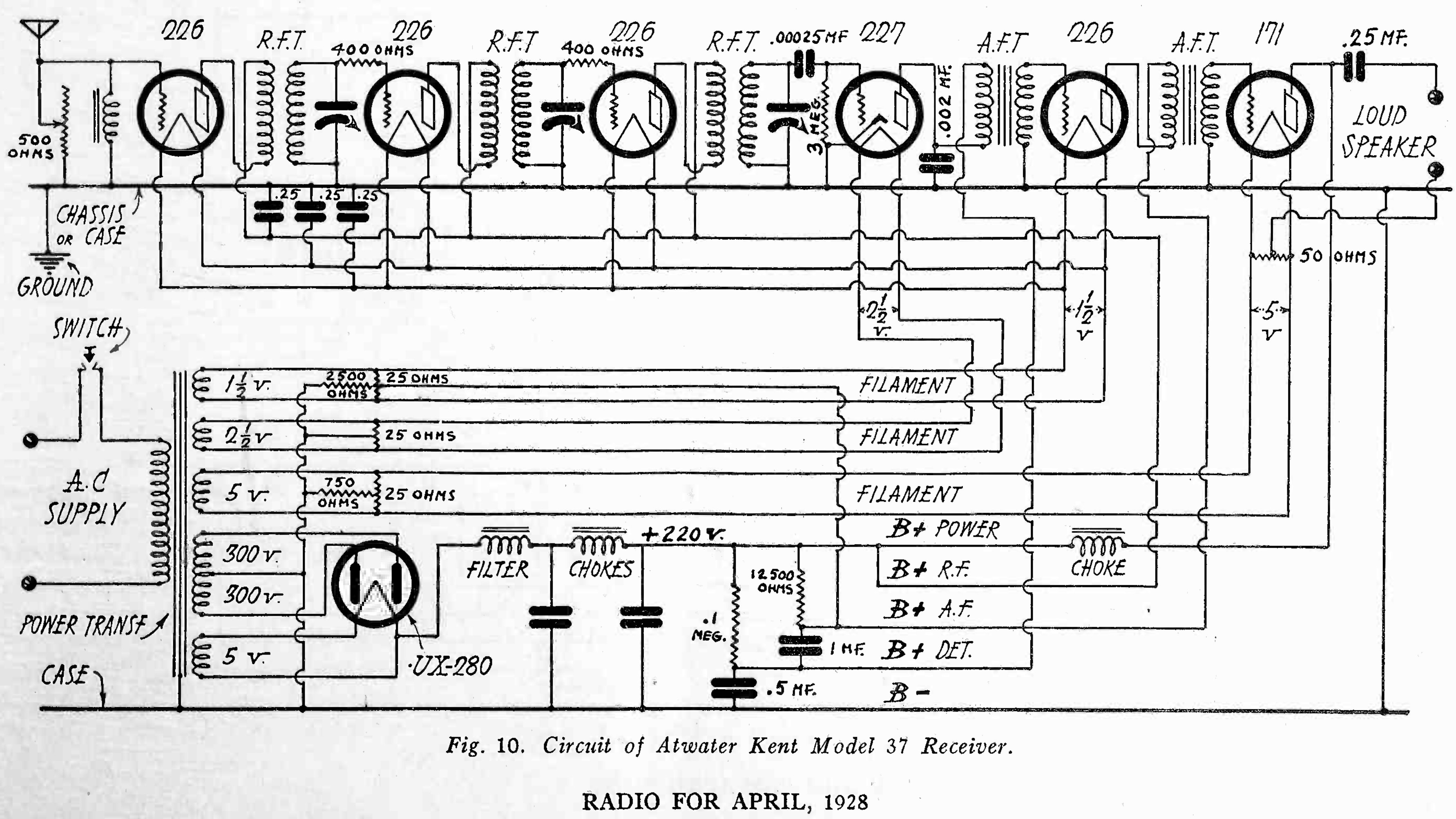

Fig. 10. *Circuit of Atwater Kent Model* 37 *Receiver.*

Factory Built Sets With Series Filament

A.C. MODELS employing series filament connection, with rectified a.c. for filament supply are divided into two classes, one using type A tubes, with 250 milliampere filament current, and the other using type 99 tubes, with 60 milliampere filament supply. Of the former, the Federal is a typical example, and its circuit is shown in Fig. 1. The receiver itself is a five tube tuned r.f. set of conventional pattern, with two stages of transformer coupled audio amplification, using a type 71 power tube, and four A tubes.

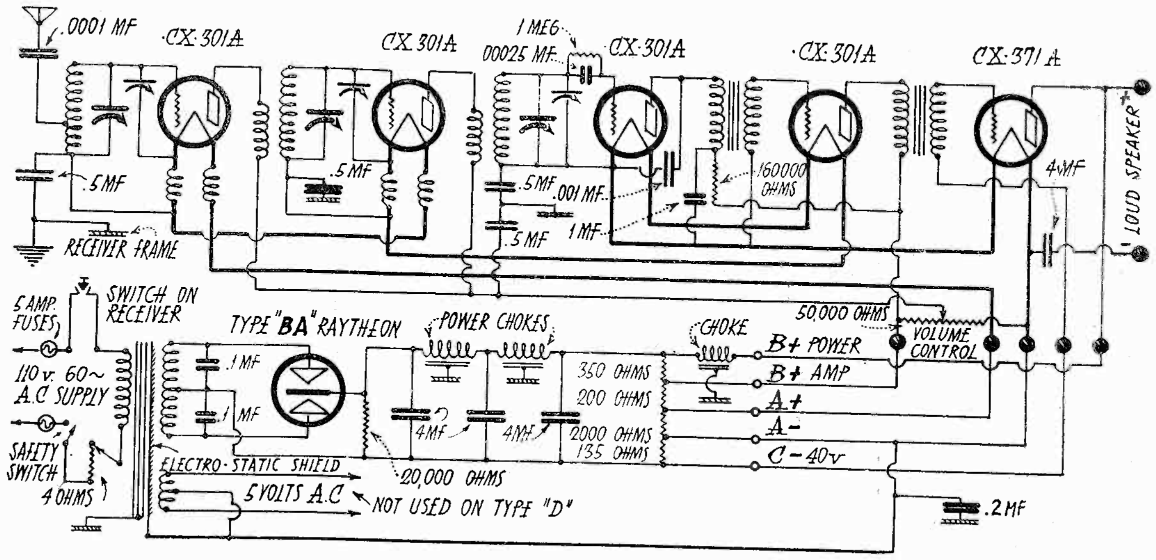

Fig. 1. Series Filament Circuit of Federal Receiver.

The power supply consists of a power transformer and Raytheon type BA 350 milliampere rectifier tube, with filter system and voltage distributor resistance, so that the same rectifier supplies both *A* and *B* voltages. *C* bias for each amplifier tube is obtained by means of the voltage drop across one or more filaments of the other tubes in the set, as can be traced out in the diagram.

The volume control is a 50,000 ohm potentiometer placed between the plus 70 volt and the negative *B* terminals, so that in effect the *B* voltage applied to the two r.f. tubes is varied to control the amplification. R.f. choke coils are placed in the filament leads of the r.f. amplifier tubes to prevent oscillation due to the presence of the filament in a common circuit with the filaments of the other tubes. These are wound with heavy enough wire to pass the 250 milliamperes of filament current without undue loss.

THE best example of a set having series 99 filaments is the Radiola 32, which is incidentally the only a.c. superheterodyne now on the market, as well as the only one employing series filament circuit with 99 tubes. There are other models than the 32 made by the same manufacturer, but the basic circuit is the same in each model.

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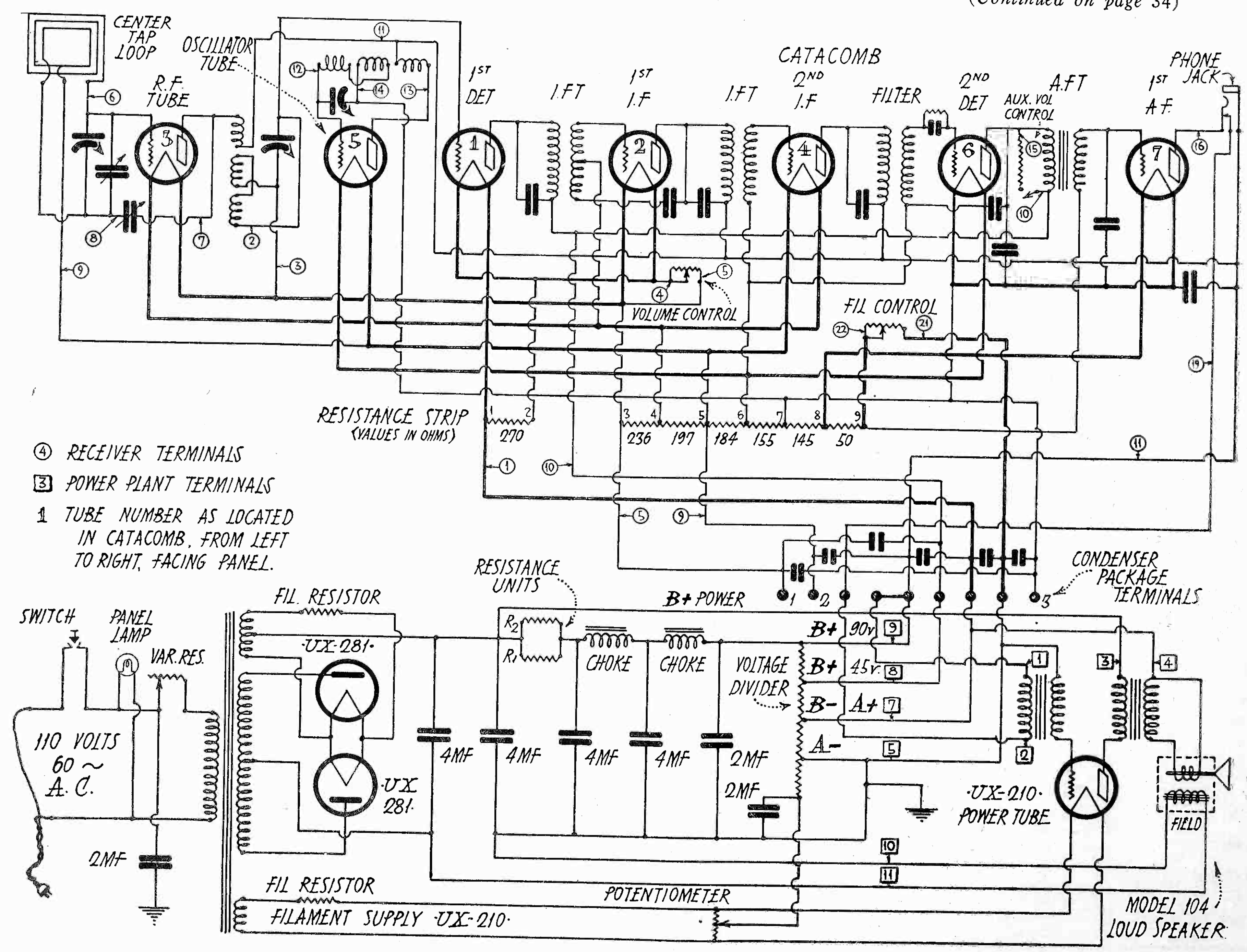


Fig. 2. Complete Circuit Diagram of Radiola 32.

Conversion of D. C. Sets For A. C. Operation

THE modification of sets originally wired for storage battery tubes consists of removing the filament wiring and substituting twisted pair wires in place of the straight, parallel sections of bus wire previously used, and in changing the system of volume control, which in almost every case is not suitable for a.c. tubes. For example, the Kellogg type 507-8 has been modified for a.c. operation in a number of cases, the new circuit for a.c. tubes being shown in Fig. 1. Here the filament wiring was removed, and new wiring run in its place.

The three r.f. amplifier tubes and the first audio tube were changed to type 26 a.c. tubes, so that those four sockets are wired for 1½ volts a.c. The detector tube was changed to a type 27, with the filament leads connected to the 2½ volt winding of the filament transformer. The power tube was already a type 71, but twisted pair filament leads were substituted, and the tube filament operated from the 5 volt winding of the power transformer.

To obtain electrical balance in the circuit containing the 26 tubes, a 20 ohm potentiometer was installed, so that the slider can be adjusted to the electrical center, where the hum is at a minimum. A ½ ohm rheostat is used as a volume control, in conjunction with a 200,000 ohm variable resistance. The former is placed in the supply lead from the 1½ volt filament winding to the four type 226 tubes, and the 200,000 ohm resistor is placed in shunt across the secondary of the second audio transformer. These resistors are mounted on the front panel in place of the former filament rheostat and volume control apparatus.

C bias for the r.f. tubes is obtained by the voltage drop across a 1000 ohm fixed resistance placed in the negative *B* circuit. The detector tube filament is biased by connecting the center tap of the 2½ volt filament winding to the 45 volt *B* terminal, and a ¼ ohm fixed resistor is inserted in one side of the filament circuit to limit the current in the heater to a safe amount.

The above changes, with the installation of the filament lighting transformer, are the only ones required to convert the set to full a.c. operation. Any other tuned r.f. set may be modified in a similar manner. In any of these sets, the system of volume control is the most important consideration, and by reference to the various diagrams of factory-built sets, the system which seems best adapted to the particular r.f. amplifier at hand should be selected.

Another method of rewiring receivers for a.c. operation is to install a heater type a.c. tube having a four prong base, such as the Arcturus. The necessary changes in the set from the old circuit to the new are illustrated in Fig. 2, which shows a standard five tube tuned r.f. set before and after wiring for the Arcturus tubes. As previously described, these tubes have a 15 volt heater element, to one side of which the cathode or sheath around the heater is connected, so that the fifth prong required by the type 227 tube is eliminated. The only actual wiring changes in the filament circuit are to replace the old parallel filament wiring with twisted pair, as the use of non-twisted wire would cause a large amount of a.c. hum.

Where the re-wiring of the set is not convenient, a complete equipment commonly called an "a.c. harness" is now available, as illustrated in Fig. 3. The harness consists of six socket adapters, in the case of a six tube set, with a three-winding step-down power transformer, *C* bias resistances, and filament current regulator. The adapters are first plugged into the tube sockets, and the a.c. tubes are then connected into the adapters. The *A* and *C* batteries are disconnected, and the *C* minus and plus binding posts shorted together.

The old filament wiring remains unused, and the *A* minus and plus terminals of the sockets are automatically shorted together by the adapters, making sure that the grid returns in the set all connect to a common point, since it might be that some of the grid returns

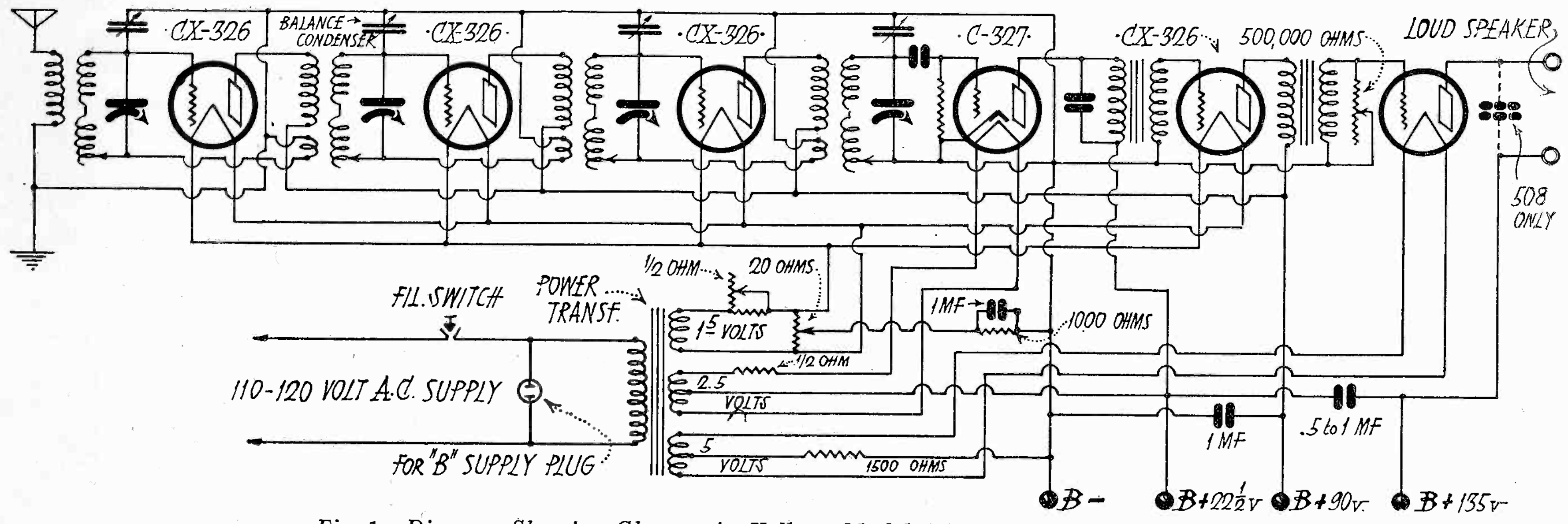


Fig. 1. Diagram Showing Changes in Kellogg Model 507-8 Receiver, for A.C. Tubes.

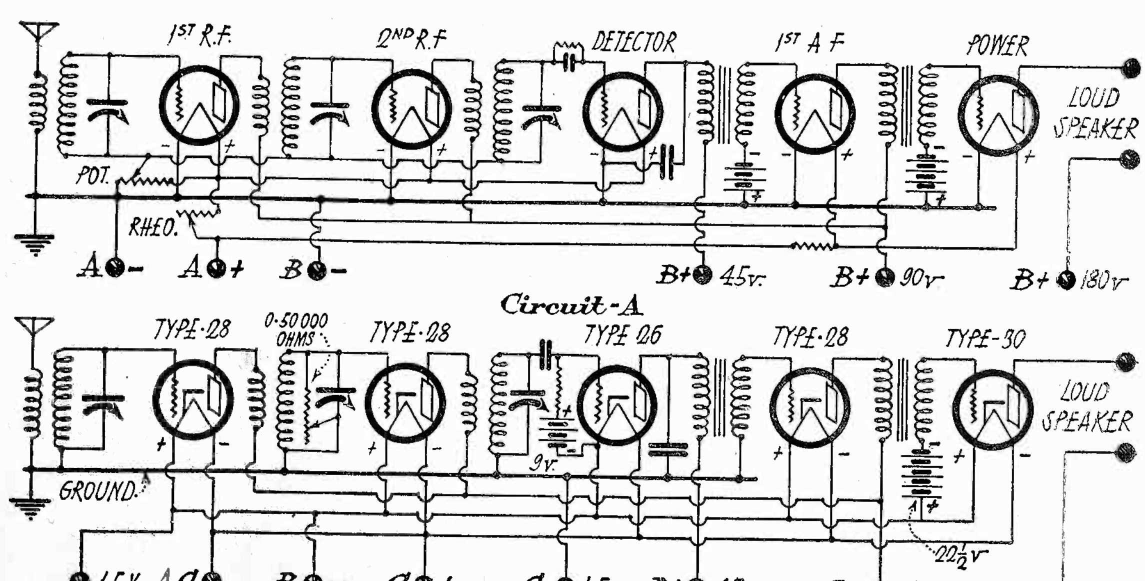


Fig. 2. Standard Five Tube Circuit, Before and After Wiring for Arcturus A.C. Tubes.

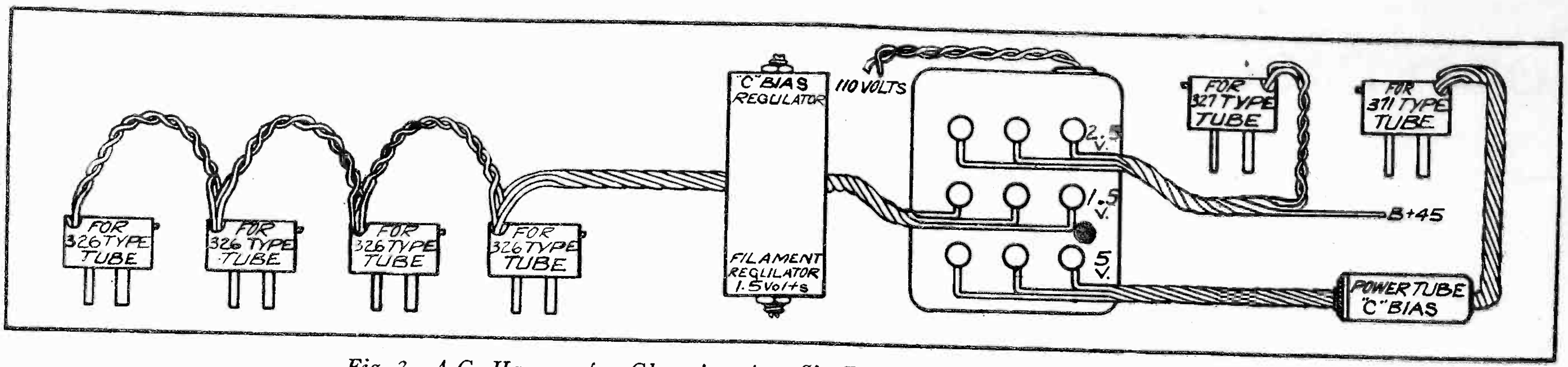


Fig. 3. A.C. Harness for Changing Any Six Tube Receiver to A.C. Operation.

connected to the positive *A* and some to the negative *A*. This old filament wiring is connected to the center tap of the 1½ volt winding of the filament transformer, thus connecting the grid returns to the point of electrical balance.

In case the transformer has no center tap, a harness can be obtained with a shunt resistance having a sliding contact, to be used as a "hum adjuster." By means of a variable resistance placed in the *C* bias lead, a voltage drop in the plate circuits of the tube can be produced, and the *C* bias obtained for the r.f. and first audio tubes, in the same manner as in many of the factory-built sets described. The filament regulator is a 1/5th ohm variable resistance placed in the 1½ volt filament circuit to reduce the voltage to the 326 tubes in case the circuit is unstable with full filament voltage.

Separate wiring is included for the heater type tube and for the detector circuit. The 45 volt positive *B* wire is connected to the center tap of the 2½ volt winding to provide a positive bias to the heater of the 27 tube. A power tube *C* bias resistor of 2000 ohms, suitable for either the 12 or 71 power tubes, is contained in the center tap circuit of the power tube adapter. The manufacturers of these harness equipments recommend as a volume control the installation of a variable high resistance across the antenna and ground connections, as is done in the case of the Radiola 17, shown in Fig. 1.

Most of the new sets have built-in *B* voltage supply equipment. Where the home set constructor wishes to purchase a complete power supply for his a.c. receiver, he can now obtain a device which supplies low voltage a.c. for the filaments of the 26 and 27 tubes, *B* current for all voltages required, and has a type 210 power amplifier included in the same metal case with the *A* and *B* equipment. Its circuit is shown in Fig. 4, this particular model being best adapted to five or six tube tuned r.f. sets. No harness wiring or adapters are included, as it was intended principally for use with sets in which the filament circuit is rewired and new sockets installed for heater type tubes where required.

For *A* current supply to sets where it is desired to replace the storage battery with an a.c. device, without rewiring the filament circuit, and for a.c. supply to receivers such as those using the new type 322 shielded grid tube, which is not yet available in an a.c. model, there are a number of rectifier units conventionally known as *A* eliminators. These units consist of a rectifier and filter system, so that the line voltage is first stepped down and then rectified and filtered so as to give a humless d.c. output of approximately 6 volts at from 2 to 3 amperes. The rectifier is in different forms, either one or two Tungar bulbs; a contact rectifier unit; or a chemical rectifier, depending on the make. The principal types now available are the Abox, which uses a chemical rectifier, the Sterling, which uses a full wave Tungar bulb, and the Elkon and the Knapp, which employ a contact rectifier.

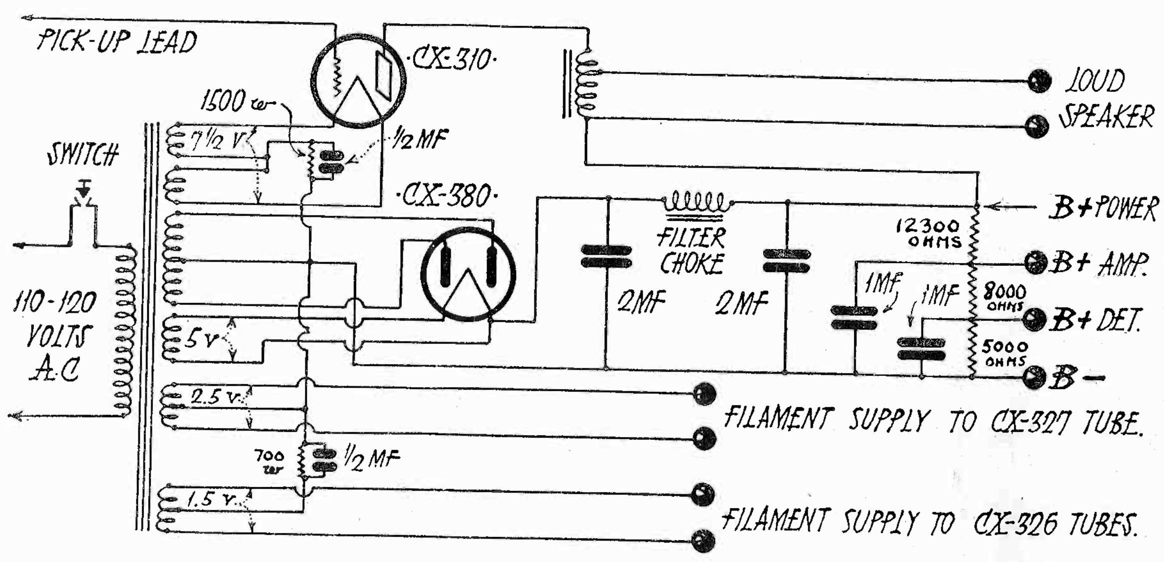


Fig. 4. "Powerizer" Circuit for Any A.C. Receiver.

A CHEAP STAND-OFF INSULATOR

By Hugo E. Anderson, 9BKN

In the accompanying figures is shown the construction of a cheap, but efficient, stand-off insulator, which can be made from the usual odds and ends found lying around the work-bench. The glass towel bar can be bought for ten cents. An insulator such as this will prove very satisfactory in a short-wave transmitter, where the leads must be kept at a respectable distance from the wall and where insulation of the best sort is desired.

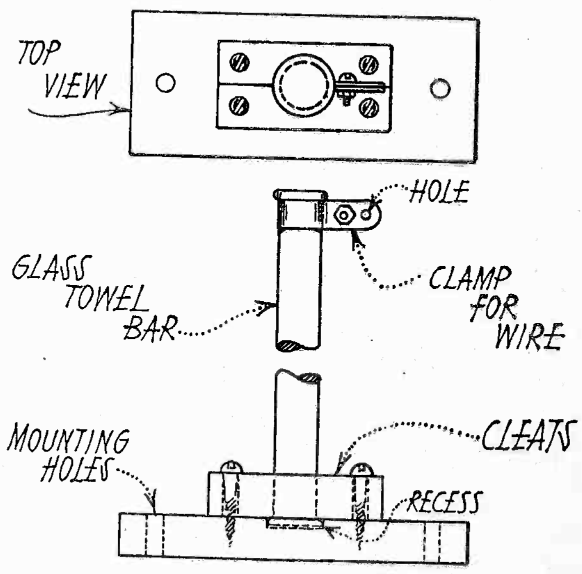


Fig. 1. Top and Side View of Insulator

The base is preferably made from a hard wood which is varnished or painted when completed. All pieces used in the making of the base are ¾ in. in thickness. As can be seen in the diagram, the towel bar is held fast to the base by means of the clamp of wood which in turn is fastened by means of wood-screws to the 6x2½x¾ in. piece that forms the bottom section of the base. The clamp for the base is best made by drilling a hole the size of the diameter of the bar in a piece of wood 3x1½x¾ in. in size; then this block is sawed through the center as shown in the top view of Fig. 1. The clamp to take the wire is located at the end of the rod away from the base, and is made from a piece of scrap sheeting. A small hole is drilled in the clamp for the wire as shown in Fig. 1.

The Balanced Impedance A. C. Tube Receiver

Constructional Details of An Interesting Experimental Six-Tube Model Having Excellent Sensitivity

By Francis Churchill

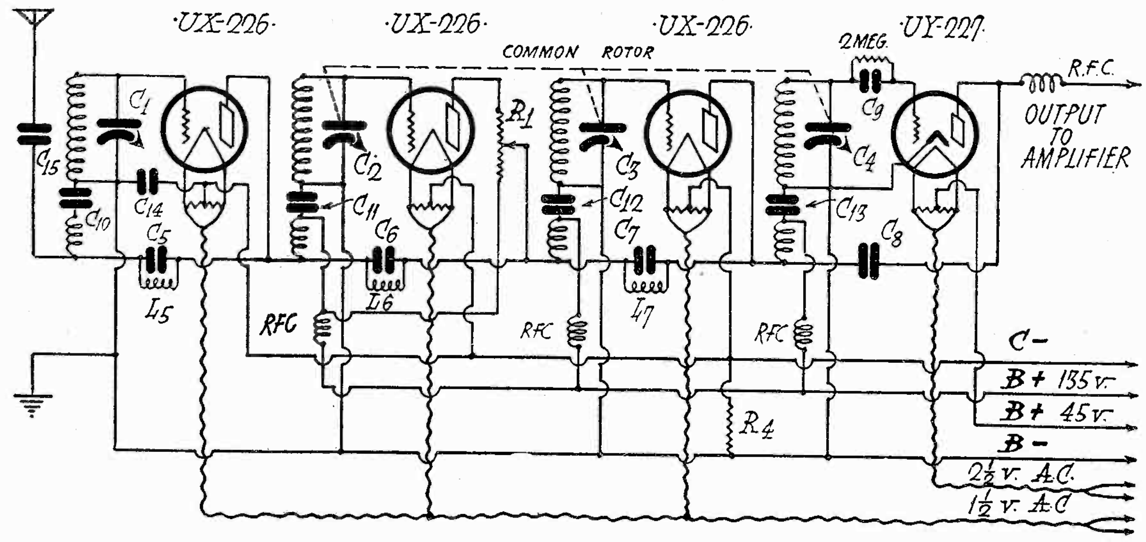


Fig. 1. Diagram of R.F. and Detector Circuit for Balanced Impedance A.C. Tube Receiver.

C_1, C_2, C_3, C_4—.00035 condensers, variable
C_5, C_6, C_7, C_8—20 to 100 mmf. variable condensers
C_9—.00025 mfd. grid condenser
C_{10}, C_{11}, C_{12}, C_{13}, C_{14}—.1 mfd. by-pass condensers
C_{15}—.0001 mfd. (depends on aerial)
R_1—0-10,000 ohm volume control resistance
R_4—600 ohm C bias resistance
R.F. Transformers—see text

THIS circuit combines the convenience of a receiver operated directly from alternating current socket power with the advantage of obtaining even sensitivity throughout the entire broadcast band. It can be applied to most tuned r.f. receivers employing two or three stages of r.f. amplification. The circuit is published for the benefit of the experimenter rather than the person interested only in what he hears. Consequently considerable latitude is allowable in the choice of parts.

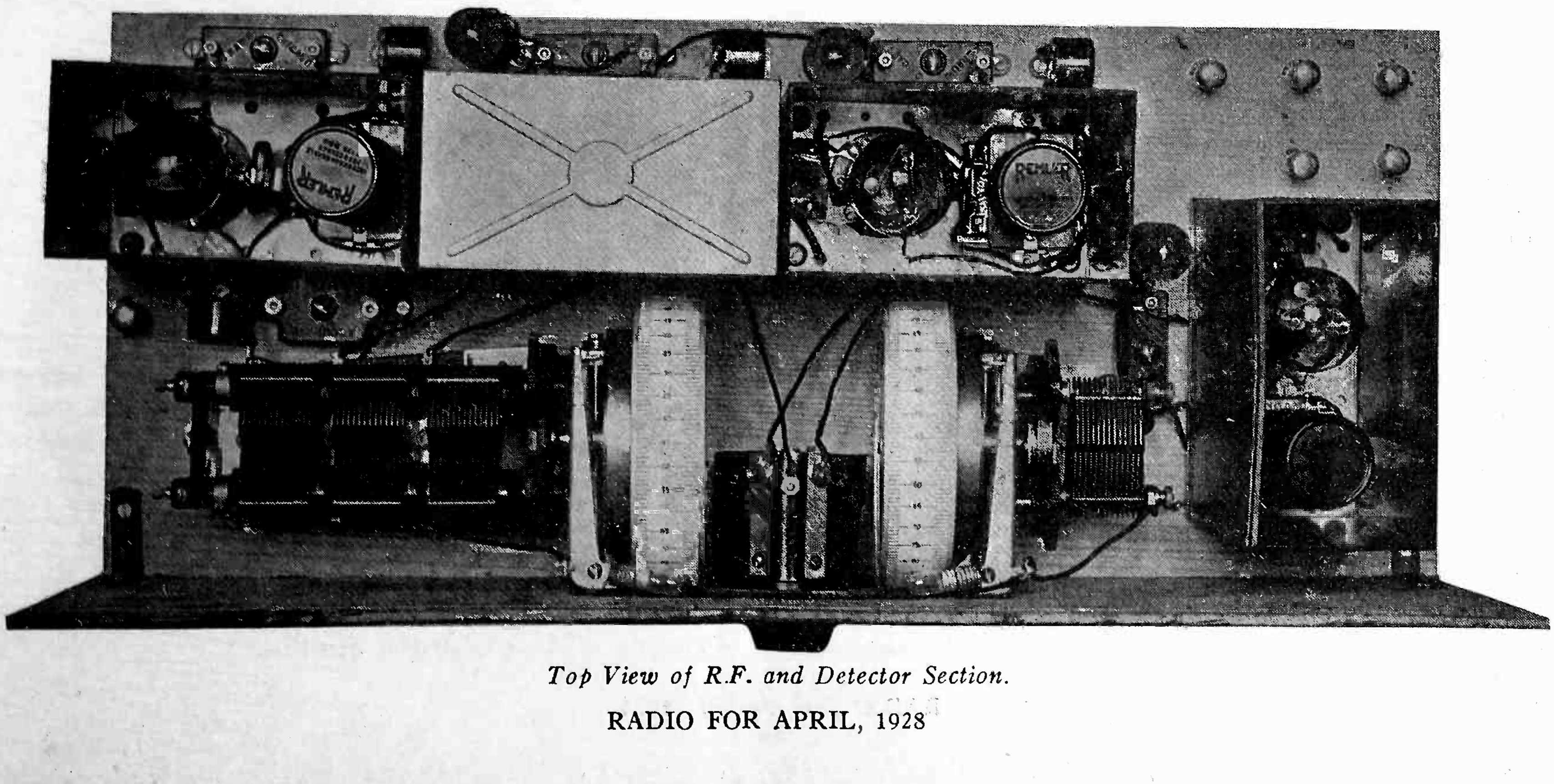
The circuit is shown in two sections, Fig. 1 being the r.f. amplifier and detector and Fig. 2 the audio amplifier. From Fig. 1 it will be noted that the plate circuit of each r.f. tube consists not only of the standard plate coil for transferring energy to the next tube but also of a peculiar phase-changing circuit for neutralization over the entire broadcast band.

The primary or plate coils of each r.f. transformer are wound in the same direction as the secondaries. The grid comes out at one end and the plate at the other, with the two inside terminals tied together through the bypass condensers C_{10}, C_{11}, C_{12} or C_{13}. Then C_5, C_6 and C_7 are the usual neutralizing condensers, the values depending on the grid to plate tube capacities and the turn ratio between the plate and grid coils. These values are usually between 30 and 80 micro-microfarads.

So far the circuit is a normal neutrodyne arrangement. Now let's consider the effect of the coils L_5, L_6 and L_7. These coils are compact windings of a value of one millihenry apiece and when shunted across the condensers C_5, C_6 and C_7, resonate at about 500 meters if those condensers are of the proper value for that wavelength. These inductances, really small r.f. choke coils, have very little effect down towards 200 meters where a combination such as C_5L_5 give a capacitive reactance. In other words C_5 is the predominating factor and L_5 simply increases the apparent capacity of C_5.

The action up towards 500 meters is different because of resonance of the condensers and coils up there. The impedance becomes less reactive and the neutralizing effect is lost. This is desirable because the sensitivity on the high wavelengths is normally poor. When the receiver is tuned to 500 meters, oscillation may take place because the plate circuit impedance is such as to cause that effect. However, the next plate coil is in parallel to this circuit and it is of fairly low impedance, say 5000 or 10,000 ohms in most cases, thus stopping the aforesaid effect.

In the actual receiver C_5, L_5, C_6, L_6 and C_7, L_7 are each tuned to different wavelengths in order to spread out the resonating effects and so obtain nearly constant gain over the whole broadcast band. C_5, C_6 and C_7 are small variable condensers having a range of from 20 up to 100 micro-microfarads. L_5, L_6 and



Top View of R.F. and Detector Section.

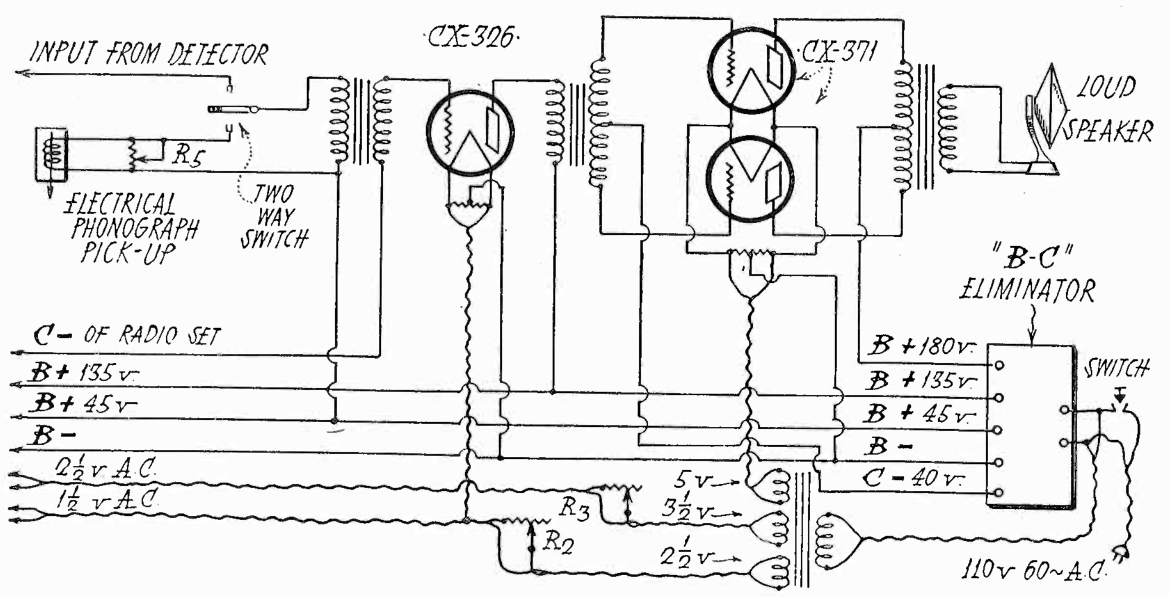


Fig. 2. Circuit Diagram of Audio Amplifier With A.C. Tubes.

R_2—½ ohm rheostat
R_3—1½ ohm rheostat
R_5—0-2000 ohm volume control for phonograph

L_7 can be made by winding about 400 turns of No. 32 or 34 wire on a thread spool, though it would be better to wind 600 turns on each coil with taps brought out at the 300th, 400th, 500th and 600th turns. Such coils can also be purchased.

As an a.c. tube receiver requires a volume control which does not change the *B* voltage or filament current, the arrangement shown in Fig. 1 is used. It consists of a 10,000 ohm tapered variable resistor, R_1, wired as a potentiometer. The plate coil L_3 is shunted across the portion of the resistance between the slider arm and the small tapered end. The remainder of the resistance is in series with the plate coil, as is also the neutralizing circuit. This also tends to cut down the volume. The result of these two actions gives good volume control, far better than that obtained in the usual a.c. tube receiver, to which this idea can be applied profitably. This type of resistance is now a commercial product.

Since this is an a.c. receiver, it was necessary to eliminate all *C* batteries also. There are several methods of doing this, one of the easiest being to use a voltage divider resistance in the *B* eliminator circuit with the negative *B* lead tapped in at the proper place. In this arrangement both the *B* and *C* supply leads should be from variable taps on the voltage divider resistance in order to obtain best adjustment for the complete receiver. This arrangement was used in the receiver shown for the *C* bias on the power tubes.

For the other tubes less *C* bias was desired, that is about 9 or 10 volts, so a 600 ohm resistance R_4 was used in the common negative *B* return as shown in Fig. 1. The value of this resistance depends on the number of tubes used and the impressed plate voltage. It can be calculated from Ohm's law and the tube manufacturer's data sheet; these data containing the plate current at different plate voltages.

The r.f. transformers can be of nearly any type, though better results are obtained from those having adjustable primaries. The transformers shown in the set each have about 120 turns on 1½ in. diameter for the secondary and 20 turns on 1 in. diameter for the primary or plate winding. The four coil terminals are brought out to four pins in the base of the coil for plug-in mounting with a standard UX tube socket. The primary or plate coil is removable and so can be wound with the correct number of turns for any type of tube.

The audio amplifier was built up on a separate baseboard as a unit with the necessary power equipment for the rest of the receiver. This was done in order to use the amplifier for either phonograph or radio reproduction by means of a single pole double throw switch mounted as shown, or in any nearby location desirable. This switch connects the detector tube of the radio receiver to the first audio transformer on one side, or a phonograph pick-up unit and volume control on the other side.

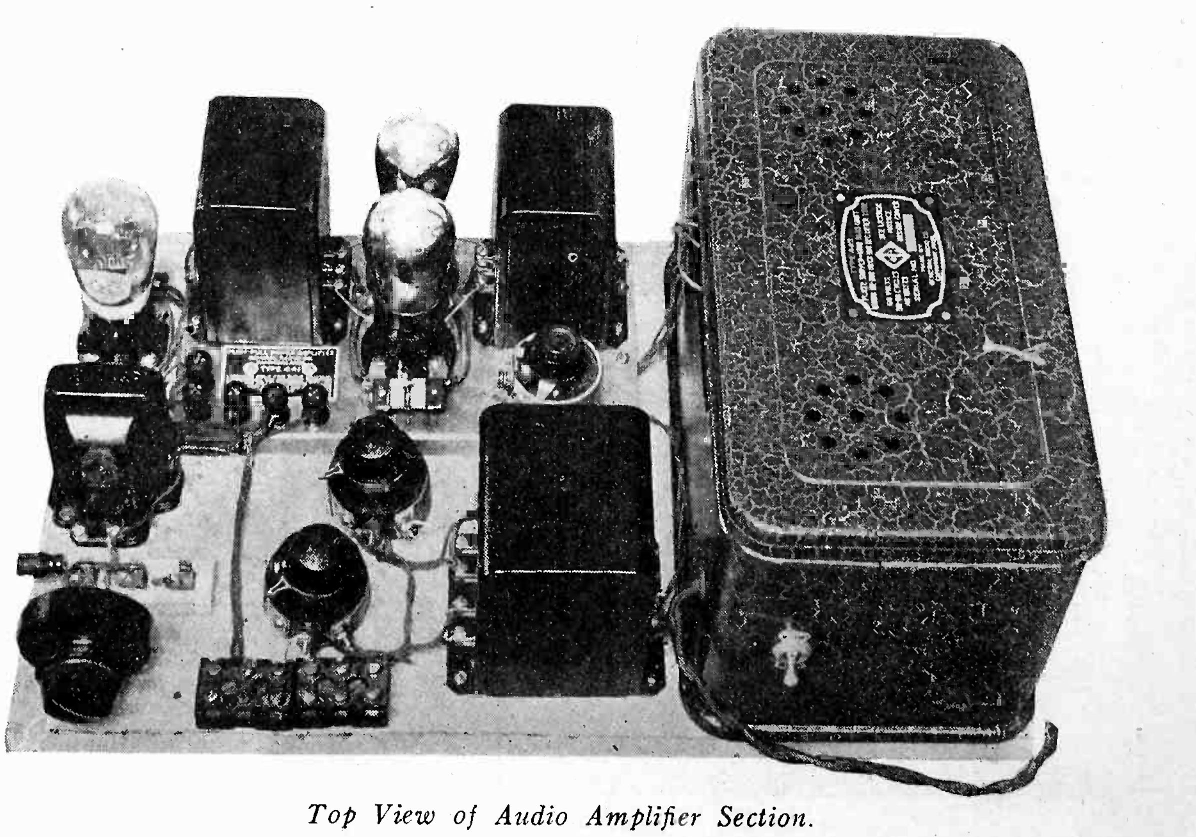
The audio amplifier consists of a 1 to 2.7 ratio input transformer, a 226 tube, and a push-pull amplifier unit with a pair of 171 power tubes. The use of a push-pull amplifier reduces the a.c. hum to a negligible amount so that the set gives good reception even on low volume. In a push-pull amplifier the a.c. potential across the grids from a.c. filament supply cancels out in the output transformer, so is inaudible. On the same baseboard are mounted the a.c. tube filament transformer and rheostats, and the *B-C* power supply unit, the latter using a 280 rectifier tube. No panel or baseboard layouts are given as the parts used by different constructors would probably vary greatly in size and type.

The external filament resistor R_3 practically eliminates burnouts of the 27 detector tube. This limits the starting current until the tube has a chance to heat up enough to increase the resistance so that 1.5 amperes instead of 4 amperes will flow when 2.5 volts are applied. Thus almost a minute may elapse before reception starts after turning on the power switch.

The phonograph pick-up unit can be any of the so-called "electrical pick-up units" on the market. As in most all radio equipment, the more expensive types are generally far superior in frequency characteristics to the cheaper varieties.

The volume control R_5 in Fig. 2 is a 0-2000 ohm variable resistance and should be connected as shown for best apparent effect as a volume control. It acts as a termination for the pick-up unit and gives the audio amplifier a good frequency characteristic because it shunts the primary of the first or input transformer. Some phonograph units require a scratch filter in shunt to remove the needle scratch from the out-

(*Continued on page 34*)



Top View of Audio Amplifier Section.

A. C. Operation of the 115 K. C. Superheterodyne

By Gerald M. Best

THE heating of the filaments of any receiver from the a.c. lighting circuit is possible by two methods: wiring the filaments of the tubes in series for current supply from a heavy duty rectifier system, or heating the filaments from raw a.c. through step-down transformers. In the 115 kilocycle superheterodyne, it is easy enough to replace the type 99 tubes with appropriate a.c. tubes, but no a.c. substitute for the shielded grid tube is yet available. Hence, the series filament method is apparently the only practical one now possible, although experiments are being made with the 322 tube, using raw a.c. on the filament, and it may develop that a.c. operation of this tube in a superheterodyne is practicable.

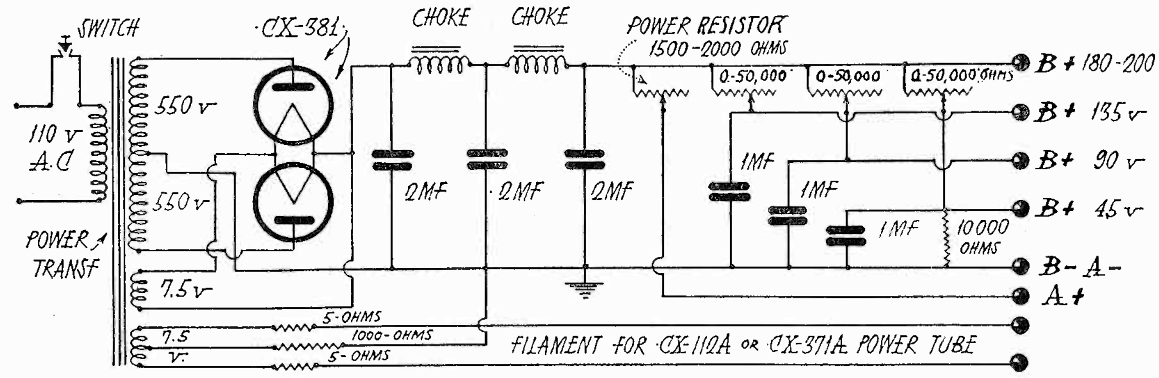


Fig. 2. Power Plant Required for Series Filament and Plate Voltage Supply.

Since the type 322 tube requires 132 milliamperes at 3.3 volts, it is obvious that the tube cannot be connected in series with tubes requiring different values of filament current, without some scheme whereby the current drain may be equalized, and each tube receives its proper filament current and voltage. As can be seen in Fig. 1, this is easily accomplished by shunting the type 99 tube filament with a 50 ohm fixed resistance. The resistance of the shielded grid tube filament is 25 ohms, and that of the 99 tube is 50 ohms, so by shunting the latter with a 50 ohm resistance, the resultant resistance is 25 ohms, and a current of 132 milliamperes passing through the 99 tube filament and its shunt resistance will result in 66 milliamperes in the filament, and 66 milliamperes in the resistance, while the full 132 milliamperes will pass through the shielded grid tube filaments.

As far as the high frequency and audio ends of the circuit are concerned, few changes are necessary to wire the set for series filament operation. Starting with the detector tube negative filament, which is connected to the negative of the rectifier system, the first and second r.f. amplifier, mixer, oscillator, first and second intermediate, and the first audio amplifier tubes are connected in series, the positive of the latter tube going to the positive of the rectifier system, through a resistance which will probably be set at 1600 ohms, based on practical experiments with the circuit. The position of this resistance is shown in Fig. 2, which is the circuit of the power plant associated with the receiver. The resistance may be a 1000 ohm fixed resistor, placed in series with a variable resistance of 750 to 1000 ohms, or it may be a variable resistance of at least 2000 ohms maximum, and capable of dissipating at least 25 watts. A series of 25 watt Mazda lamps, each of 600 ohms resistance, may be used, as they will stand at least 250 milliamperes without excessive strain.

To furnish the proper grid bias for those tubes requiring bias, fixed resistances are placed in series with the filament circuit. Each shielded grid tube requires 1½ volts negative grid, so that 10 ohm fixed resistances placed in series, as shown in Fig. 1, will provide 1.3 volts, which is adequate. The first audio amplifier tube grid obtains its 4½ volt bias through the voltage drop across the detector tube filament and the 10 ohm resistance which also provides bias for the second i.f. amplifier tube. The oscillator grid bias is furnished by the drop across the mixer tube filament, while the power tube bias is obtained by the voltage drop across a 1000 ohm fixed resistance placed in the negative *B* connection to the filament of the power tube, through the center tap of the filament lighting transformer.

The reason for starting the series filament circuit at the detector is that it has been found good practice to have the detector filament grounded, as the presence of an ungrounded grid in the detector may lead to annoying a.c. hum which cannot be eliminated, and the nearer the detector grid is to ground, the less hum there will be. The dial lamps located above the drum dials on the panel each require .13 amperes, so that they are connected in series with the main positive filament supply lead, and will serve as an indication that everything is O. K. in the filament circuit.

The main volume control is a 500,000 ohm variable resistance in the *B* supply lead to the front end r.f. amplifier. This replaces the 200,000 ohm resistance previously specified for this circuit. This is because it has been found that in congested localities where there are a number of high powered local stations,

(*Continued on page 36*)

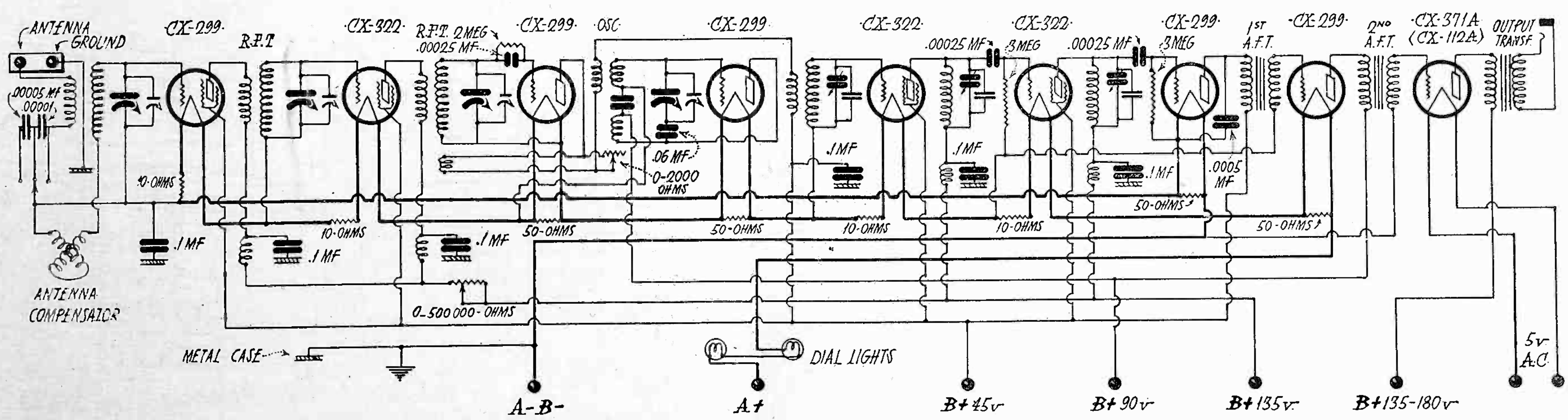


Fig. 1. Wiring Diagram of 115 K.C. Superheterodyne, With Filaments in Series.

Taking the Hum out of A. C. Sets

By Clinton Osborne

A WELL-DESIGNED and properly operated radio receiver using a.c. tubes should give little or no audible hum in the loud speaker. When it does occur, its minimization requires knowledge of a few facts that are here presented. Some have to do with the design and others with the method of operation.

The most puzzling problem in design is to balance out the a.c. hum. For instance, the old practice of connecting the negative *B* and positive *C* to one side of the filament, usually the negative *A* in d.c. sets unbalances the filament circuit of a.c. tubes and introduces considerable hum.

The type 26 tube, whose filament takes 1.05 amperes at 1.5 volts, when used as an r.f. or first audio amplifier may be balanced by several methods. The purpose is to find the exact electrical center of the filament circuit so that no alternating voltage from the power supply will be impressed upon the grid circuit so as to produce an a.c. hum.

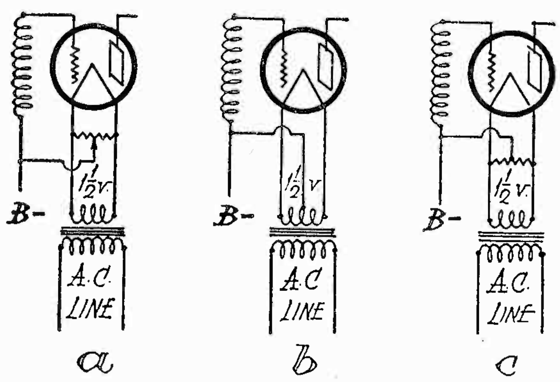


Fig. 1. (a) Filament Balance by Variable Resistor (b) Center Tapped Secondary (c) Fixed Balancing Resistor.

These methods are shown in Fig. 1, circuit "a" being the one most commonly used. In this case, a potentiometer of 15 ohms or more is shunted across the secondary winding of the step-down transformer, and the grid return lead, as well as the negative *B*, are connected to the slider, so that the latter is moved back and forth until no hum is heard in the headphones or loud speaker, as the case may be. This electrical center will sometimes be slightly to one side or other of the center as measured with direct current measuring apparatus, due possibly to the inductance of the potentiometer windings, or to unbalance in the power transformer secondary winding, with respect to ground.

Fig. 1b shows another method, where the power transformer secondary is tapped at the exact center of the winding. This requires careful design of the transformer, as a tap taken out at the center of the total number of turns on the transformer may not be the exact voltage center, and unbalanced filament circuits will result.

Fig. 1c shows another method, using a fixed resistance in shunt across the filament circuit, with a tap taken at the exact center. Here, too, the same trouble as with Fig. 1b may occur, in that the tap may not be at the exact electrical center for that particular installation, so that for the experimenter and professional set builder, the use of a low resistance potentiometer is the best in the long run.

Some receivers use a single potentiometer across the entire group of type 26 tubes, thus obtaining the exact position of balance in one operation. This may work out in many cases, but it is better to have individual filament balancing resistors to insure the best possible operating conditions. One manufacturer makes a tiny 60-ohm resistance strip, with a variable center tap. These are cheap and a set of four or five resistances takes little room, as they fit underneath the terminals of the tube socket. In wiring the filaments of the type 26 tubes, the 1½ volt supply lead should be twisted pair, well insulated, and kept as far away from grid circuits as is possible.

The same applies to the type 27 detector tube, the 2.25 volt filament circuit of which should be wired with twisted pair of at least 16 gauge, so as to carry the current. At the minute of starting, the heater current of the 27 tube may run as high as 4 amperes, so that very small gauge wire is unsuited to this part of the circuit. As the resistance increases as the filament gets hot, the normal operating current is 1.75 amperes. The type 27 tube requires a positive bias on the heater, with respect to the cathode. This is obtained by shunting the heater with a potentiometer, in the same manner as in Fig. 1a, and connecting the slider to the positive 45 volt *B* terminal. Adjustment of the slider is made in the same manner as for the type 26 tube. Once the condition of balance is attained, the slider can be left permanently set.

It has been found that in some circuits, the presence of resistance in the grid return leads causes r.f. oscillation. This is overcome by shunting the two halves of the resistance with .005 mfd. fixed condensers. These condensers bypass most of the r.f. and prevent the oscillation trouble.

Where a negative grid bias is to be furnished in the r.f. stages, and also in the first audio stage, it may be obtained either by the use of individual resistances in the negative *B* supply lead to each filament, or by the use of a tapped resistance placed between the common connection to the center of all tube filaments and the negative *B* supply. This is illustrated by Fig. 2, where "a" shows a three stage r.f. amplifier in which the *C* bias is furnished by a single fixed resistor placed in the negative *B* connection to the filament circuit, and "b" shows a tapped resistor which is also used to supply negative bias to the audio amplifier tubes.

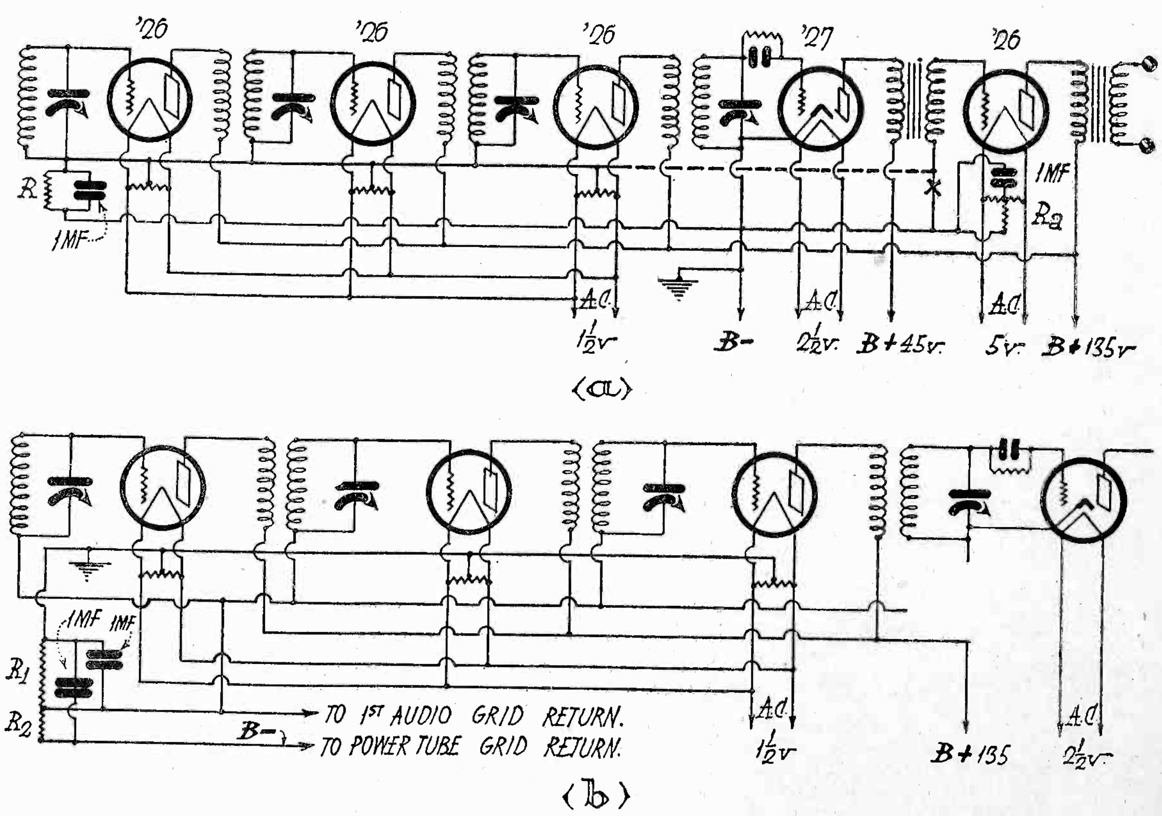


Fig. 2. (a) Method of Furnishing "C" Bias by Individual Fixed Resistors (b) Use of Tapped Resistors in Common "B" Supply Line.

The method used in "a" is perhaps the most inexpensive to employ in the home built set, as fixed resistances of the right value are cheap and easily installed, while a resistor which is accurately tapped at the right points may be expensive and cannot always be obtained in the right values. To figure out the value of the resistance to furnish any given grid voltage, it is necessary to use Ohms Law, where R equals E/I. R being the unknown resistance, E the required grid voltage, and I the plate current of the tubes to which the grid voltage is being provided.

Inasmuch as the tube manufacturers have determined that the least amount of a.c. hum is produced by the 26 tube when the plate current is 3 milliamperes and the average plate voltage 135 volts, it develops from the grid voltage-plate current curve that approximately 9 volts C bias are required. The plate current per tube, in a three stage r.f. amplifier, will be 3 milliamperes, so that the total plate current will be 9 milliamperes, and by substitution in the formula, R equals 9 divided by .009, or 1000 ohms as the correct value for the C biasing resistance R in Fig. 2a. A 1000 ohm fixed resistor is a standard value, easily obtained, and does not require adjusting, provided that the plate voltage is maintained somewhere near 135 volts.

If grid voltage for the first audio amplifier tube is to be obtained from the same resistor, the total plate current will be 12 milliamperes, and the resistance will work out 750 ohms, a value which can be made up from a 500 and a 250 ohm fixed resistor placed in series. If a separate resistor for the first audio stage is to be used, as is preferable, the grid resistor will be 3000 ohms, since that value will be required to produce a voltage drop of 9 volts, with 3 milliamperes flowing through the resistance.

In Fig. 2a, the separate grid bias resistor for the first audio tube is shown as R_a, while in case the resistor R is to supply grid bias for all four tubes, the dotted line shown on the diagram is connected, and the solid line is broken at the point X. Both grid bias resistors should be shunted by 1 mfd. by-pass condensers, to prevent the amplifiers from oscillating due to coupling through the resistance.

In Fig. 2b, the tapped resistor method is shown, whereby a resistance of such value as to produce a given voltage drop with the total plate current of the set flowing through it is selected, and tapped at certain points so as to give the right values of C bias. This resistance is placed between the negative B supply lead and the common center tap connection of the tubes, so that the plate current to each tube has to pass through the common resistor. The tap is so set that it provides say 9 volts negative for the r.f. and first audio amplifiers, and from 9 to 45 volts negative bias for the power tube, depending on the type. To figure out the size of this resistance, it is first necessary to compute or measure the plate current drain of the set, and then by Ohms Law work out the total value of the resistance and the position of the taps. As in the case of the individual resistors, each section is shunted by a 1 mfd. by-pass condenser, to prevent oscillation.

The selection of a volume control in any a.c. set is important, as some methods which are proper for sets using d.c. tubes are not good for the a.c. tubes. The insertion of a filament rheostat in the 1½ volt supply line to the r.f. amplifier filaments is usually unsatisfactory, since the filament of the 26 tube is sluggish in action and an appreciable period of time elapses before any effect can be noticed when the filament current is changed. Trouble is also likely to result when the rheostat becomes worn or dirty through continued use, as a current of over 3 amperes will flow through the rheostat, and this will cause minute arcs in the dirty contacts, resulting in a noisy set.

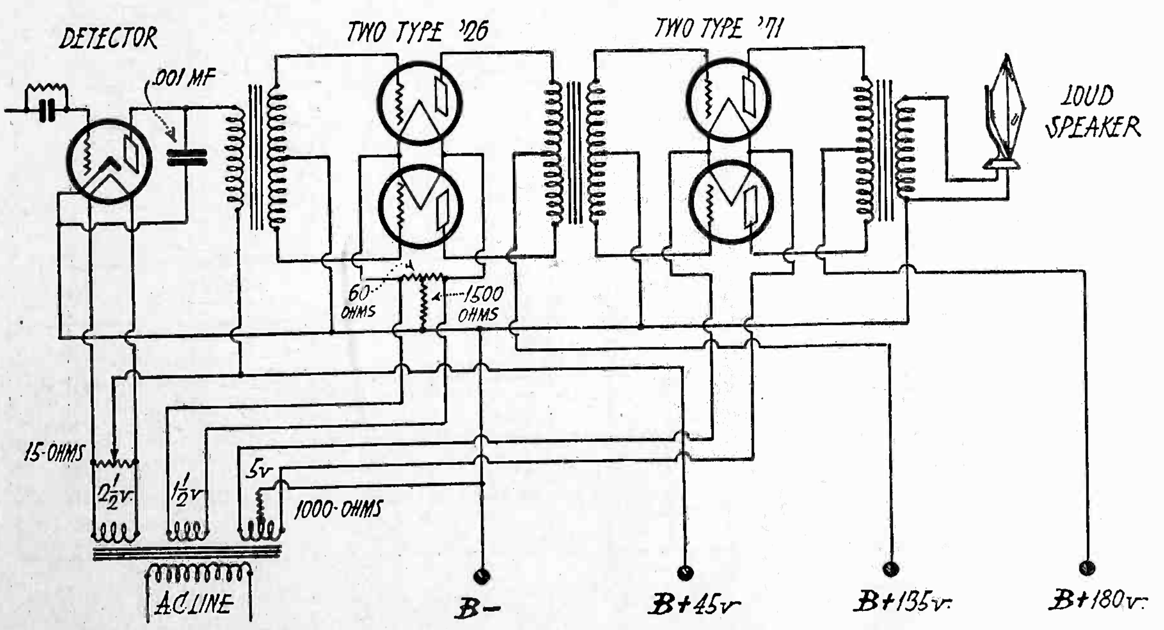


Fig. 4. Push-Pull Two-Stage Audio Frequency Amplifier.

Many of the factory built sets use a system which is strongly recommended by the tube manufacturers, in the shape of a potentiometer at the input to the r.f. amplifier. It may consist of either of the two methods shown in Fig. 3. Circuit "a" consists of a 2000 to 5000 ohm potentiometer, with the slider connected to the grid of the first r.f. amplifier tube, and the resistance connected to the antenna and ground, so that the impressed voltage on the grid of the first tube may be varied from zero to maximum, thus controlling the volume in the loud speaker. No tuning of the antenna circuit is required with this method of volume control. The tuned circuits in the receiver should be selective, as the first r.f. tube will amplify all stations alike, and in the case of powerful locals, poor selectivity may result if the tuned circuits associated with the remaining r.f. amplifier tubes are not selective.

Circuit "b" of Fig. 3 is another method in which a tuned circuit is used ahead of the first r.f. tube, the primary coil being shunted by a potentiometer, so that the input to the primary may be varied to properly control the volume.

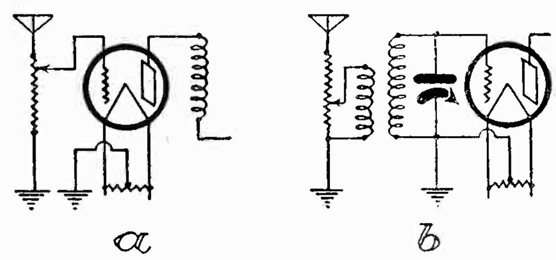


Fig. 3. Volume Control Methods, (a) Potentiometer in Antenna Circuit, (b) Potentiometer Across Primary of Antenna Coil.

The suggested value of this potentiometer is 25,000 ohms, although resistances of smaller value can undoubtedly be used.

Among the other methods of volume control are a 50,000 ohm variable resistance shunted across the secondary of one of the r.f. transformers, and a variable 200,000 ohm resistance placed in series with the positive B supply lead to the r.f. stages. The latter is the least preferable, as it varies the plate current of the tubes and causes the ripple voltage in the grid circuits to be so increased that the a.c. hum will be noticeable.

A great deal has been written on the subject of voltage regulation of a.c. tubes, so it will not be covered in detail here. It is customary to insert a ½ or ¼ ohm rheostat in one side of the 1½ volt secondary winding supplying the type 26 tubes, to limit the filament current to as low a value as is consistent with good operation. The type 26 tube will usually operate at several tenths of a volt below its rated normal voltage, and if the set can be made to work satisfactorily at lower filament currents than

(*Continued on page* 44)

How and Why an Electric Filter Works

By *Arthur Hobart*

AN electric filter is used to separate the alternating current component of the pulsating current output of the rectifier used in a socket power device so that the direct current component may be without ripple or hum. Its action depends upon the fact that a coil of wire offers but little opposition to the flow of direct current, but great opposition to the flow of alternating current, while a large condenser stops direct current but passes alternating current. For the direct current, the choke coil offers a line of least resistance and the condenser says "thou shalt not pass." For the alternating current, the condenser offers an avenue of escape when the way is blocked by the choke coil. A proper combination of choke coils and condensers provides a smooth and constant direct current.

Unless the a.c. is separated and by-passed from the d.c. it causes a hum in the loud speaker. When 60 cycle a.c. is the source of current this hum has a fundamental frequency of 60 cycles per second from a half-wave rectifier and of 120 cycles from a full-wave rectifier. As an electro-dynamic speaker, when used with good transformers, readily reproduces these low frequencies, their elimination from the plate supply becomes a matter of prime importance.

By putting a single condenser in shunt across the load, this hum may be reduced in volume but not eliminated. This shunt condenser not only by-passes the a.c., but also stores energy during that part of the cycle in which the voltage is increasing so as to charge the condenser, and releases energy when the voltage is decreasing. This alternate storage and release of energy reduces the amplitude of the pulsations.

Likewise a choke coil in series with the load slightly reduces the hum by blocking the a.c. and alternately storing and releasing current so as to prevent a rise to maximum or a drop to minimum. But this effect is not very great at the low frequencies here to be eliminated. Furthermore, its d.c. resistance reduces the voltage delivered to the load.

By combining the two, putting the choke in series and the condenser in shunt, as in Fig. 1, considerably more filtering action may be secured than

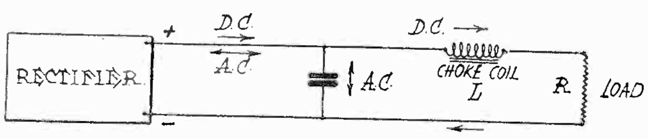


Fig. 1. Filter Action of Series Choke and Shunt Condenser.

with either when used singly. This filtering action may be enhanced by putting two condensers in shunt with the

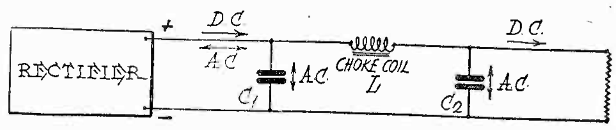


Fig. 2. One Unit of Low-Pass Filter.

choke coil as shown in Fig. 2. Experiments show that the main effect of the first condenser, C_1, is to act as a storage reservoir to regulate the steadiness of the output voltage and of C_2 to suppress the hum.

As the blocking action of a coil is less at low than at high frequencies, a choke coil to block 60 and 120 cycles should have an inductance of at least 25 henrys and also a resistance of less than 250 ohms. The by-passing action of a condenser is also less for low than for high frequencies. So at least 2 mfd. capacity is necessary to by-pass 60 and 120 cycles.

To be inaudible, the unfiltered ripple or a.c. voltage should not exceed 0.08 per cent of the load voltage. A single filter unit, as shown in Fig. 2, using a 25 henry choke and two 6 mfd. condensers gives about 0.1 per cent ripple, which is sufficient to be audible in the headphones, though not bothersome in a loud speaker.

Better results with smaller condensers may be secured by combining two such filter units, as shown in Fig. 3, where C_2 is common to both units. The first unit eliminates a certain percentage of the ripple, depending upon the values of C, R and L and the second unit eliminates a similar percentage of the residual hum. Two sections, as shown in Fig. 3, using two 25 henry chokes and three 4 mfd.

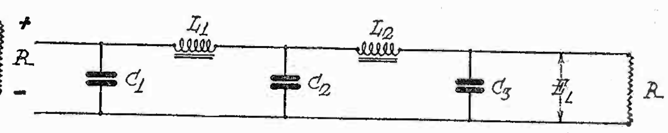


Fig. 3. Two Units Combined in One.

condensers will completely eliminate the hum. So the most economical design is the two unit type.

In the conventional filter shown in Fig. 3, the chief function of C_1 is to regulate the voltage, of C_2 to suppress the ripple, and of C_3 to store energy to take care of fluctuations in voltage demand from the audio amplifier. The reproduction of loud sounds requires many times more energy than does the reproduction of weak sounds. Low notes require more energy than high notes. So C_3 must be quite large if distortion is to be avoided. Good practice calls for 8 mfd. in this condenser.

Some excellent curves have been prepared by the Raytheon laboratories to illustrate these facts. While these curves were drawn with special reference to the performance of full-wave Raytheon gaseous conduction rectifiers, most of them also apply to thermionic filament type rectifiers. This information is supplied through the courtesy of James Millen.

The effect of variations in C_1 upon voltage regulation is shown in Fig. 4 and upon ripple in Fig. 5. So far as suppression of hum is concerned, there is evidently little to be gained by using large values of C_1.

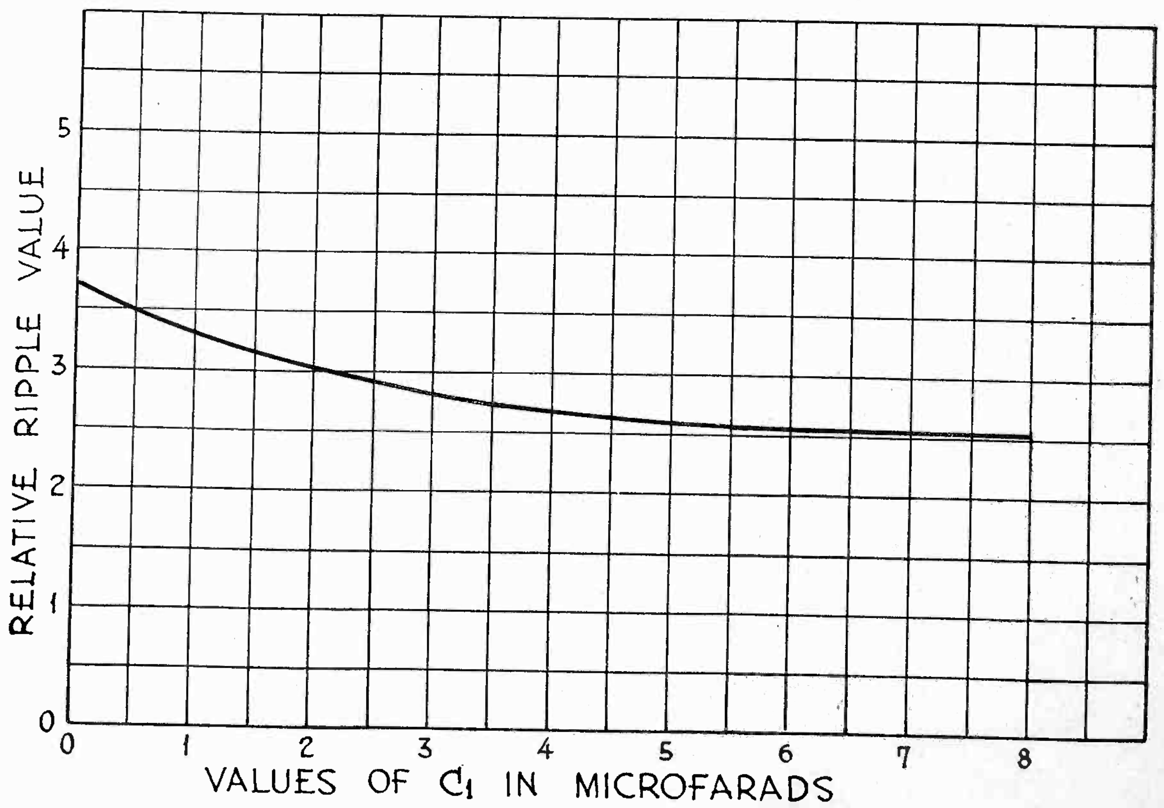


Fig. 5. Effect of "C_1" on Ripple.

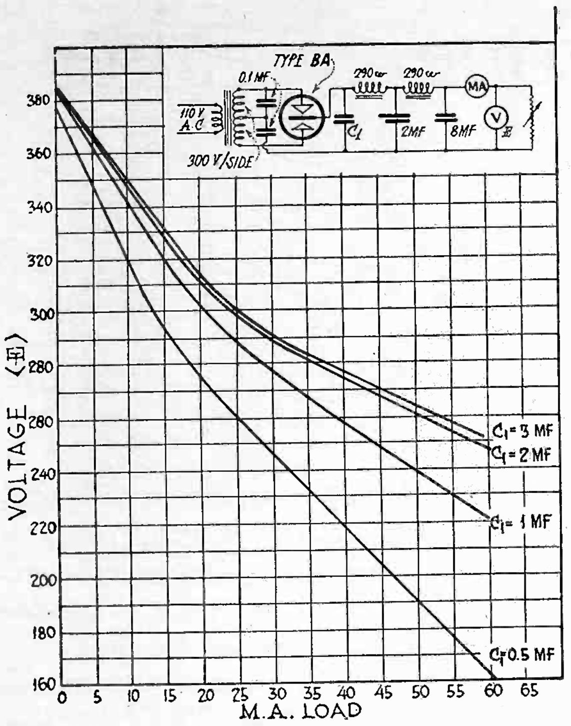


Fig. 4. Voltage Regulation for Different Values of "C_1."

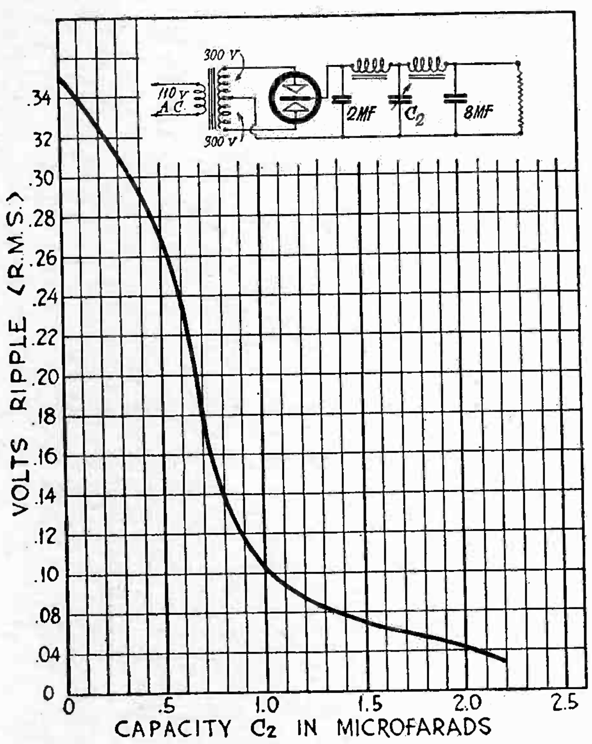


Fig. 6. Effect of "C_2" on Ripple.

Fig. 6 shows the effect that variations in C_2 produce upon ripple voltage in the output. The value of C_2 should not be such as to form a circuit resonant to 60 or 120 cycles with the first choke coil.

From Fig. 7 it may be noted that variation in C_3 has relatively little effect for capacities above 8 mfd. The main function of C_3 is to supply the sudden demand for increased energy by the power tube. It also lowers the shunt impedance of the eliminator as a whole, thus preventing such forms of unstable operation as "motor-boating."

The effects of variations in inductance on ripple suppression are shown in Fig. 8, whose curves contain much valuable data, hitherto unpublished. All the inductance values were obtained by actual measurement under a d.c. saturation of 40 m.a.

From a set of curves of this type, one may determine at a glance what ripple will result when using any given combination of inductance or capacity or one may with equal facility determine the various combinations of inductance and capacity that will result in a certain value of ripple voltage in the output.

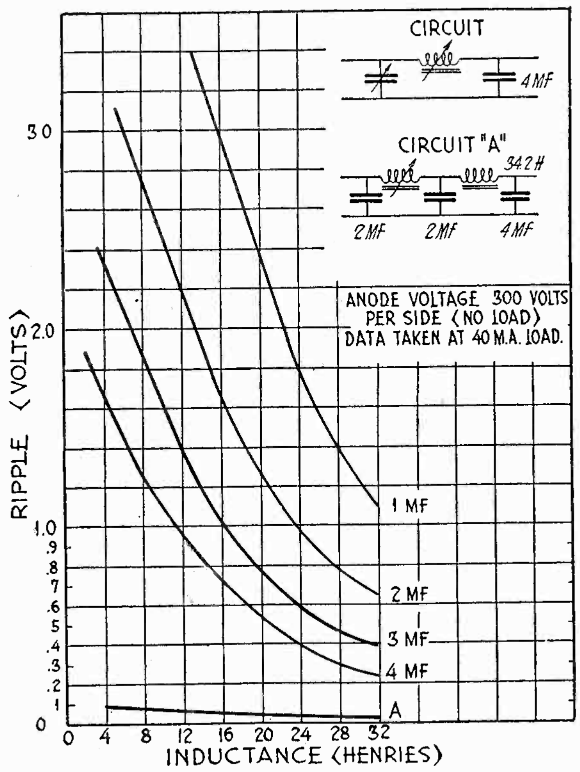


Fig. 8. Effect Upon Ripple Voltage of Changes in Both Inductance and Capacity.

One factor, ordinarily overlooked in resistance of the load. The ratio of rip- the use of a socket power device, is the ple voltage to load voltage for the type of filter shown in Fig. 2 is

$$1 \div fC_1\sqrt{R^2(1-39.44f^2LC_2)+39.44f^2L^2)}$$

where f is the frequency, R the load inductance, C_1 and C_2 the condenser capacities in farads and L the inductance of the coil in henrys. In general it may be noted that a low resistance in the load allows more ripple to be transmitted than does a high resistance. The impedance of the load, furthermore, should be approximately equal to that of the filter in order that energy not be reflected from the load to the filter. In addition, the total impedance of the choke coils should be four times the impedance of the condensers.

Failure to consider the load impedance is often the cause of unsatisfactory results from a socket power device. It may work well with one radio set and not with another because of the great difference in their load impedances. Although this article is merely an attempt to explain in simple language how and why a filter works, it is believed to contain some information of value to anyone who intends to assemble an electric filter. At least it will serve as an introduction to more detailed treatises of a mathematical nature, for an understanding of the qualitative usually precedes the best quantitative work.

No. 18 rubber covered twisted pair is the smallest wire that should be used with a.c. filament tubes. No. 16 or 14 is preferable. No. 20 is not large enough to safely carry the heavy filament current required. Each —26 tube draws more than 1 ampere, the —27 tube 1.75 amperes.

Shield grid tubes require r.f. transformers having a high primary impedance in order to give the high amplification of which they are capable. This means that the transformer primary should have about the same inductance as the secondary. Less selectivity but equally good amplification is obtained with impedance coupling, using a single coil common to both the plate circuit of one tube and the grid circuit of the next.

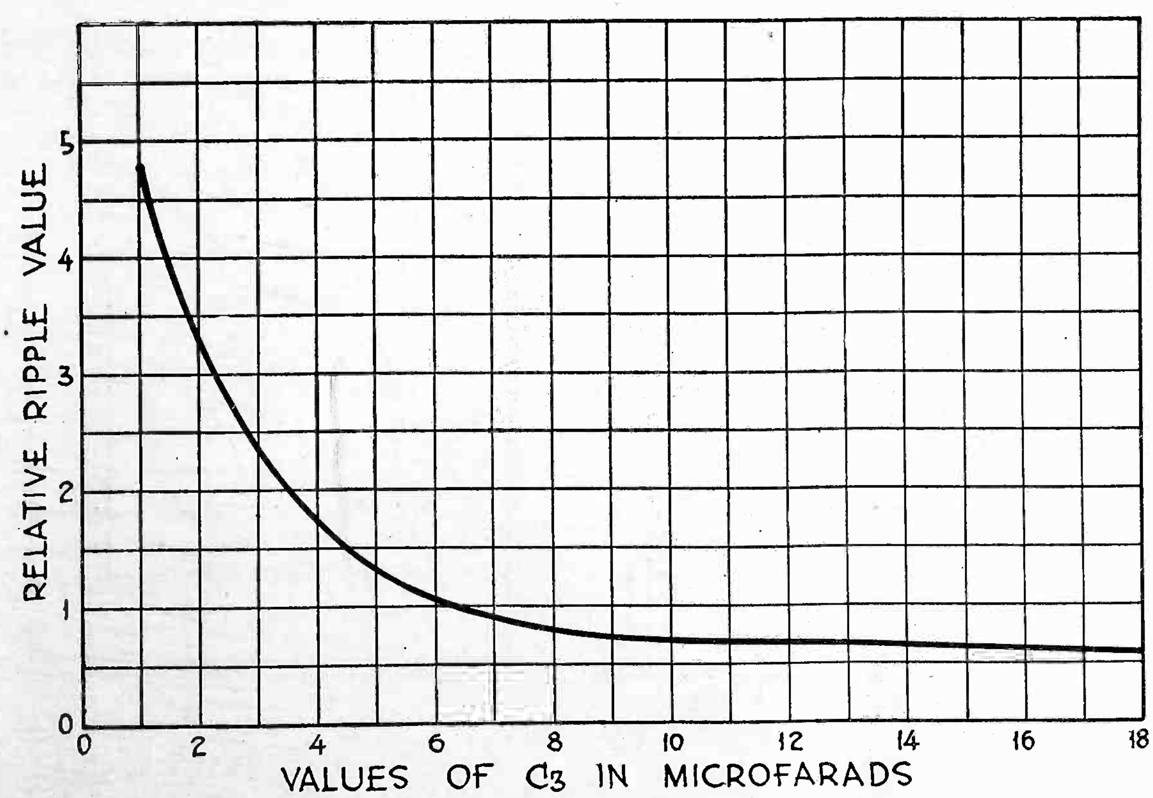


Fig. 7. Effect of "C_3" on Ripple.

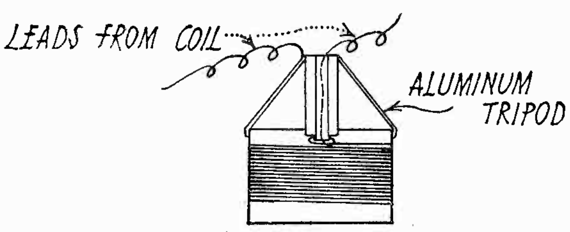
Making an Electrodynamic Cone Speaker

By E. F. Kiernan

THE electrodynamic unit used in the old horn type of Magnavox loudspeaker can be made the basis for a modern cone reproducer having remarkably fine tone quality. One of these old speakers can now be picked up for a fraction of its first cost. The disassembly of the old speaker and the assembly of the new is a comparatively easy job.

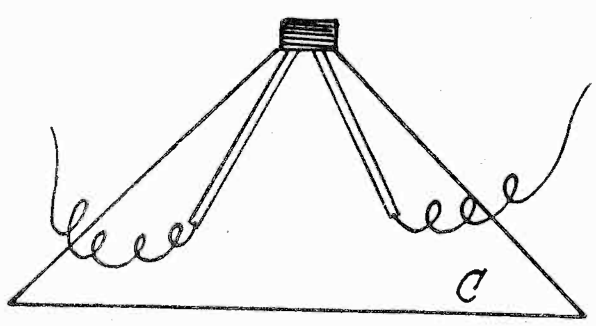
The first operation is to remove the horn from its socket and also the surrounding pressed steel cover, removal of which exposes the screws which fasten the socket plate and diaphragm. The plate is taken off by loosening the screws.

Just under the diaphragm support are two terminals to which the leads from the moving coil are soldered; these leads should be unsoldered; after which the diaphragm and moving coil may be lifted out. The leads from the coil are pasted to the diaphragm under narrow strips of tape. These strips are pulled off and the leads separated from them. An aluminum tripod, bolted to the center of the diaphragm, supports the moving coil. By removing the bolt, the coil



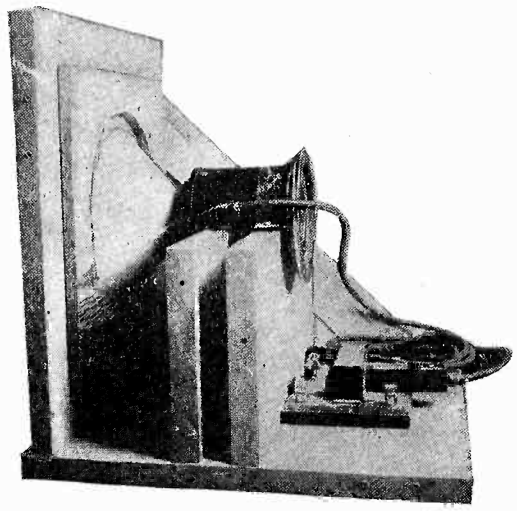
Moving Coil as Removed from Horn Speaker.

and support can be taken off. The coil leads are fastened to two legs of the tripod in the same manner as they were to the diaphragm, and should be carefully unfastened. Straightening the ends of the tripod legs, allow the ends to be pulled loose and the tripod to be separated from the moving coil. The coil is put away in a safe place during the construction of the cone.

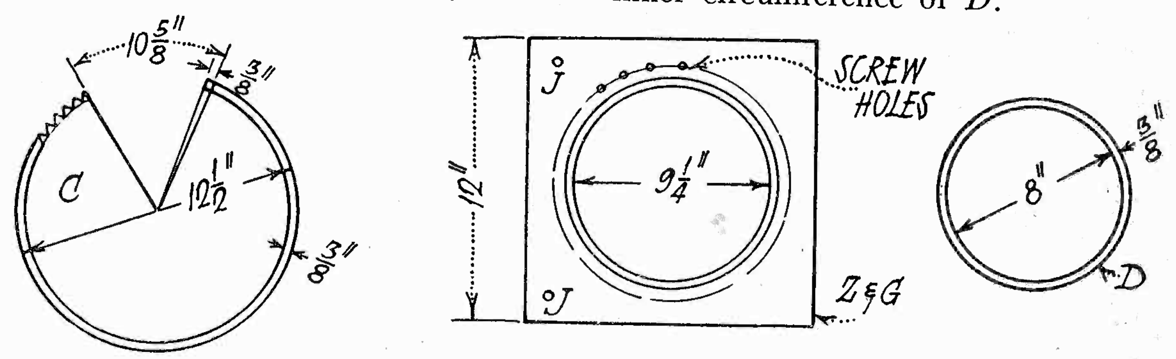


Moving Coil Mounted on Cone.

A sheet of heavy drawing paper about 13 in. square is needed for the cone. Two circles are drawn on the paper, one 12½ in. in diameter and one ¾ in. smaller. The sheet is then trimmed down to the larger diameter. Two radii are drawn, separated on the outer circle by an arc



Rear View of Completed Job With One Supporting Brace Removed.



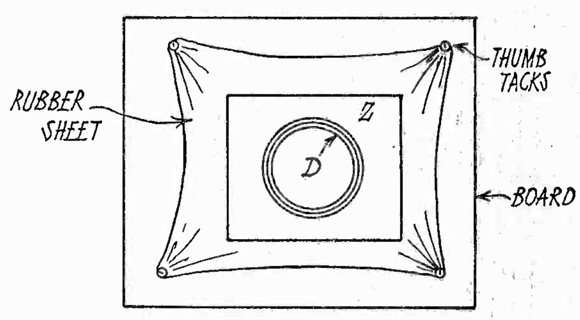
Preparation of Cone.

10⅝ in. long. A third radius is drawn between the other two and separated from the nearer by a ⅜ in. arc. The wedge included between this last radius and the one farther away is removed with a pair of scissors. Little triangular pieces are cut from the remaining circumference, giving it a saw tooth appearance. The disk is then formed into a cone by applying glue to the narrow wedge and pressing the opposite edge (overlapping) on it. After the glue has dried, the saw teeth are all turned out and back so as to lie in the same plane perpendicular to the axis of the cone.

While the glue on the paper cone is drying, the cone support should be made. This support consists of a cardboard ring, *D,* 8 in. in diameter and ⅜ in. wide, fastened by a rubber membrane ¼ in. wide to a square cardboard flange, *Z,* 12 in. by 12 in. with a 9½ in. hole in the center.

To assemble the support, a thin rubber sheet, procured at a drug store, is stretched slightly over a board and fastened with thumb tacks. Glue is applied to one side of ring *D* and flange *Z,* and the two are placed concentrically on the stretched rubber sheet. When the glue has dried, the superfluous rubber is cut away from the outer edge of *Z* and the inner circumference of *D.*

A portion of the cone is cut off just below the apex so as to leave an opening



Method of Attaching Rubber Membrane to Cardboard.

slightly smaller than the internal diameter of the moving coil tube. The coil

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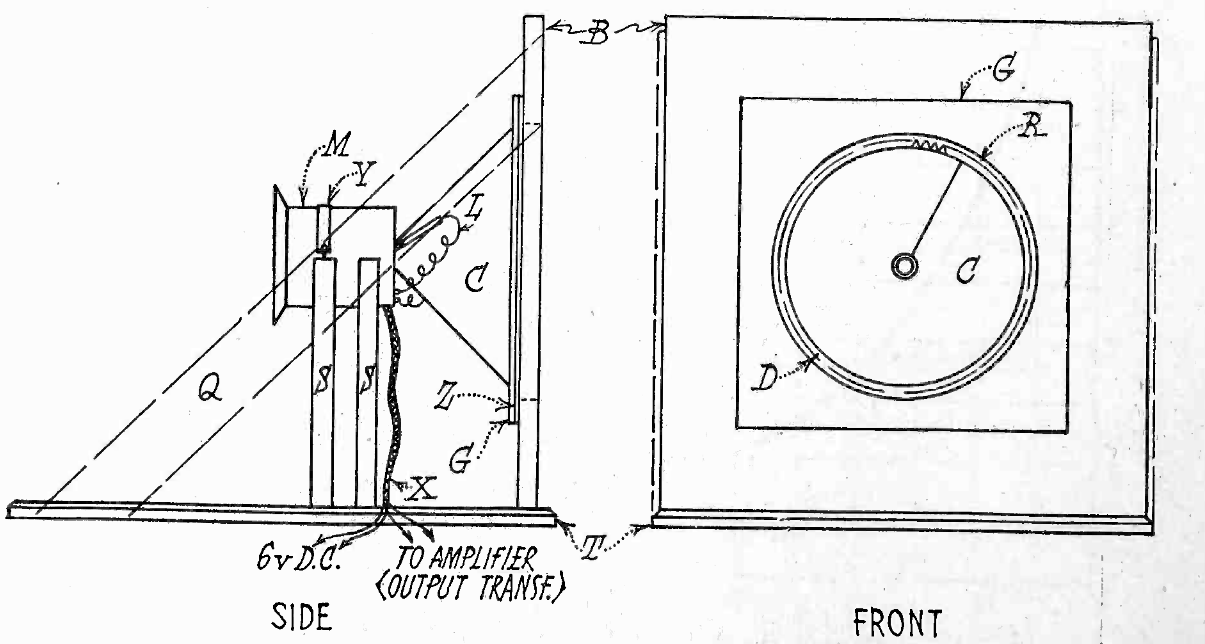
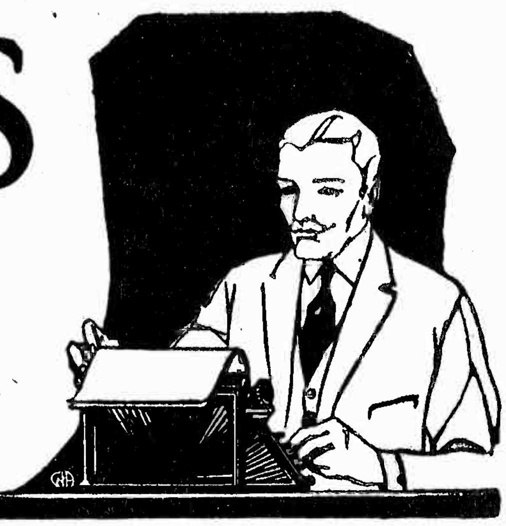


Side and Front View of Cone Mounting.

QUERIES and REPLIES



Questions of general interest are published in this department. Questions should be brief, typewritten, or in ink, written on one side of the paper, and should state whether the answer is to be published or personally acknowledged. Where personal answer is desired, a fee of 25c per question, including diagrams, should be sent. If questions require special work, or diagrams, particularly those of factory-built receivers, an extra charge will be made, and correspondents will be notified of the amount of this charge before answer is made.

In the article on the Capacity Coupled Receiver in February RADIO, two Variodensers are listed, but I can find no place for them in the circuit. Please identify these two condensers for me, as to their correct position in the receiver.—W. A. D., Jamaica, N. Y.

The 100 mmf. Variodenser is used as a feedback condenser in the loop circuit, and is shown as C-2 in the schematic wiring diagram. The 20 mmf. condenser is used as a trimmer across the tuning condenser next to the detector, and can be plainly seen near the center of the baseboard, in the picture of the rear of the set, as well as in the pictorial wiring diagram.

Will intermediate frequency transformers of the type which were used in the 1924 and 1925 model Best 45,000 cycle superheterodynes be satisfactory with the new shielded grid tubes?—R. S. K., Waco, Texas.

These transformers were designed for the type 99 tube, and would be practically useless with the shielded grid tube. The secondaries might be used as tuned impedances, but the intermediate frequency would then be too low for practical use. Using the primary winding as a tuned impedance, with a condenser of .0001 mfd. might enable the use of the old transformers in an impedance coupled, shielded grid intermediate amplifier, but as transformers, they would be useless.

I have a push-pull audio amplifier using two type 210 power tubes, and have an electro-dynamic speaker which has a built-in output transformer without center tap. How may I use the speaker in the push-pull circuit? Can I connect another loud speaker in series with the primary of this output transformer, and still get good results?—W. H. F., East Ely, Nev.

If you have a push-pull output transformer or choke which is designed to fit the impedance of the average cone or horn type speaker, you can use the electro-dynamic speaker output transformer by simply connecting the primary of the speaker's output transformer to the two plates of the push-pull stage, leaving the center-tapped output transformer connected, but abandoning the secondary winding, which will not be needed. No bypass condensers are needed, unless you have a particular reason for avoiding the passing of high voltage through the loud speaker cord, which is thoroughly insulated, and should not give any electrical shocks through contact with exposed terminals. If you connect another loud speaker in series with the electro-dynamic speaker, you will rob a certain amount of energy from the latter, and may affect its efficiency at the low frequencies, but there is no reason why the combination should not work.

Would like to have a schematic wiring diagram for the r.f. amplifier used as the front end of the new Infradyne. Would also like to use a shielded intermediate amplifier, preferably the S-M time signal amplifier, in a superheterodyne. What kind of oscillator coil should be used, and what would be the most satisfactory circuit for the entire combination.—A. M. S., Canton, O.

A diagram of a combination superheterodyne such as you suggest is shown in Fig. 1. The internal connections to the tuned r.f. amplifier are shown inside the dotted lines, these connections already being made. If a variable condenser having insulated rotor and stator plates is used in the oscillating circuit, the arrangement shown in Fig. 1 will be best. A coil wound on a 2 in. tube, consisting of two stator windings of 45 turns of No. 26 enameled wire each, with a rotor wound on a 1½ in. tube, with 35 turns of No. 36 silk covered wire, for the coupling coil, will be right for tuning through the broadcast band with a .0005 mfd. variable condenser.

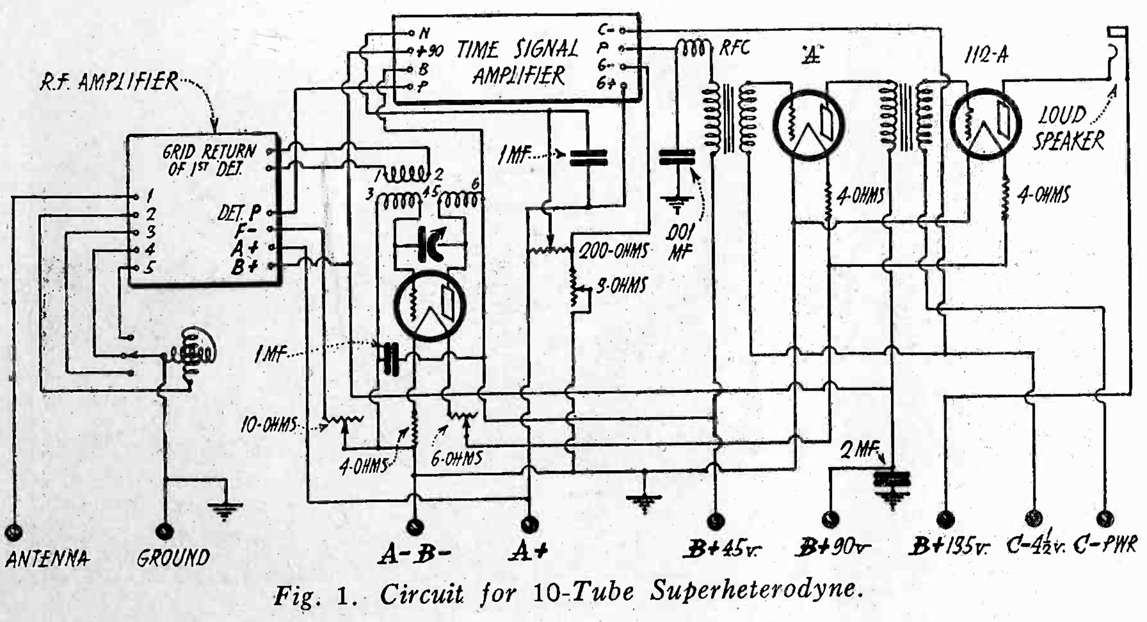


Fig. 1. Circuit for 10-Tube Superheterodyne.

Have built an "A" eliminator using two Tungar bulbs, filter choke, and a set of resistances as shown in RADIO. Am troubled with too much hum. How may this be eliminated?—J. S. S., Bakersfield, Calif.

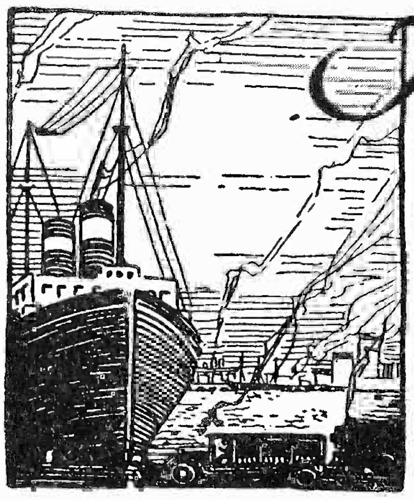
The trouble is probably in your filter choke, the core of which is saturated by the flow of direct current through the windings. Try adjusting the air gap to a greater distance, and set the shunt resistances at a higher value. The best filter is made up with a set of electrolytic filter condensers like the Mershon, which can now be obtained in the proper values for *A* eliminator work. Connect a condenser of this type having three capacity terminals and a common terminal, the three taps going to the two ends of the filter choke and the center, and the common terminal to the negative of the rectifier circuit.

Is the six tube short wave receiver shown in November 1927 RADIO suitable for receiving phone and short wave broadcasts? Will it operate with a loop? In the diagram, a 50,000 ohm variable resistor is shown with two connections, while the one in the picture shows three.—C. G. M., Pendleton, Ore.

This set is suitable for receiving short wave phone as well as telegraph. It is not as satisfactory with a loop antenna, as with a small outdoor antenna, and it is recommended that the outdoor antenna connection be used. The 50,000 ohm variable resistor shown in the picture is a potentiometer, and may either be used as such, or as a variable resistance, in the latter case only the center and one end terminal being used.

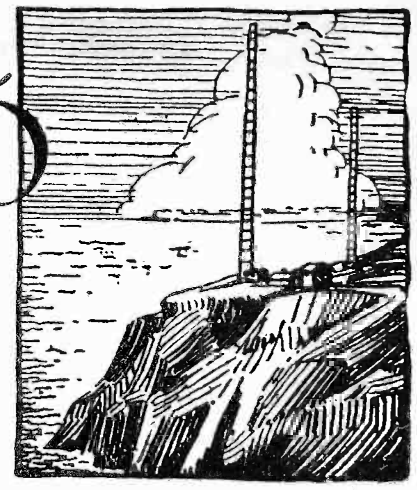
In September 1927 RADIO was a story on a plug-in adapter for converting a broadcast band receiver for use on short waves. Have built this outfit, but it does not work on my neutrodyne receiver. What can be the trouble?—J. H. R., Cootamundra, N. S. W., Australia.

This adapter is so simple to construct, and has so few parts that there is very little chance for anything to go wrong with it. It is possible that you have not plugged the adapter plug into the detector tube socket; if it was placed in either of the r.f. tube sockets, you would get nothing in the way of short wave signals. It is also possible that you have the tickler coil windings reversed. Try reversing the plate and *B* leads to this coil, and if the adapter works after this change, it is a certain indication that the secondary and tickler coils were poled wrong. It may also be possible that the tube you are using is a poor oscillator, and requires more *B* voltage than you have been giving it. Try at least 45 volts, as many tubes require this at the short wave lengths for proper regeneration and oscillation characteristics.



The Commercial Brasspounder

A Department for the Operator at Sea and Ashore



Edited by P. S. Lucas
R. O. Koch, *Assistant*

ABOUT THOSE EXAMS

We have often wondered whether the ease with which a man may become a commercial radio operator is not detrimental to the profession. With two or three books available which answer all the askable questions, it is absurdly simple to master the theory of radio telegraphy sufficiently to pass the examination, and this with a very few months' study. Under these circumstances many a man finds himself the proud possessor of a white ticket without ever having laid eyes upon a Navy Standard Spark.

Now, we are not condemning this type of question and answer book. In fact, after much thought on the subject, we believe that a man can get more practical information from it than by trying to dig through a more strictly theoretical treatise on the subject. What strikes us is the fact that, even though a man can answer any question put to him, he might not be able to find the location of a secondary condenser, *if he knew* it was the secondary condenser that had gone out; which he probably wouldn't.

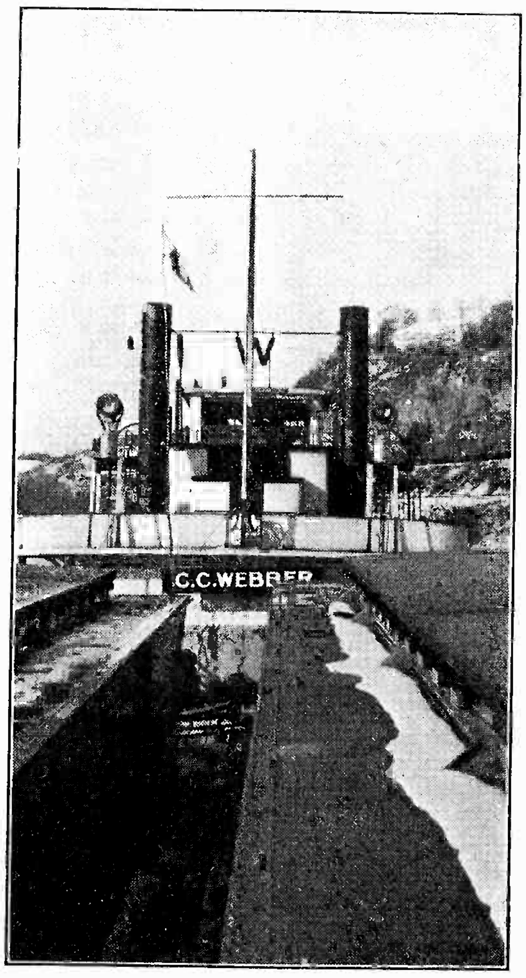
In England, Sweden, Holland and probably all the other countries that appreciate the value of slow, deliberate training, the embryo operator has to spend a couple of years learning the profession whether he *can* learn it in two months or not. Then, when he comes up for his examination he is confronted with all different types of transmitters and receivers, each of which has been tinkered with and is in need of fixing. He fixes it—or goes back to school. And this sort of thing lasts five days!

When he gets his ticket, however, he goes aboard a boat feeling perfectly at home among all his switches, while the American "first tripper" feels like little Alice, alone in the biggest power plant in Niagara.

What to do? Well, we believe more comprehensive exams would solve the problem, and result in training that would cause a greater familiarity with that missing (on one cylinder, at least) link that connects theory to its application.

Also, in the matter of code work most of our schools are inefficient. They teach us to copy so many words per; again looking to the possession of a white ticket rather than one's ability to hold down a job. Why not apply some time to teaching a man how to think when his fist is working? If the would-be brasspounder were content to wait a few months longer, learn to send messages, receive them, attend to routine details with all the trimmings (and this on a *crowded wire*) he would never grace the ranks of the "lids." Just to know when to use the key and when not to use it comes only from the ability to "think twice before you oscillate."

Now that we have our tickets it is safe to bring this subject to the attention of those interested in the development of our profession. (Thank goodness we don't have to go through that which we advocate for those who follow us.) We have heard many opinions expressed along this line in the past few years, and now we'd like to see them in print, for there are undoubtedly lots of arguments for and against the policy we have suggested. Hoping to hear from you, etc., we now admit NM.



Close-up of the "C. C. Webber," Showing Radio Mast.

THE UPPER MISSISSIPPI RIVER

By George Brown

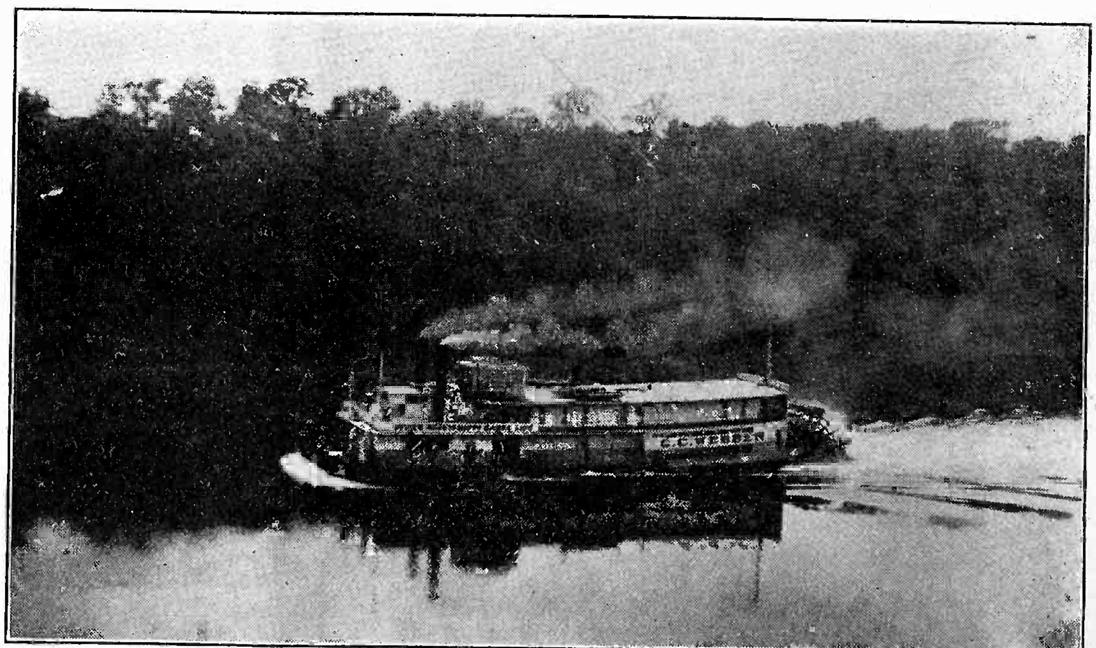
Steamers *C. C. Webber, S. S. Thorpe, General Ashburn* and *Weeks* are a type of Mississippi River steamboat, belonging to the Upper Mississippi Barge Line, which is operated by the U. S. Inland Waterway Corporation. Stern wheelers of 130 ft. in length, these boats carry a crew of 18 men and are called towboats, towing barges of general merchandise between St. Louis and Minneapolis, which is the head of navigation on the Mississippi River. They run on schedule on the order of a railroad, dropping and picking up barges of freight at the different cities and terminals along the way, receiving all orders via radio.

Two transmitters and two receivers have been installed on each towboat, a Westinghouse M. O. controlled 750 watt ICW-CW on 1100 meters and a 100 watt set on 37.5 meters. A break-in relay may be used an either receiving set. Up to this date the short wave set has not had a chance to do its stuff but splendid work has been done with the long wave set, the *Thorpe* having worked the *Webber* with ease while laying at the terminal in St. Louis and the *Webber* laying at the terminal in Minneapolis.

Schedules are kept every three hours from 6 a.m. to 9 p.m. with the office in Minneapolis through the Army station at Fort Snelling, WZS, a 2 KW Federal arc, on 2000 meters. All traffic will go through the big 2 kw. tube set direct to the office when the two 250 ft. towers are completed at the office in the new Minneapolis Municipal Terminal.

The radio operator on each boat has the title of operator-clerk and does all the boat's clerical work. He receives $110 a month to start and if he makes good this is raised to $125 after six months, after one year it is raised to $135.

All operators are hired by Mr. F. C. Moore, the radio supervisor in New Orleans, or Mr. J. C. Goodsell, the general superintendent in Minneapolis.



The "C. C. Webber" on the Mississippi River.

TIME, PRESS AND WEATHER SCHEDULES

By L. O. Doran

TIME SIGNALS

Time signals are available as shown in the schedule list hereafter.

NPG does not carry well through the QRN south of Manzanillo but NBA can be heard from there to the Canal and XDA is good anywhere on the Mexican coast.

NSS day signal is fairly good along the western coast and the 37.4 meter signals of NAA can be heard with excellent strength anywhere on the run.

PRESS

KPH press can be copied about as far south as Manzanillo but QRN generally kills it beyond there. NPL and NBA can be heard anywhere on the western run but QRN may kill one or the other at times. WNU day and night schedules can be copied anywhere on the run unless QRN is especially bad. Same for WAX. WNU-WAX press is not QST.

The best bet for "sure fire" press, free from static difficulties, is the short wave 40.8 meter schedule of 2UO, the N. Y. *Times,* and the 37.4 meter transmissions of NAA press. Both can be easily copied anywhere on this run, even during lightning storms which kill all long wave signals.

KPH and 2UO are the best schedules for "live news." Navy press from NAA-NSS-NPL-NBA is generally a day late when sent and contains much official or naval news, not especially interesting to merchant vessels. WNU-WAX press also contains many non-interesting items and is inclined to be very British in character at times.

Other short wave press can be intercepted from NPG between 8 PM and Midnight, P.S.T., or the same press can be heard relayed through NPM after Midnight. NPG is on approximately 35.5 and NPM on 37.0 meters. Neither station has any regular schedule.

MAIN SCHEDULES—PACIFIC COAST TO CANAL

*P.S.T.	CALL	WAVE	SENDS
12:10 AM	KPH	2200	S. F. Examiner press
2:00	NPL	9798	Navy press
2:00	NBA	6518	Navy press
3:30	WAX	5551	Press to KUS
8:30	WNU	3331	Ditto after Wea and Tfc
8:55	NPL	9798	Time sigs
8:55	NSS	17130	Time sigs
9:00	NPG	7005	Major Wea Bulletin
9:55	NBA	6518	Time sigs
10:55	XDA	2800	Ditto and Wea Bulletin
11:30	Mexican Stns	600 up	Weather
11:55	NPG	4836-2776	—Time sigs, both waves
6:55 PM	NAA-NSS	17130-37.4	Time sigs, both waves
7:30	NPG	7005-2776	Major Wea Bulletin
8:05**	KPH	675	Weather, repeats on 2200
8:30	WNU	3331	Wea, tfc and KUS press
9:55	NPG	4836-2776	Time sigs, both waves
10:00	2UO	40.8	N. Y. *Times* press
11:00	NAA-NSS	17130-37.4	Navy press, both waves

*Add three hours for E.S.T.

**May start 10 to 15 minutes later.

GENERAL NOTES

Interference with Lightship weather broadcasts on 600 meters at 8 AM, Noon and 8 PM, P.S.T., is a *hanging* offense on the Pacific Coast.

All Pacific Coast commercial stations call and answer on waves between 675 and 735 meters. KPH and KFS at San Francisco maintain 2400 meter watch. KPE at Seattle works 2400 meters every other hour from 9 AM to 9 PM, P.S.T.

A "zone of silence" or "dead spot" exists to the northwest of Cape Mala, Panama, and it is impossible to work NNT or NBA more than 50 or 100 miles north of Cape Mala on 600. NAX can be worked from about Corinto to the Canal.

LOCAL WEATHER SCHEDULES—PACIFIC COAST

P.S.T.	CALL	WAVE	SENDS
10:00 PM	VAE	600	British Columbia forecasts and 5 PM observations
8:00 AM	All Lightships		
Noon	WWBO		
8:00 PM	WWBP WWBU WWBV	600	Observations
(Above four stations may not send when radio fog signal is in operation).			
9:00 AM 1:00 PM 5:00 PM 8:00 PM	NPD	799	Observations
(Weather for Strait of Juan de Fuca and Puget Sound).			
9:30 AM 1:30 PM 5:30 PM 8:30 PM	NPE	600-2677	Observations
(Forecasts for Wash., Ore., and Puget Sound).			
9:00 AM 2:00 PM 5:30 PM	NPW	600-2883	Observations
(California coast weather).			
Various times during day	KUO	690	S.F. Examiner radiophone reports to Pilot boats, weather, ships arrivals, departures, etc.
8:30 AM 2:00 PM 8:30 PM	NPL	600-2993	Observations
(California coast weather).			

Where double wave length is shown, the station calls or transmits on 600 meters before shifting to the longer wave. All the above stations have good range.

(*To be continued*)

When it comes to going after QRMers we would like to mention the fact that we have had two mighty pert suggestions which might do a lot of good. The suggestions are similar in nature and come, as might be expected, from two operators who are old-timers in every sense of the word; efficient, conscientious and reliable. The plans run like this:

We wish to thank the operators (?) on the following ships for QRM during lightship weather.

DATE	TIME	CALL
DATE	TIME	CALL

Or: The Honor Roll . . . .

K— for jamming N— during Wx Rpt Date & Time.

The plans are a little rough and we hate to resort to it. We are also afraid that any operator so careless will be found too busy pounding the pillow to read this humble department. However, we leave it up to you. Shall we take a few personal slams or not?

Well, our little request box brought results. We asked for stories about the Mississippi River boats and have received two; one featuring the southern end and the other the northern section. We yelped for some dope on South American stations and got it. We asked for WNU's power and have it coming up. Now we know how to find out anything we want to know about the commercial operating game the world over, and invite all the CB readers to make use of the method. If there is anything you would like to see make its appearance in this department just drop us a line and we'll have your request set up with a fence of stars around it.

THE OPERATOR, HIMSELF

By L. B. Dustin

This is the third and last installment of the report in which Mr. Dustin sums up the situation which confronts the ship radio operator. In the first two sections, as published in the January and February issues, the author makes some interesting observations and suggestions regarding construction and use of present-day transmitting and receiving equipment aboard ship. In this issue he goes after the game from the angle of the operator himself. The following is good common sense and there are suggestions in it which will apply to nearly every one of us.

A discussion of the personal element entering into marine radio service is a much more ticklish proposition than that of mere machinery. There is, however, a great deal to be wished for in the wireless personnel of ship stations as a rule, mainly along the line of training.

In spite of the high requirements for obtaining a government radio license, the average operator aboard ship would be able to give a higher grade of service, if his preliminary training had been more thorough and inclusive. How many operators holding licenses really have a thorough grounding in elementary and general electricity which would enable them to do any repair work of an electrical nature that might be necessary aboard ship, such as locating and correcting generator trouble, grounded and leaky circuits, which cause a large part of the induction which is so often troublesome, particularly aboard old vessels, etc.? The real radio man should be able to cope with any problem of an electrical nature that might arise aboard ship. Also, just insofar as the radio man broadens his capabilities for usefulness in this manner, will he increase the chances for better pay and incidentally increase the prestige and standing of the radio man aboard ship.

The institutions training operators, as well as the prospective operators themselves, seem to entirely ignore the fact that, while the majority of their training must be technical, a not inconsiderable part of their future duties is to be clerical, such as abstracting traffic, writing up reports, and press. Often a small amount of ship clerical work is also delegated to "Sparks," such as making out crew lists, payrolls and such minor clerical duties, making him an unofficial ship's writer and clerk.

That this is true, is attested by the number of wireless men who own typewriters of some kind, and are willing to go to the trouble of carrying them around on different vessels on which they are employed. In view of this fact, it would seem the part of common sense to include some little preparation for this work in his training. Although it might be considered a little too much to require, the future operator would benefit greatly by learning to operate a typewriter by the touch system, for the man who intends to become a first class telegrapher on a well paid radio circuit it is an essential, therefore it might well be included in every operator's curriculum.

Along this line, a general knowledge of vessel and radio abstracting forms would not be amiss. The first session with the radio abstracts of a voyage is usually a painful one and the result often a terrible mess. Usually it requires several voyages, and numerous mistakes to master the bookkeeping side of radio. Let's teach the budding radio man of tomorrow the solution to the puzzle, before he comes to it and not leave it to chance.

May I take one more "slam'" at an existing state of affairs, before I close? Namely—the abbreviations and forms, used and abused by operators. How many abbreviations have we heard for those helpful words: "Thank you" and "Please"? Tnx, Tks, Tu, Tx; Pls, Pse, P,

(*Continued on page* 40)

Radio Kit Reviews

THE BROWNING-DRAKE WITH A. C. TUBES

The Browning-Drake kit, previously described in these columns, can readily be converted for operation with Arcturus a.c. tubes Tests show that the set operates without hum and the results are equal to those secured from most battery-operated sets. The completed receiver, as changed for a.c. operation, is shown in the picture. Fig. 1 is the circuit diagram.

All filament wiring should be done with two-color twisted pairs, the same color being connected to the respective filament terminals of each socket so that all the positives are connected together and likewise all the negatives.

It will be noted that the minus *B* lead is connected to the plus terminal on the detector tube socket. The bypass condenser in the plate of the detector tube must also go to minus *B*. A 1 mfd. condenser should also be placed between the shield, which is ground, and the minus *B* on the r.f. tube. This is the terminal marked plus *A* on the r.f. socket.

The *C* batteries are connected as shown. Care should be taken that a plus 4½ volts is on the detector tube while a minus 1½ to minus 3 is on both the radio frequency tube and the first audio stage.

The volume control consists of a Clarostat in series with the plate lead of the r.f. tube and controls the volume by cutting down the plate voltage. It should be well insulated from the mounting bracket, otherwise a short circuit will result.

Shields should be employed as the Arcturus type 28 tube has an amplification between 8 and 11 and it is hard to neutralize unless a complete set of shields are employed. As it ordinarily takes about sixty seconds for the tubes to attain full operating temperature and for various noises to quiet down, neutralization should be delayed for this length of time. It is secured by setting the neutralizing condenser until rotation of the trimmer does not throw the first circuit into oscillation when the tuning dial is set at about 20 on the scale.

Oscillations may be determined by a "click" or "pluck" in the speaker when the trimmer is rotated or, by placing the fingers on the stator plates of the first tuning condenser, whereupon a "click" or "pluck" will be heard in the loud speaker. However, this would necessitate removing the top shield in the first compartment and the constructor can usually tell by turning the trimmer condenser, whether the set will oscillate or not. The receiver is then ready to operate and may be tuned in the same manner as any of the other Browning-Drake kit sets.

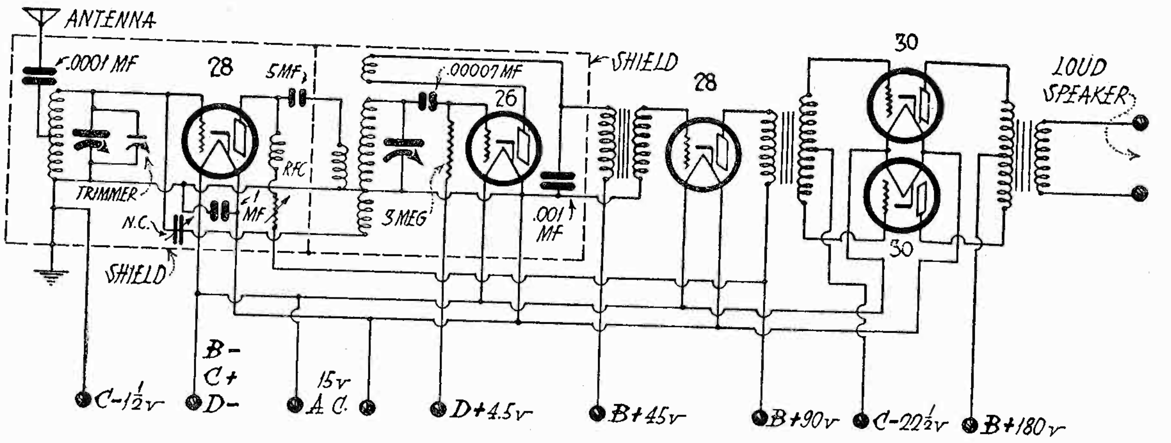
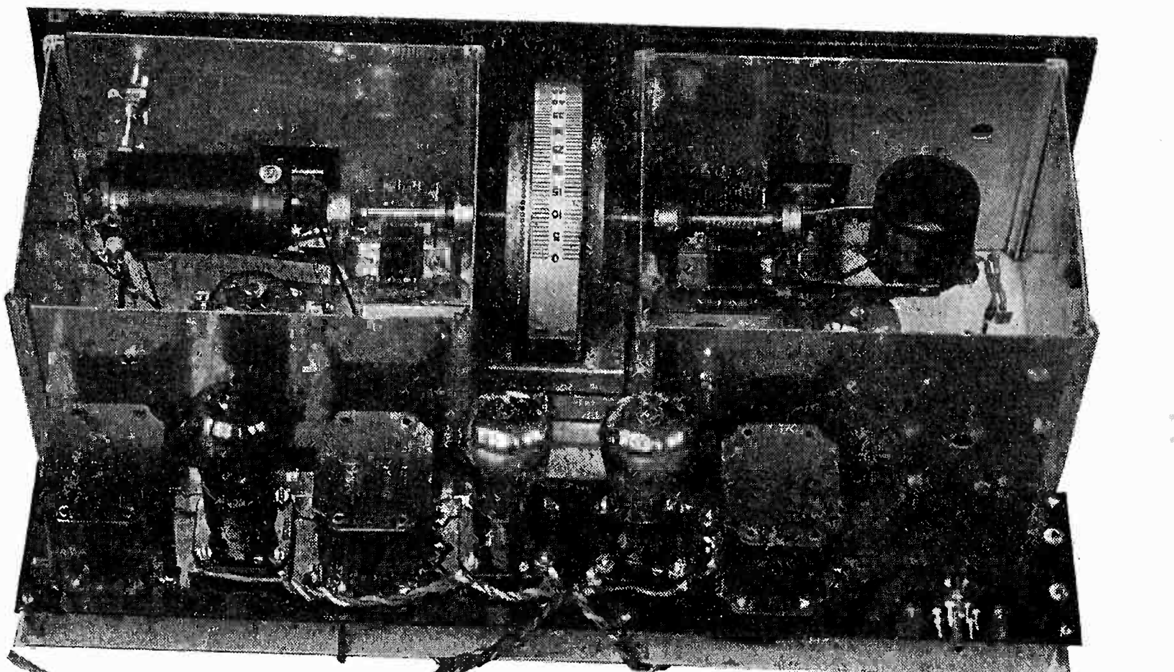


Fig. 1. Circuit Diagram for A.C. Browning-Drake.



Assembled Browning-Drake A.C. Receiver

The LL charges on radiograms to Mexican States will be 22c per word and $2.20 minimum. Radiograms transmitted via Mexican stations intended for delivery in Mexico will remain 5c per word, 10 word minimum, with no charges for local delivery.

A NEW POWER AMPLIFIER TUBE

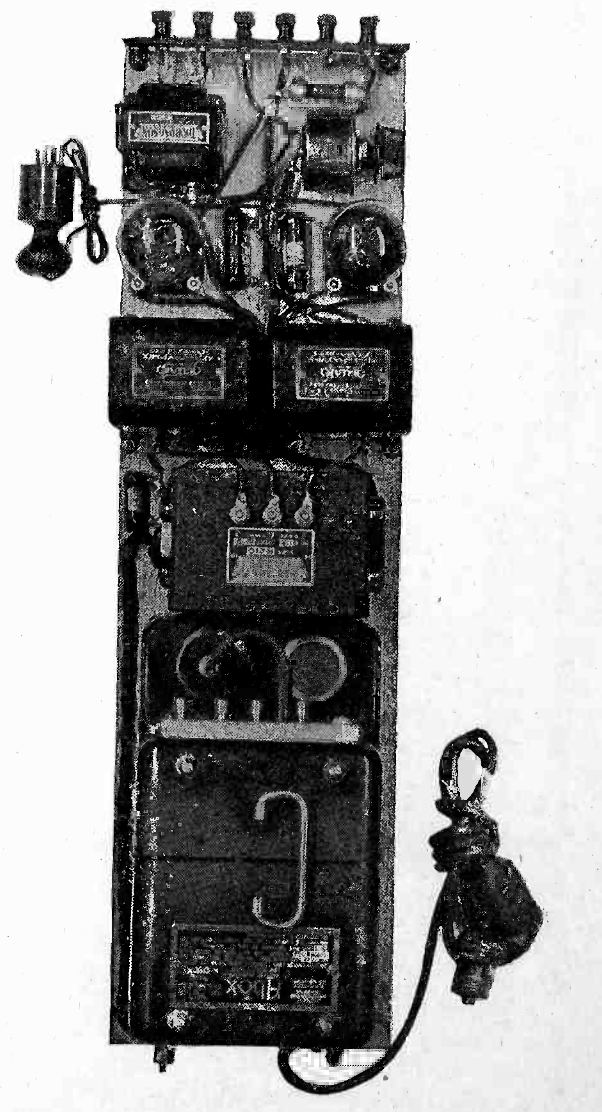
The CX-350, UX-250 is a new tube for use in the last stage of a transformer-coupled audio frequency amplifier. For the same filament current and plate voltage it has more than twice the undistorted power output of the -10 tube, which thus adapts it for use with loudspeakers to be used in large auditoriums. Due to its low plate impedance it must be used with an output transformer or choke coil and bypass condenser. Its filament current is 1.25 amperes at 7½ volts, the filament being of the coated ribbon type. It has a height of 6¼ in. and a diameter of 2 11/16 in., fitting a large standard socket. Its characteristics at various plate voltages are as follows:

Plate Voltage ..	250	300	350	400	450
Negative Grid Bias (Volts)	45	54	63	70	84
Plate Current (Milliamps)	28	35	45	55	55
Plate Resistance (a.c.) (ohms)	2100	2000	1900	1800	1800
Mutual Conductance (Microhms)	1800	1900	2000	2100	2100
Voltage Amplification Factor	3.8	3.8	3.8	3.8	3.8
Max. Undistorted Output (Milliwatts)	900	1500	2350	3250	4650

ABOX ELIMINATOR AND POWER AMPLIFIER

The compact *A* and *B* battery eliminator and one-stage audio frequency amplifier illustrated herewith permits the operation of almost any standard receiver from a.c. socket.

(*Continued on page* 37)

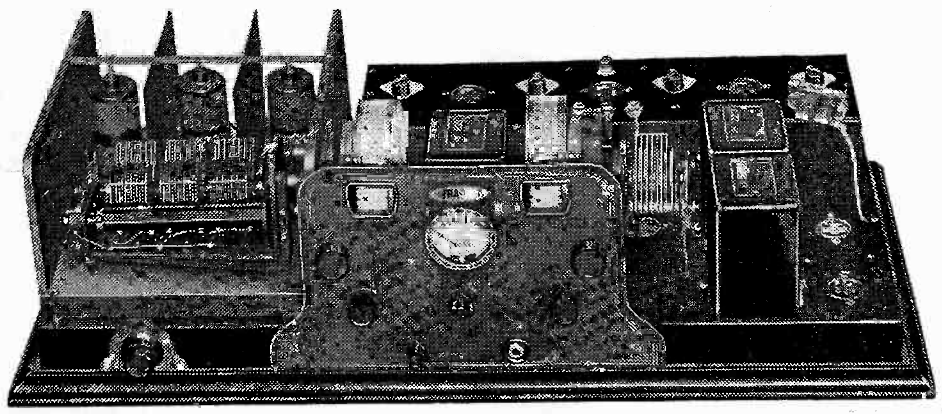


Abox Eliminator and Power Amplifier

ROAMING THE ETHER

The men who are way out ahead in radio, the pace-setters, are the men who own the

1928 INFRADYNE



Maquoketa, Iowa,
February 21, 1928.

...terested in knowing the re... the Infradyne circuit, I wish ...wing results were obtained last ...urs of 7 and 12 P. M., Central

... nine stations listed)

...ons ... received with good loud ... very ...erodyning of stations ...at S... Habana, Cuba, and ...les ... but lacking in ...ig... a good sized

...GHT.

2159 West 89th Street,
Cleveland, Ohio,
January 9, 1928.

"I am operating your 1928 INFRADYNE and find it the most wonderful receiver I have ever seen and I have built and used innumerable Supers.

"I am logging 10 watters that are 500 miles from Cleveland, consistent daylight reception of WEAF and WJZ as well as Chicago and many others.

"I use 210 power Amplifier and my own idea for Audio. My friends marvel at the volume and rave over the quality. You may well believe I am boosting INFRADYNE."

ANDREW W. GROWE.

Houston, Texas,
January 12, 1928.

"I am more than pleased with my 1928 INFRADYNE and, while I have not tuned in any foreign station, loud speaker reception of coast-to-coast stations, Mexico and Cuba is a regular thing.

"WEAF is very weak at Houston and I have not seen any other set that will bring them in direct except the INFRADYNE. Their strength is about half of that that KFRC carries, possibly due to their aerial being somewhat shielded by tall buildings."

JAMES F. OVERTON.

Pacific Electric Bldg.,
Los Angeles, Calif.
Feb. 8, 1928.

"... You know, of course, that I was using my Infradyne and that it is unncessary for me to tell you that all stations listed were received on the loud speaker as I have never used the ear phones in connection with the Infradyne.

"All of the stations in the United States and Canada came in very strong. WGY, Schenectady; WJZ, New York, and the Chicago stations were just as good and just as strong as Los Angeles stations, located 35 miles away. At 1 A. M., I had the dials set for 2BL, Sydney, Australia, and heard the carrier come on the air at that time. Both Sydney and Brisbane, 4QG, were strong during the evening. At 4:29 A. M. when Sydney signed off, the orchestra played "God Save the King." Just to see how much volume I could get, I turned it wide open and it could have been heard at least a block away."

O. A. SMITH.

Referring to the performance of his new Infradyne, Earle W. Muzzy, 2710 Dean Avenue, Spokane, Wash., writes as follows:

"It is well worth a little loss of sleep to be up early these mornings and listen to Japanese and Australian programs. Stations JOAK, JOCK, JODK and JOBK, Japan, have been picked up with very good volume, as well as 5CL and 3LO, Australia. For the benefit of those who may wish to pick up these foreign stations, all of the above mentioned will be found on settings between where KJR (Seattle) and KWSC (Pullman) are received. One morning JOAK came through with volume loud enough to wake the entire family and to cause some good natured sarcasm from neighbors.

The fact that Australia is approximately 11,000 miles from Spokane on the other side of the equator, and that the present time is their summer season, adds to the thrill. Their clock time is 18 hours ahead of Spokane time, therefore their reception comes in best between 2 and 4 a. m. A good portion of the musical numbers broadcast by the Japanese stations can easily be recognized. Some of their stations are keen on American jazz. Station JOAK features a very good soprano regularly. Although she sings in Japanese tongue, her voice is as beautiful as some of the grand opera singers heard through American stations."

571 Bird Avenue,
San Jose, Calif.,
January 24, 1928.

"I have built a number of the old INFRADYNE receivers and have just completed two of the 1928 Models. These sets surely have it all over every other make of radio in distance, volume, tone and ease of handling. I have built them all and know."

ALFRED TAROT.

Seward Alaska,
February 5, 1927.

"This is to thank you for your literature and circulars regarding the "INFRADYNE." You will be pleased to learn I have constructed one of these sets and, as we are ideally situated to try it out, it has exceeded my greatest expectations.

"At least 2000 miles is our average distance from nearest broadcast stations, and the writer, during the past four years, has constructed practically all the better known types of "Supers." While it has been but three days since the "INFRADYNE" was constructed (for re-sale) it has so far surpassed the old set that no comparison can be made."

J. P. HANNON.

"I wish to express my a... prompt and courteous atten... quiries. I received the follow... distance) on my 1927 Infrad... 1928, with good loud speaker v... a period of about 1½ hou... listed, from Florida to ... (Se... Washington.) ...rnia,

"Considering I ... very hilly ... cars and h... ...he lo... record ... ...ded ...bov... A

1129 Herbst Street,
McKees Rocks, Pa.,
March 1, 1927.

"I received the Infradyne set Tuesday. Have been slow in writing but wished to try it out. It is the best job I ever saw. One of the best jobs inside and out. The looks alone would sell the set. The quality is fine.

"The Infradyne is a wow. The distance stations come in like locals as you listen and enjoy them. This Pittsburgh district is a hard district for any radio but believe the Infradyne will overcome everything the other is lacking."

M. A. RICHARDSON.

12 Arnold Street,
Jamestown, N. Y.,
January 10, 1928.

"From experience, I can safely say that you have in the INFRADYNE without doubt the greatest set on the market."

W. M. AIKEN.

Sandersville, Ga.,
February 13, 1928.

"I purchased a Remler Infradyne Receiver 1928 Model through the Hamilton-Carr Corporation, Chicago, last December and it is just about the finest set the writer has ever listened to, or has ever had the pleasure of looking at."

HERBERT W. ELDER.

228 Jenkins Building,
Pittsburgh, Pa.,
January 23, 1928.

"I have been a proud owner of one of your INFRADYNE receivers for the past year or more and must say that words cannot express the superb qualities of the set as a distance getter and also its reproducing qualities."

PAUL L. SNYDER.

Toledo, Ohio,
982 Wall Street,
March 9, 1927.

"I am so well pleased with my Infradyne that I am writing this letter telling how it works out.

"As an example of what it will do, please note the attached letter to KFI. It is no feat to listen to a distant station for a couple of numbers but when you receiver one for over half hour without missing a bit of the program and the quality is perfect, it is all anyone can ask."

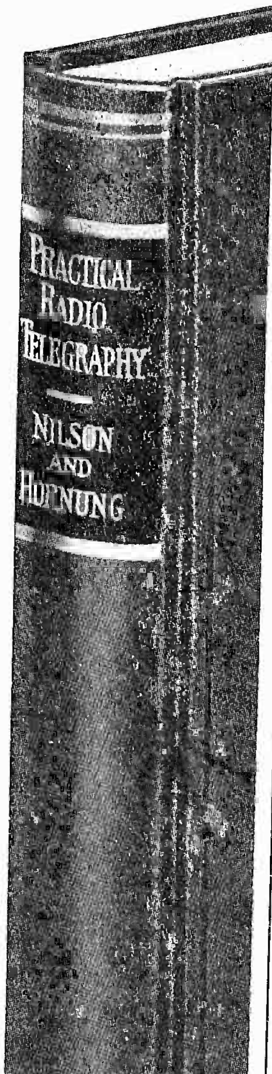
E. D. COLLINS.

Remler Division, Gray & Danielson Manufacturing Co.
260 First Street, San Francisco, Calif.

Please send me complete information about the Infradyne and folder describing all Remler Parts.

Name.. *Street*.. *City*..

Do you build and sell sets?.. R-4



SERIES FILAMENT

(*Continued from page* 18)

This receiver has 7 type 99 tubes, with filaments in a series-parallel arrangement, and a type 210 power tube, with rectifier equipment built in as a unit. Its circuit is shown in Fig. 2, and represents the latest edition of a fundamental circuit for a.c. operation which has been in use since 1925, and was first described in RADIO in December, 1925. This is perhaps the most elaborate of the a.c. receivers now available, but is shown in order to give the reader an idea of the equipment required, and the method of operating the tubes in series. As is the case with the Gilfillan receiver shown in Fig. 4, the field winding of the electro-dynamic loud speaker acts as part of the filter circuit associated with the rectifier equipment, and obtains its exciting current from the plate current flow through the filter.

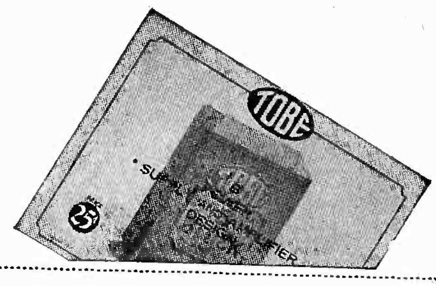
This receiver is equipped with a "glow tube" voltage-regulator in the 90 volt *B* supply circuit, as well as a ballast lamp in the primary circuit of the power transformer, both special features for which no general rules applicable to any set can be laid down. The ballast lamp requires a certain current flow through it to be operative, and the lamp has been designed specifically for the current requirements of the Model 32 set. Hence this lamp cannot be used with other receivers having different power requirements. The power transformer for the Model 32 is wound with 65 volt primary, the lamp absorbing the remaining 55 volts of the total of 110 volts.

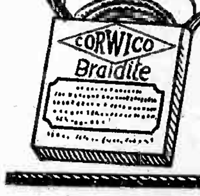
BALANCED IMPEDANCE A. C. TUBE RECEIVER

(*Continued from page* 22)

put. A 250 millihenry r.f. choke, several varieties are available listed as No. 125 r.f. chokes, in series with a .005 microfarad fixed condenser is satisfactory as a scratch-filter. This combination should be connected directly across the leads from the pick-up unit. The size of R_5 depends on the type of pick-up used. Some of them are already equipped with a volume control. The resistance may run as high as 50,000 ohms.

Little needs to be said about adjusting and tuning the receiver because these depend on the parts used in the set. Of course it is necessary to line up the sections of the three-gang condenser by means of trimmer condensers, and the "neutralizing" condensers C_5, C_6 and C_7 should be adjusted for maximum effect. These condensers and C_8 should be adjusted so that the receiver will not quite oscillate over the whole tuning range when the volume control is turned up to full value.





COMPARE IT!

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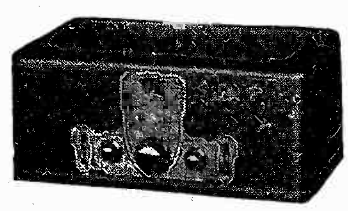
SINGLE UNIT
AC BANDBOX

or in two units
for console installation
at $90

Check it with any set you choose!

—then hook it up and learn first hand its superior tonal and reception qualities!

SPECIFICATIONS	AC BANDBOX 704	?	?
1. Genuine Neutrodyne circuit.	Yes		
2. *All* elements totally shielded.	Yes		
3. Full 180 volts on plate of output tube.	Yes		
4. Supplemental tuning devices for hair line alignment of condensers to secure sharpest possible tuning (Acuminators).	Yes		
5. Single station selector.	Yes		
6. Illuminated dial.	Yes		
7. Volume control that will reduce heavy local reception to a whisper without detuning and without distortion.	Yes		
8. Power plant with a condenser of 30 mf capacity.	Yes		
9. Self-healing condenser.	Yes		
10. Modern, neat, compact, richly finished cabinet.	Yes		
11. Adaptability to any type of console cabinet by being available in single or double units.	Yes		
12. Quantity production price of less than $100.	Yes		



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Bandbox Junior

A new dry cell receiver with all the Crosley Bandbox features—selectivity, sensitivity, volume and appearance. Ideal for homes having no alternating lighting current or where storage battery service is not available or desired. Especially desired because of its economical installation cost and operation. Batteries last months! Use Crosley Musicone for perfect reproduction! $35.

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THE CROSLEY RADIO CORPORATION
CINCINNATI, OHIO
POWEL CROSLEY, Jr., Pres.

A. C. OPERATION OF 115 K. C. SUPER

(*Continued from page 23*)

the gain of the r.f. amplifier is still too great at zero volume setting, which is with the full 200,000 ohms in the circuit, and so a higher resistance is desirable to reduce the gain and cut the volume of locals to a minimum. If the present volume control is satisfactory, there is no need for change, but if the locals are too strong, a higher resistance at this point will probably cure the trouble.

The regeneration control in the plate circuit of the mixer tube serves as an auxiliary volume control on distant stations, and is not needed for local service. It will be noted that a type 112-A or 171-A power tube is used in the last audio stage, when a type 210 tube might seem more appropriate. In testing the series-filament operated receiver from several power plants using transformers designed to supply two type 381 rectifier tubes with 550 volts per tube, it was found that after drawing 132 milliamperes from the rectifier to supply the filament circuit, the effective voltage at the output of the filter had dropped to 250 volts, and when the plate current required by the 9 tubes was added to the 132 milliampere filament current, the effective voltage available for a power tube was as low as 200 volts. At this voltage, a type 71 tube will deliver a great deal more power than a type 310, and is preferable thus both from the standpoint of power output and initial cost.

What actually causes this excessive voltage drop is that the power transformers were undoubtedly designed to supply a 310 push-pull amplifier together with *B* voltage for the receiver, a total which would never exceed 70 to 80 milliamperes, so that with a load of 150 milliamperes or more, the effective voltage of each side of the power transformer secondary probably amounted to not over 300 volts. After the voltage drop across the filter chokes was deducted, the resultant voltage available for *B* supply was below the minimum required for proper operation of the 310 tube. A 5 ohm fixed resistance must be placed in each leg of the transformer winding which supplies filament current to the power tube, assuming that a 112-A or 171-A tube is used, and in case the power tube is the older style 112 or 171, with ½ ampere filament, the resistances would be 2½ ohms each.

The best procedure in deciding what type of power tube to use is to first connect the filament circuit and the plate circuits of all the tubes except the power tube. Then measure the effective voltage across the output of the filter, and unless the voltage exceeds 300, a type 171-A tube would be the best to use. An output transformer is necessary with either the 171-A or 310 tubes, as the plate current would burn out the loud speaker windings in a short time. In a short time the type 350 power tube will be available, and this will be even better than the 171-A at voltages of 250 or more, at the same time not requiring fixed resistances in the filament leads, as it has a 7½ volt filament. The plate current of the 350 tube at 250 volts is 28 milliamperes, and the tube requires a negative grid bias of 45 volts, which can be obtained by increasing the size of the bias resistance from 1000 to 1500 ohms.

It is important to adjust the plate voltage of the shielded grid tubes to 135 volts or slightly below, as excessive voltage on the plates will result in uncontrollable oscillation. The writer recently tested one of these receivers, a d.c. model, in which the front end oscillated violently, and it was found that the voltage on the plates of all four shielded grid tubes was 185. It can be seen in Fig. 2 that the 135 volt lead is brought out separate from that of the power tube plate supply, so that if trouble is had with d.c. models which are being operated from a *B* eliminator which has but one power tube tap, the voltage can be cut down for the shielded grid tubes by inserting another variable resistance and 1 mfd. condenser.

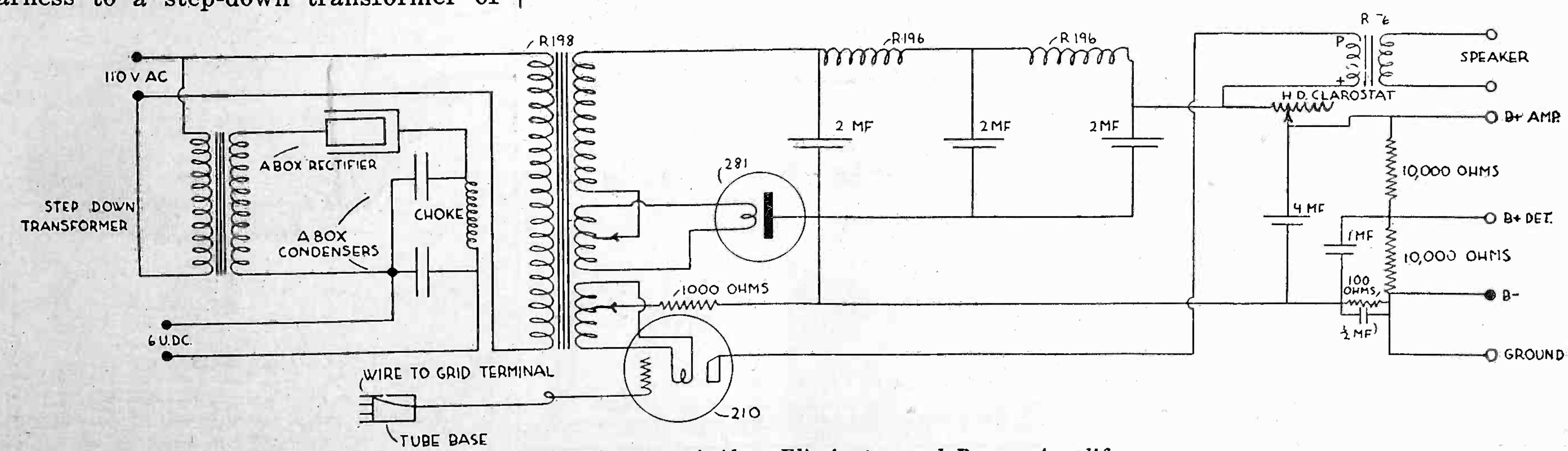
A. C. KIT REVIEWS

(*Continued from page* 32)

power. It uses the conventional circuit shown in the schematic diagram and is assembled from standard parts.

As may be seen from the picture, it consists of an Abox rectifier and filter mounted on the same baseboard with a type 210 Thordarson compact, two Muter condenser blocks, a 281 rectifier and 210 power tube, and a type R-76 Thordarson transformer, together with necessary Ward-Leonard resistances and the binding posts. The Abox supplies 2 amperes at 6 volts for filament supply and the rectifier and filter system supplies the necessary *B* voltage for the operation of the receiver and the one-stage power amplifier.

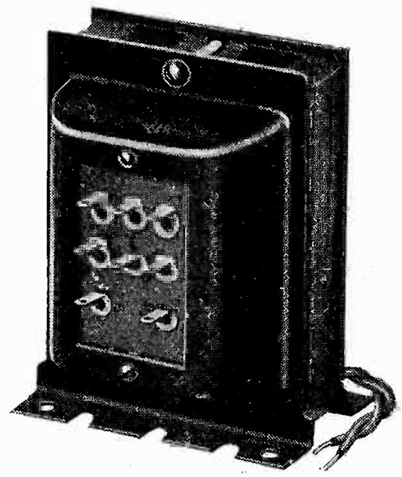
The Corwico a.c. adaptor harness consists of a twisted cable of heavy flexible wire and the necessary number of adaptors to fit into the sockets of a battery-operated set to be converted into a receiver to be operated with a.c. tubes. The adaptors pick up the plate and grid connections of the original circuit while the harness supplies the required new filament circuit. No re-wiring is necessary, the only changes being to connect the harness to a step-down transformer of



Schematic Diagram of Abox Eliminator and Power Amplifier.

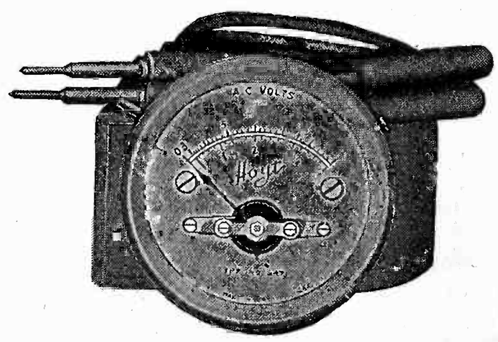
proper voltage ratio and to insert the a.c. tubes into the adaptors. The harness is made in two styles: one for use with 5 prong tubes, such as the R. C. A. and Cunningham a.c. types, and the other, without adaptors, for 4-prong tubes such as the Arcturus.

An Acme transformer is being marketed for converting 110 volts 50 or 60 cycle a.c. to 1.5, 2.5 and 5 volts for use with a.c. tubes. It is provided with cord and plug for the line and short output



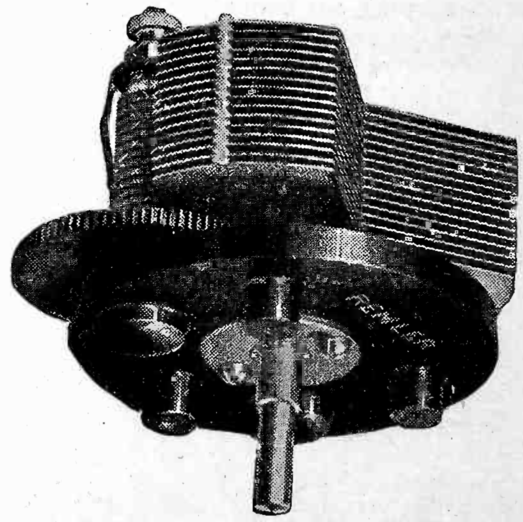
lugs with eyelets, to which the filament leads of a converter cable or harness may be soldered. There are also two lugs for the "C" bias.

The Hoyt a.c. pocket voltmeter is a compact instrument for measuring voltages on a.c. types. Type 547 is a two-scale model, 0-3 and 3-9 volts, for measuring filament voltages. Type 5473 is a three-scale model, 0-3, 3-9, and 50-150 volts, for measuring both filament and



input voltages. Both types are supplied with special leads and are packed in a leather carrying case. These instruments have a resistance of more than 20 ohms per volt and are constructed on the magnetic repulsion principle. Equivalent instruments are also suitable for panel mounting.

A new **Remler condenser** of the straight-line wavelength type is provided with an adjustment which permits rotation of the dial shaft in either direction

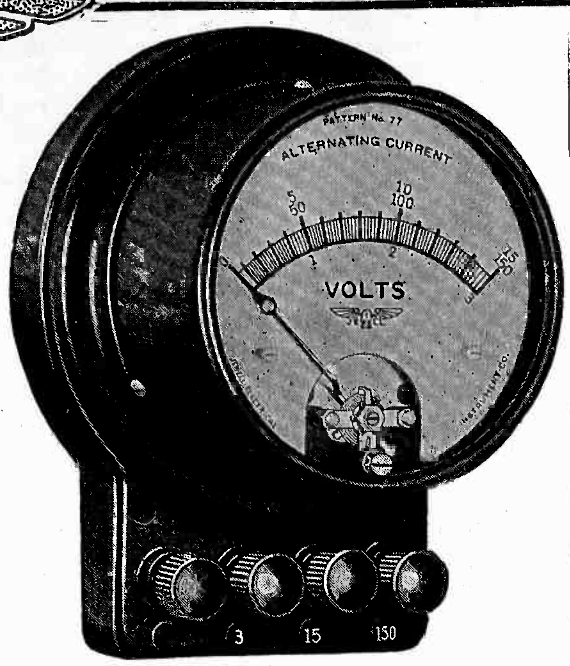


to secure an increase in capacity. Two of these condensers mounted on opposite sides of one or two drum dials can thus be made to read in the same direction.

(*Continued on page* 48)

JEWELL

Don't
Burn Out Tubes



Pattern No. 77

One of the chief troubles in the new A. C. sets using either A. C. tubes or D. C. tubes in series is paralysis or damage to the tubes due to incorrect filament voltage. This invariably can be traced to line voltage, which in some localities varies considerably throughout a twenty-four hour period. In the sets using the new A. C. four and five prong tubes it is very important that the filament voltage is right, as it is sometimes found that a particular filament setting is necessary to eliminate hum.

All of the above troubles call for some definite method of adjustment and this can be best accomplished by a suitable A. C. voltmeter having ranges which cover the trouble expected.

Such an instrument and one used by many service men in their work is the Jewell Pattern 77 triple range portable A. C. voltmeter. It is a very desirable instrument for the set owner as it enables him to operate his set at safe filament voltages at all times. The combination range is 0-3-15-150 volts. The scale is silver etched with black characters, and the movement is mounted in a metal case on a bakelite base.

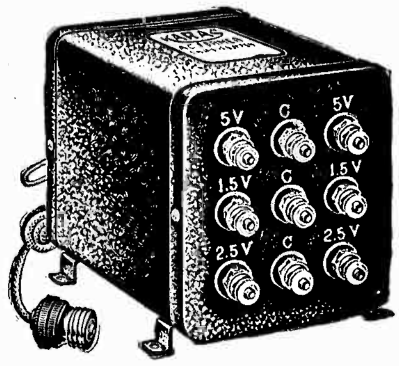
Every owner of an A. C. operated set should have one. Write for descriptive circular No. 1145.

Jewell Electrical Instrument Company

1650 WALNUT STREET, CHICAGO

"28 Years Making Good Instruments"

CONVERTS
any set to A-C!



The KARAS A-C-FORMER

Bring your set up-to-date with this new KARAS achievement! Delivers correct voltage to the new AC Tubes 226 and 227. Needs no separate device for center tap. Has plug-in connection for B Eliminator and loop of wire for connection to panel switch. No rewiring. Operates with Carter, Eby and other cable harnesses.

Write for details to

$8.75 List Price

Type 12 supplies up to 8-226, 2-227 and 2-171 tubes.

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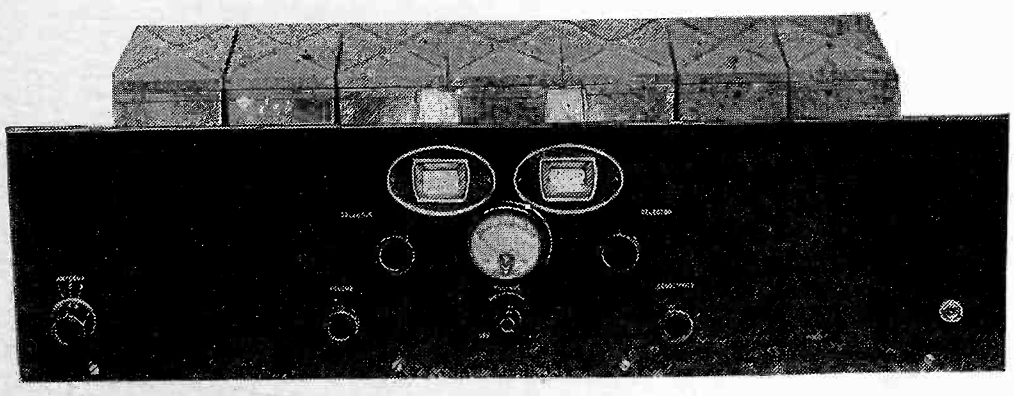

Best Super Hets giving trouble? Check, adjustment and placing in first class shape, $7.50. Ship in, and they will be made OK and returned express C.O.D.

TESTED TUBES for all sets can be supplied. Simply state set they are to be used in and they will be hand picked and matched to suit, and each tube marked with a sticker to show its place. REGULAR PRICES ONLY.

LABORATORY TESTED PARTS, KITS AND EQUIPMENT

All standard parts can be supplied on demand, EACH PART BEING GIVEN A LABORATORY TEST prior to shipment, without extra charge.

1928 Best Kit	$163.00
Silver-Marshall Screen Grid SIX	97.00
Tyrman "SEVENTY"	115.30

All other Parts and Kits can also be supplied.

TESTING AND CALIBRATION SERVICE

Wavemeters, oscillators, receivers and other equipment calibrated. SUPERHETERODYNE TRANSFORMERS matched to exactly the same frequency. State type of tube used. $2.50 and up.

Radio Transmitting Equipment ~ Ham and Commercial

D. B. McGown's Radio Laboratory

435 PACIFIC BUILDING **SAN FRANCISCO, CALIF.**

THE OPERATOR, HIMSELF

(Continued from page 31)

Pz. This is only an example of the boxcar code in use. There *is* a standard code for abbreviations, which all good operators know and use, namely the Phillips Code, which is not hard to learn, is sensible, and time and QRM saving.

For instance—why say "WX PLS," which means please wait, when we mean "WEA PLS," for weather please, or in another part of the world we hear "WTR PSE" for the same thing. Why refer to press as "PX," which means price, and so ad infinitum. Some may contend that as long as the other fellow knows what you mean, the desired end is satisfied, but non-uniformity breeds confusion, and does not tend to the greatest development possible.

Although I am not advertising Mr. Phillip's useful little book I would suggest that all operators inquire of some Associated Press, or commercial telegrapher (any of them will be glad to give the information), where a Phillip's code book may be purchased (they cost $1.25), peruse it, and digest the contents as much as possible. If every operator knew no more than the two hundred odd two-letter contractions, supplemented by a few common three-letter contractions, he would have a vocabulary to cover all ordinary needs, and enough to entitle him to be called "operator," with real meaning in the term.

Radio, although a distinct art, has borrowed and adapted so much from its parent art, land line telegraphy, particularly along the line of operating procedure, that we might well make operating procedure standard for both as far as possible, taking into consideration, of course, their inherent differences. In fact it was only by a narrow margin that radio escaped using the Morse rather than the International Code, along with Morse line procedure. There are still operators who can remember when both were in use, to the confusion of the other.

While I cannot attempt to explain some of the signals in use in radio, others are obviously of land line origin, as for instance, the finish signal, AR, which is the Phillip's code abbreviation meaning "answer." 73, CUL, and others in use, have their direct counterpart in Morse. Others such as 25 (busy), 5 (anything for me), etc., are replaced by the QR and QS signals of radio. Again, the operator who becomes expert and is assigned to shore stations, comes in contact with Morse working, so that the more similarity between radio and Morse procedure, the more readily he can adapt himself to line operating. Even Morse message forms might advantageously be adopted by its younger brother, radio, for brevity, ease in copying, uniformity, quick transfer to land lines, etc. Throughout the years, Morse telegraphers have eliminated the unnecessary and evolved the most efficient procedure through stress of necessity, congestion of circuits, and the demands of commercialism. Useless signals, lost motion, and inefficient procedure are much more thoroughly eliminated in land line working, than in radio, though there is no QRM to fight. Radio can well adopt the most valuable methods and short-cuts, for use against that bugaboo, "QRM."

While we are comparing radio and Morse procedure may I remark that radio etiquette is on a much higher plane than that on land lines. One never hears the type of language on the air that is too frequently the cause of much hard feeling and non-co-operation between Morse men. This is largely due to the rule forbidding the use of bad language on the air. But, aside from the lack of abusiveness, there is a spirit of forbearance and helpfulness in the contact of radio men with one another at their work which is a pleasant contrast to the operating manners of a great many of the best Morse operators.

Still, there are a number of ways in which an operator can make association with his fellow operators on the air more agreeable. The first of them is by staying off the air. The first rule of a real operator should be "never make an unnecessary signal." He should be governed by Shakespeare's advice:

"Give every man thine ear,
But few thy voice."

When he has something of importance to transmit it should be sent, then . . . . STOP. Silence is certainly the golden virtue of the radio operator.

May I inflict a few don'ts on you?

Don't No. 1. Unnecessary signals. Don't call a dozen times, make several Vs, - . . . - s or other unnecessary signals, and end up with four or five ARs, Ks and SKs. Make it snappy. I know you have all heard this before, and seen it in print, too, but it needs to be repeated about every so often.

Don't No. 2. Unnecessary power. Don't transmit without listening at least three to five minutes on the wave you are going to transmit on, and also the one you are going to listen for a reply on, if it is different from your sending wave. Don't call unless you are reasonably sure you are in good working range, and then make it a short call. Don't "CQ." Don't test. Nine tenths of this "sitting on the key" is unnecessary. You can clear your spark up just as well with the aerial switch off, and a slight adjustment with the aerial on again will keep it clear. A very short dash will tell you whether you are getting maximum radiation.

Don't repeat for another operator. Don't butt in and offer to "QSR" everything, or don't tell the other fellow to "QRT." Stay "QRT" yourself! In other words, don't transmit unless you have some good legitimate reason for doing so. Whenever you feel the urge to exercise your key, first wait, second think "is it absolutely necessary?" then don't.

Don't try to burn up a slow man, or poke with a fast man. An operator usually prefers to copy at about the speed at which he himself sends. If a man sends fast to you, come back in like manner, and vice versa. Gauge your speed by that of the fellow you are working, and he will think you're OK.

In considering personal contact, may we mention its importance in connection with those aboard ship as well as on the air. Our relations with those around us are of importance everywhere, as affecting our happiness, and our working efficiency. The ability to "get along" with our fellow men is one which is acquired only in the hard school of experience, and unless we are fortunate enough to have been endowed by nature with this valuable trait, we will learn it nowhere else.

Many an operator who starts out full of enthusiasm in his work becomes discouraged with marine operating as a vocation, through his inability to adapt himself to the society in which he must live aboard ship. Therefore it seems that a few words "to the wise" may give the prospective operator an insight into what he must be prepared for. "To be forewarned is to be forearmed."

The status of an operator is rather a difficult one. To begin with, he is usually young and inexperienced in the "ways of the world," particularly the "seafaring world," and is considered fair "bait," by the majority of the crew, so that unless he can stand considerable "razzing" he is apt to become a grouch. The wireless operator often has a little better education than the average sailor or ship's officer, and is apt to consider himself above them in this respect, which will not conduce to friendliness. His work is neither arduous, nor exacting, and he will be considered a "passenger" by the rest of the crew unless he shows a willingness to "chip in" occasionally and prove that he is not absolutely lazy, or shows his industriousness in other ways. Due to the fact that the radio is a department by itself, a new operator often feels his responsibility, and makes no effort to hide the fact that he feels it, which is amusing or otherwise to those who have real responsibilities aboard ship, and consequently, does not improve his standing.

There is the type of fellow who, after a few years marine operating, becomes a hardened sea-dog, has acquired all the characteristics, virtues and vices of a sailor, and is only incidentally an operator. He can probably box the compass, tie a knot, or heave the lead as well as the bo'sun. He is considered a good fellow by his shipmates because they almost forget that he is an operator. Next there is the man who has isolated himself entirely from those around him; lives the life of a hermit; is considered an incurable "crab," and is let strictly alone, which is probably what he thinks he wants. Finally, there is the operator who has the respect of everyone, is good fellow enough to be accepted into the friendship of those around him, and is a true operator in the best sense.

FACTORY BUILT SETS WITH A. C. TUBES

(*Continued from page* 17)

The circuit of the Atwater Kent Model 37 A. C. Receiver is shown in Fig. 10, and a top view showing how the power plant is placed in the rear of the metal cabinet is shown in the picture. This receiver has a three stage tuned r.f. amplifier using type 26 a.c. tubes, a type 27 detector, and two stages of transformer coupled audio amplification, using a type 26 and a type 71 tube. The latter is impedance coupled to the loud speaker, and has its filament operated from a 5 volt winding of the power transformer.

Filament balance in the r.f. and first audio stages is obtained by means of center-tapped fixed resistances located in the power plant, and in the case of the power tube, a balancing resistor for the loud speaker return lead is shunted across the filament circuit in the receiving set, and another center-tapped resistor is placed across the filament leads, for the negative *B* connection, in the power plant. Fixed resistors cut down the effective *B* voltage from 220 volts to 45 and 90 volts, for the detector, r.f. and first audio tubes, and a total of 180 volts is supplied to the power tube, with 40 volts negative bias through the voltage drop in a resistance placed in the negative *B* circuit. Volume control is obtained by means of a 500 ohm potentiometer shunted across an r.f. choke, which is placed between the antenna and ground connections, with the grid of the first r.f. tube connected to one side of the choke. The filament circuit of the r.f. amplifier is by-passed with 1/4 mfd. condensers, to prevent oscillation due to the presence of resistance in the grid return leads to the r.f. tubes.

ELECTRO-DYNAMIC CONE

(*Continued from page* 28)

is then glued to the cone by placing a liberal quantity of the adhesive in the small trench formed by the inner wall of the tube and the projecting edge of the cone. Care is needed to make sure that the axis of the coil is coincident with that of the cone. After the glue has set, the leads from the coil are fastened to the sloping rear surface of the cone under strips of writing paper glued on. The cone can then be fastened to its support by placing *D, Z* on a flat surface and gluing the saw teeth to *D*.

While the cone assembly is drying, a baffle plate and supporting structure can be constructed. The baffle should be at least 16 in. square, larger if possible, and of 1 or 1⅛ in. wood. White pine is easy to work and is generally obtainable in the desired widths. The base *T* has the same dimensions as baffle *B*. A hole 9¼ in. in diameter is made in the center of the baffle. Two brackets *S, S* for the field coil have the same width as *T* and *B* but one-half the height of *B*. Semi-circular notches are cut in the center of the upper edge of *S, S* to fit the diameter of the field magnet *M*. The base *T*, baffle *B* and brackets *S, S* are assembled with screws and stiffened on the side by the diagonal braces *Q*. To fasten the cone to the rear of the baffle, a clamping plate *G*, having the same linear dimensions as *Z*, but made of ⅜ in. pine is necessary. This plate is fastened to *B* with 18 equally spaced screws set in a circle about 10 in. in diameter. *Z* is clamped between *G* and *B*.

The field magnet *M* is placed in its notches and the moving coil leads resoldered to the terminals on *M*.

The speaker is now ready for a tryout, except for an input (amplifier output) transformer. The transformer supplied with the speakers are generally unsatisfactory as their small cores become saturated with strong signals and cause distortion. If it is possible to secure a potential transformer, such as is used to step down 2300 volts for metering purposes, the builder will be in luck as these transformers have relatively large cores and a turn ratio of about 23 to 1, which is very satisfactory. Otherwise it will be necessary to try whatever output transformers are at hand.

With the transformer installed and the speaker connected to a receiver and field exciting source, the final adjustment is made while the speaker is in operation. Field magnet *M* is moved back and forth and bushed with strips of paper until the moving coil vibrates freely without striking the pole faces. As soon as this adjustment is satisfactory the magnet is securely fastened in place by screwing the yoke strap *Y* to *S*.

—SEVENTEEN RADIO ....

(Continued from page 25)

normal, so much the better, for the tubes will last much longer. Practically all transformers supplying 2½ volts for the type 27 heater tube should have a ¼ ohm fixed resistance inserted in the filament supply lead, as otherwise the current consumed by the heater when the set is first turned on will be excessive, and the heater may soon burn out. This resistance should be of the heavy duty type, as it will carry at least 4 amperes at starting and nearly 2 amperes normal load. Undoubtedly the insertion of the resistance will prolong the time during which no signals will be heard after turning on the set, but this is preferable to burned out detector tubes.

One of the most frequent sources of hum in an a.c. receiver is the first audio stage. Here a type 26 tube is customarily balanced in the same manner as in the r.f. stages. Where high grade audio transformers, which will amplify the fundamental 50 or 60 cycle noise as well as its harmonics, are used, it is particularly important to balance the filament circuit as carefully as possible and to maintain the plate current at about 3 milliamperes. In building an a.c. set, a milliammeter should be placed in the plate circuit of this tube, and the *C* bias resistor adjusted to such a value that the plate current will be not less than 3 milliamperes, nor more than 4 milliamperes, thus producing the least possible ripple voltage in the grid circuit.

A novel method is to install a push-pull first audio stage, as well as push-pull in the second stage. This results in a minimum of noise due to a.c. operation of the filaments. The circuit shown in Fig. 4 is an illustration of how the amplifier is assembled. *C* bias resistors for both the first and second stages are shown as separate resistances, in order that they may be easily selected after measuring the plate currents. Audio transformers having the primary winding center tapped are now on the market, so that it is easy to construct the amplifier or to add the extra tube in the first stage in case noise is now bothersome.

In testing out an a.c. set, if it is troubled with a.c. hum, the best procedure is to first terminate the primary of the first audio transformer with 10,000 ohms, in the shape of a fixed or variable resistor, and momentarily disconnect the 2½ volt a.c. leads to the detector heater circuit. Balance the first audio tube filament resistor carefully to the point where there is the least hum, and adjust the *C* bias resistor, in case it is variable, until the plate current is within the 3 to 4 milliampere limit. Now connect the detector circuit and remove the resistance from the primary. Short circuit the primary of the last r.f. transformer, and adjust the *B* bias on

the heater circuit for minimum hum. Repeat the same operation for each r.f. amplifier tube, shorting the primary of the preceding transformer so as to prevent any r.f. energy which might be modulated with a.c. hum from a badly adjusted tube from interfering with the adjustment of the following tubes. This is much better than turning on the set and trying to adjust the resistors, starting from the front end and working towards the power stage.

Regarding adjustments in the power tube circuit, so long as the secondary winding of the power transformer which supplies the filament of the power tube has an accurate center tap, and the grid bias resistor is the right size, no other adjustments are needed, since any slight amount of a.c. hum introduced into this tube will not be heard in the loud speaker, as it is not amplified by following tubes. In this connection, in an a.c. set especially, one side of the output transformer to which the loud speaker is connected should be grounded, as should the metal cases of the audio transformers. If this is not done, there may be sufficient unbalance in the transformers to cause an annoying hum which no amount of balancing in the filament circuit will overcome.

Incidentally, do not always blame a.c. hum on the filament circuit. The writer recently tested an a.c. receiver which could not be quieted, no matter what the adjustment of the filament resistors, and finally disconnected the *B* power plant and inserted a set of dry cell *B* batteries. The set was as quiet as could possibly be desired, and an investigation of the *B* eliminator showed that only one side of the rectifier tube was operating, resulting in a very noisy *B* supply.

NAVAL RESERVE NOTES, LOS ANGELES AREA

By W. R. Snyder, Lieut. (jg) C—V (S)

The radio fraternity of Los Angeles is well represented in the Naval Reserve Force; the roster being as follows:

From the Federal Telegraph Company:
Lieut. Commander F. L. Dewey
Lieut. (jg) H. D. Watson
Ensign L. Winser
Ensign S. N. Barton

Radio Corporation of America;
Lieut. H. M. Harding
Lieut. (jg) L. C. Dent
Lieut. (jg) W. R. Snyder
Lieut. (jg) R. B. Walling

Others:
Lieut. (jg) C. S. Pratt, I. W. T., inspector and instructor of the Y. M. C. A. Radio School.
Ensign Forbes Van Why, who was S. O. R. S. man here
Ensign P. S. Lucas, ex-Federal and S. O. R. S. operator
Ensign J. G. Alverson, ex-Federal operator

Efforts are being made to enroll amateur radio men in the volunteer reserve and train them, under the above officers, in both commercial and naval procedure. A network of amateur stations, under the direction of the headquarters station, NRRW, is now being established, and very thoroughly covers the whole 11th Naval District area, comprising Southern California, Arizona and New Mexico.