RADIO & MODEL ENGINEERING

Published by

THE GENERAL APPARATUS CO., INC.
SLEEPER RADIO CORPORATION
successors

Edited by ~ M. B. Sleeper

Vol. II | APRIL, 1922 | No. 3

10 Cents a Copy | $1.00 Per Year

CONTENTS

THE RADIO DEALER'S SELLING HAND BOOK

There are two kinds of radio books—those the dealer sells, and those the dealer sells to make sales. To the latter class belongs

DESIGN OF MODERN RADIO RECEIVING SETS

By M. B. SLEEPER

What to Build Radio experimenters respond quickly to suggestions on different kinds of apparatus that they can build. Keep your customers busy by selling them the constructional ideas in MODERN RECEIVERS.

How to Build Don't spend valuable selling time in lengthy explanations of the building of radio apparatus. All kinds of detail photographs, scale drawings, and clear instructions are given in MODERN RECEIVERS.

How to Wire It costs money to draw diagrams for every customer. Explicit circuit diagrams are given for the crystal sets, regenerative long and and short wave timers, amplifiers, and other equipment shown in MODERN RECEIVERS.

What to Buy When a customer wants a set of parts to build a set do you spend fifteen minutes in making up a list of what he needs? Complete lists of parts, to help you in making up orders accompany each chapter of MODERN RECEIVERS.

EVERY RADIO STORE NEEDS A STOCK OF MODERN RECEIVERS TO SELL TO MAKE SALES

PRICE 50 CENTS

IMMEDIATE DELIVERY

THE GENERAL APPARATUS COMPANY, INC.
SLEEPER RADIO CORPORATION, Successors
88 PARK PLACE NEW YORK CITY

A Compact Receiver

Radio receiving equipment of the type here described will be in great demand during the summer months.

By W. H. Bullock

A General Description

UNLIKE the majority of articles, this one deals with a complete receiver rather than a single instrument such as a variometer, detector or condenser, to which other apparatus must be added before the receiving outfit can be used. As a rule there is a greater demand for descriptions of single units since most builders already possess parts which they wish to put to use. However, there are many others who want complete receivers for the reason that they are either just entering the game or desire a compact receiving set for office, vacation, or some other special use.

The instrument here described is particularly well adapted for automobile, motor boat and summer camp use, and has the combined expensive appearance and compactness which makes it ideal for an apartment installation. As seen from Fig. 1, the outfit represents a new departure from the general run of articles on apparatus construction in that a highly polished mahogany cabinet encloses the receiver. Heretofore cabinets have been omitted for the reason that most experimenters find them difficult to construct and expensive to buy. The cabinet measures 5 x 7½ x 6 ins. over all and has a hinged cover to permit convenient access to the interior of the instrument. On the rear four battery terminals are located, while the front is fitted with a 5 x 7½ in. L. P. F. panel which carries the controls, antenna, ground and telephone binding posts. This is an audion receiver employing a tuner of the single circuit variety. It has no plate coil or other means for obtaining regeneration, which not only eliminates one control but makes it an attractive model for manufacturers who wish to put out an audion receiver without danger of patent complications. The knob and dial on the panel serves to control the inductance of the tuning coil mounted on the reverse side. The shaft carries a contact blade which, when turned thru an arc of 90°, passes over every turn of the enameled wire of which the inductance is wound. This permits gradual variations in wavelengths over a range of 50 to about 800 meters with the average antenna. The indicating knob above the dial is the rheostat adjustment for controlling the temperature of the

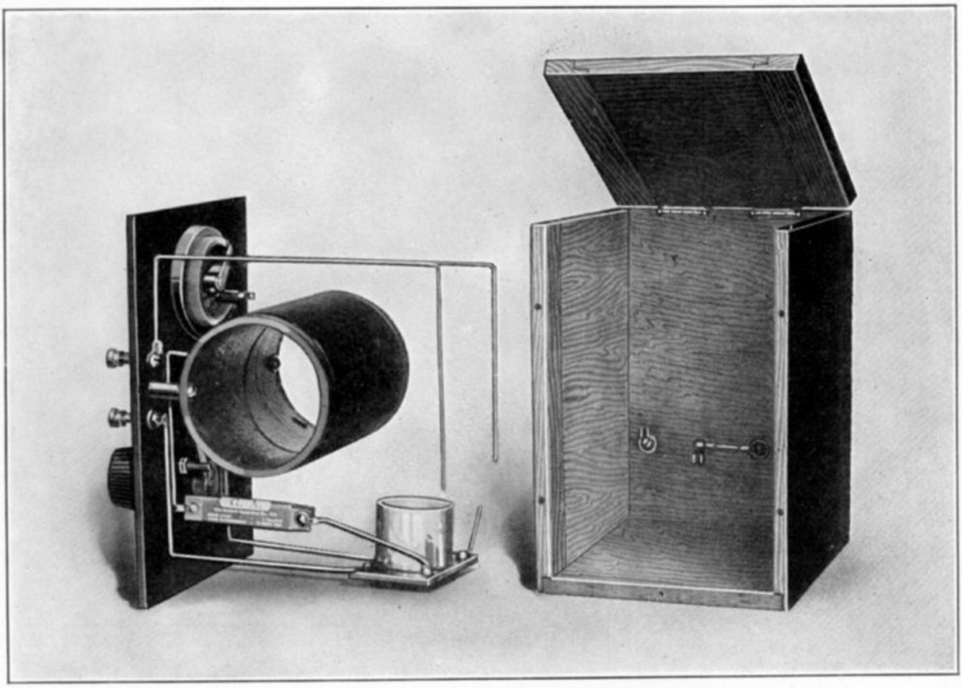


Fig. 2. For simplicity the socket is not mounted on the front, but is fastened to the case when the panel has been put in place

detector tube filament. As Fig. 2 clearly shows, all but the tube socket is assembled on the L. P. F. panel, economy of space necessitating the locating of the socket far back on the bottom of the cabinet. The wiring between the panel and cabinet is the only difficult part of the construction of the receiver.

Winding the Inductance

The inductance is wound upon a 4¼ in. piece of GA-Lite 3 in. in diameter. This may be cut from a standard 9 in. length by first drawing a line around the tube 4¼ in. from one end and then following the line with a thin sharp thru a hole made for the purpose, and then wind on the wire to within ⅜ in. of the other end. Use as much tension as possible so that the turns will not come loose should there ever be any shrinkage in the tube. A coat of varnish or shellac will also assist greatly in keeping the wire firmly on the tube. The last end of the wire is secured in the same manner as the first, leaving an end about 2 in. long for wiring to the antenna terminal. Using ¼ in. 6-32 R. H. machine screws fix two coil support pillars to the tube in the margins at each end of the coil. The inductance unit is now complete and attention is next given to the contact blade.

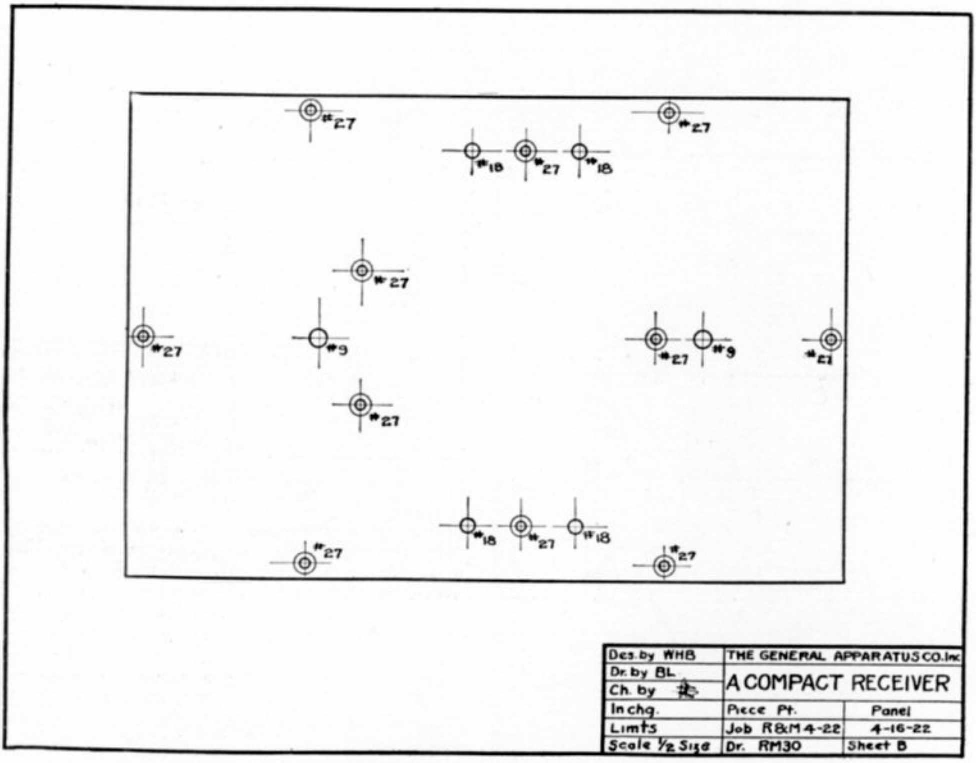


Fig. 4. One-half scale drawing of the front panel, from which dimensions can be taken readily and transferred to the L. P. F.

knife. Don't try to cut thru in one place before another, but draw the knife all around the tube with equal pressure so that when the tool goes thru in one place it will be very nearly thru in all others. In this way a smooth edge is more easily secured. On a line drawn parallel to the axis of the tube drill two No. 27 holes 3/16 in. in from each end for support pillar screws. Their centers must be exactly 3⅞ in. apart.

The winding is made of No. 21 enameled copper wire which gives about 33 turns per inch. A ¼ lb. spool is all that is required for the job. The winding is extremely simple since it is of but a single layer and no taps are taken off. Start ⅜ in. in from one end by fastening the wire in the tube

Inductance Contact Lever

As previously stated, variations in inductance are accomplished by the passing a spring contact arm over the coil thru an arc of 90°. The lever is made up of 1/64 x ¼ in. phosphor bronze strip which can be purchased in 1 ft. lengths. Referring to Fig. 3, cut off a piece 3¾ in. long and bend it over on a line 1 ¼ in. from one end. This is for the purpose of reinforcing the spring. From the place where the short leaf ends taper the blade out to a width of ⅛ in. at its end and bend the tip over 90° on a line ⅛ in. from the end. This is to make contact with the inductance winding, so the end should be rounded off with a file to provide a smooth running contact and prevent the blade covering more than one turn at a time. The lever is secured to the dial shaft thru the agency of a 3/16 in. brass collar. This carries a set screw for fastening it to the shaft while the blade is soldered to it with its end 1/8 in. from the center of the shaft hole. The blade is now 2½ in. in length, measuring from the center of the collar to the contact point. This is an important measurement to maintain, since the smooth running of the inductance adjustment depends upon it.

The L. P. F. Panel

The laying out and drilling of the front panel is next given attention. For a panel of this size a thickness of 3/16 in. is to be preferred. If it is cut from a larger piece considerable time and care should be given to squaring and bringing the dimensions to the required 5 x 7½ ins. Fortunately this happens to be a stock size of L. P. F. which has polished surfaces, straight edges, and square corners, thus greatly reducing the labor necessary

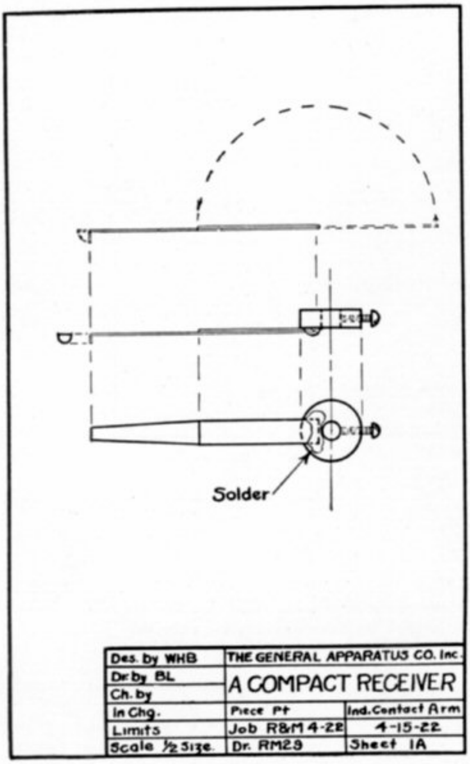


Fig. 3. One-half scale drawing of the contact arm

to construct the receiver. In Fig. 4, we have a scale drawing of the panel showing the location of the holes. Dimensions are left off to make the drawing clearer, since they may be obtained from measurements made upon the figure which is exactly half size. Beside each hole a number is shown to denote the size of twist drill to be used. Concentric circles indicate holes that are to be countersunk to take flat head screws. If the drawing is followed carefully no trouble should be experienced in getting the panel accurately laid out and drilled.

The Mahogany Cabinet

Unless the builder is skilled as a woodworker it is not advisable for him to attempt to construct the cabinet used for enclosing this receiving outfit. Owing to the fact that the box has a hinged cover it is necessary to run strips across the end of the grain of the cover and both sides to

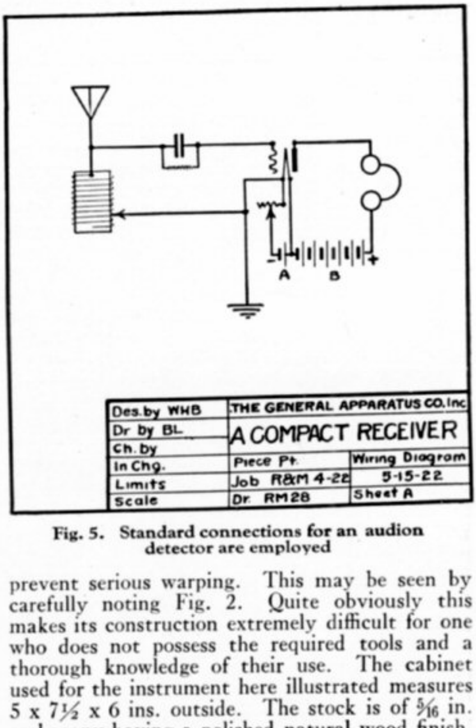


Fig. 5. Standard connections for an audion detector are employed

prevent serious warping. This may be seen by carefully noting Fig. 2. Quite obviously this makes its construction extremely difficult for one who does not possess the required tools and a thorough knowledge of their use. The cabinet used for the instrument here illustrated measures 5 x 7½ x 6 ins. outside. The stock is of 5/16 in. mahogany having a polished natural wood finish. Corners are of mortised construction and glued. The cover is hinged from the back by two brass hinges which permits the vacuum tube to be conveniently removed or replaced when necessary.

A and B battery terminals are mounted on the rear of the cabinet for the purpose of keeping unsightly battery leads out of view. All four posts are in a line, 2 ins. up from the bottom. Facing the rear of the box the two B battery terminals are at the left and the A battery posts at the right. One post is located ¾ in. in from each side of the box and the other two are 1⅛ in. from them. This leaves 1¼ in. between the two center terminals. A small copper soldering lug is clamped under each of the B battery and outside A battery terminals while two are secured under the head of the inside A battery binding post screw. Connect the center terminals together with a short piece of square tinned copper busbar and put the cabinet aside for the time being.

Assembling the Parts On the Panel The first step in assembling is to fit the rheostat terminals with soldering lugs and secure the unit to the upper part of the panel by means of a ½ in. 6-32 F. H. screw and nut. Two screws may be used but since the shaft passes thru both the rheostat and panel, one will be found sufficient. Next put the antenna and telephone terminals in place with a lug fitted to each. Under the ground terminal clamp one end of a 2⅝ in. length of ¼ in. phosphor bronze strip as shown in Fig. 2. This strip carries a second hole thru which one of the lever stopping screws pass. The free end of the strip should come just up to the shaft hole where it is bent away from the panel to form a spring contact under the collar of the inductance contact blade. The second stopping screw may now be put in place. These are simply ¾ in. F. H. 6-32 screws fitted with nuts to limit the lever to a 90° arc which exactly covers the length of the winding. The shaft to which the knob and dial are attached is of 3⁄16 in. round brass rod. A piece 1½ in. in length is cut from a stock 12 in. piece and one end is secured into the hub of the contact lever by means of the set screw. It may save some trouble and annoyance if a flat surface is filed on the shaft where the set screw is to bear. Now place a brass washer over the shaft and insert it in the shaft hole of the panel. Put another washer over the end of the shaft that projects from the front of the panel and then fasten the knob and dial to it. The inductance is next assembled on the panel. It is held in place by two ½ in. 6-32 F. H. nickled plated screws which pass thru the holes provided for them between the binding posts and turn into the coil support pillars. By rotating the knob and dial the contact blade will pass over the winding. The tension of the blade should be such that by placing a piece of sand paper under the contact the enamel insulation can be removed from the winding in the path traversed by the slider. Work the blade and sand paper back and forth for a short time and then remove the coil to determine if every turn has been cleaned where the contact is to travel. If not, the remaining enamel can be removed before the coil is replaced.

Wiring the Receiver The set is ready for the wiring operation which should be carried out in accordance with the circuit diagram, Fig. 5. Owing to the fact that the socket and battery terminals are mounted in the cabinet while the rest of the apparatus is attached to the panel the wiring requires a little more time than it otherwise would. Temporarily screw the socket to a board in the position shown in Fig. 2. Its center must be exactly 4½ ins. back of the panel, which is the position it occupies in the cabinet. Wiring to the socket terminals may now be accomplished and the socket later taken from the board for fixing in the box.

Using square tinned copper bus bar, wire the lower telephone binding post to the plate terminal of the socket while in the lug of the upper post solder a wire that will reach to the positive B battery terminal located in the box. The end of the inductance winding goes to the antenna binding post from where another wire leads thru a gridleak condenser to the grid socket terminal. From the front filament lug run another length of bus bar to the ground connection and from there to the rheostat. To the other side of the rheostat solder a wire of a length that will conveniently reach the negative A battery terminal on the rear of the box. A final piece of conductor about 1 in. in length is soldered into the remaining socket lug and bent in such a way that it can be connected to the positive A battery binding post when the panel is put in place.

Now release the socket from the board to which it was secured for wiring and put the apparatus in the cabinet. The three wires cut to reach the rear terminals are soldered in place and the socket is secured to the bottom of the box with two ¾ in. R. H. wood screws. Before attempting to turn wood screws into the edges of the box for holding the panel, run a small size drill into the wood as a precaution against splitting. The screw at the top of the panel does not extend into the cover. It is cut off to permit the cover to be used and yet maintain the balanced appearance of the instrument.

Operating the Receiver An antenna to be used with this outfit may consist of about 120 ft. of No. 14 bare copper wire. It should be run up vertically from the instrument to as great an elevation as possible and then carried out horizontally until the wire is all used. Care should be taken to keep the conductor away from power lines, conductor pipes, metal cornices, and other metallic bodies which are common to most structures. Connect the antenna lead to the upper left hand terminal of the receiver and wire the lower one to the ground. Water and steam pipes are most frequently available for this purpose in homes and office buildings, and serve the purpose quite well.

On the rear of the cabinet connect a six volt storage battery to the A battery terminals and a 22½ volt B battery to the other two binding posts. Make sure that the negative of the B battery and the positive of the A battery are wired to the two center terminals. Now connect a pair of 2,000 or 3,000 ohm telephones to the right hand panel binding posts and the installation is complete.

It is impossible to give a reliable estimate of the receiving radius of such an outfit for it depends too greatly upon local conditions and the operator's skill. Some idea of the receiving possibilities of the set may be gained from the results of a test made with it recently. It was sent to a point on Long Island where conditions for reception have always been rather poor. Here connection was made to a single wire antenna 140 ft. in length and about 35 ft. high. The operator was a man with practically no radio experience but he found no difficulty in picking up the concerts broadcasted from Schenectady with good audibility.

RADIO AND MODEL ENGINEERING

A monthly magazine published by
The General Apparatus Company, Inc.,
88 Park Place, New York City.

Editor
M. B. SLEEPER

Associate Editor
W. H. BULLOCK

Subscription Rates

Ten cents per copy in the United States and Canada; in foreign countries fifteen cents.
One dollar per year, twelve numbers, in the United States and Canada; one dollar twenty-five cents in foreign countries.
Radio and Model Engineering is mailed to subscribers on the first of the month, and appears in the radio stories on that date.

EDITORIAL

IN the May issue of Q S T Magazine Mr. Warner has written the finest, most level-headed comment on the radio industry that has appeared in any publication. If Mr. Warner "viewed with pride and sorrow" the developments of the last six months, he would have said "apprehension and shame" had he visited the radio show now being held at the 71st Armory in New York.

To begin at the beginning—the show, according to the promoters, was backed by the National Radio Chamber of Commerce, supposedly an association of established radio concerns sincerely interested in the development of radio as we old-timers know it. These companies, in mutual protection against the opportunists who are succeeding only in destroying the confidence of the public in radio, proposed to show the people, in an educational exhibit, what real radio equipment is and will be. We, at the G. A. Company, were so skeptical that we stayed out, though we were almost threatened by the promoters with the loss of public confidence if we were not represented.

Bearing this in mind, let us look in on this "educational display" which, it is claimed, cost $35,000 before the doors were opened. Two husky barroom bouncers are stationed at the gates to prevent the passage of anyone not provided with a ticket, for when space is sold at half the advertised price it is necessary to make up in gate receipts.

Right at the door the absence of familiar faces is noticeable—strangers, outsiders, new-comers to the radio world. As we pause, deciding which aisle to take first, we hear a smooth voice declaring "You understand, of course, that if there should be, by any chance, trading in this radio stock, if there should be, it will be up to us—" No one ever heard that sort of conversation at a radio show before, nor expects it in an educational exhibit.

But let's see the show. Passing down the first aisle we are still looking for radio apparatus, but curiosity holds us for a moment at a large booth amply provided with flowers, chairs, and rugs. One of a group of women, the type that has tried to sell us insurance and de luxe editions, steps over quickly to give us cards bearing vague suggestions about the availability of stock in a company organized to acquire radio patents, and smiles us an invitation to let her tell us about the wonderful possibilities of radio as an investment to be compared with Bethlehem Steel and Ford Motors.

We retreat in disorder, coming smack up againt a booth where receiving sets are displayed—the kind we got out after the War and wondered how we ever committed such atrocities. Shocked, we rebound across the aisle and almost carry away a counter covered with the most awful celluloid knobs and dials, rough, ragged, and knobby. Hastening on, we detour in time to avoid another opportunity to make a fortune in the securities of a chain store syndicate, tho our intelligence is insulted by a man who dashes up from under cover to sell us a book illustrated with futurist sketches indicated as radio apparatus and drawings copied from a Bureau of Standards publication. As we pause to look at a loud speaker from which issues music supplied by a portable phonograph our eyes are caught by a wall of magazine covers portrayiug a dashing cavalier mounted on a galloping steed. The rider holds a phone to his ear, and, to judge from the caption, he is receiving instructions by wireless from headquarters.

A sense of depression and apprehension descends upon us. The nearest exit takes us past displays of wreckage labelled radio apparatus, but, looking neither to left or right, holding our breath, we rush out to the open air.

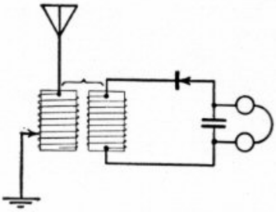
This was the "educational exhibit," a collection of stock promoters, empty booths, and the most miserable substitutes for radio equipment ever shown. Which proves what Mr. Warner said, that radio cannot be commercialized among the real radio men to whom the radio business will look for support when sales settle down to a competitive basis. Conclusions can be drawn by the individual, the dealer, jobber, or manufacturer. One fact must be faced by every one—the spirit of radio is fraternal, and the future of radio is in the establishment of mutual confidence from the experimenter to the distributor and manufacturer.

Summer radio activities are now being planned, and, in keeping with the season, work along this line is progressing in the laboratory at the G. A. in preparation for some good stuff in the next issue of R and M. Because broadcasting stations will give so much interesting news, doubly interesting to those away on their vacations, radio experimenters are expected to do a great deal of work this summer. Radio frequency amplification will help greatly to cut down static interference.

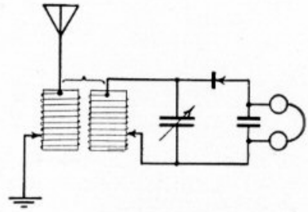
M. B. SLEEPER,
Editor

101 Receiving Circuits

Second Installment



(16)

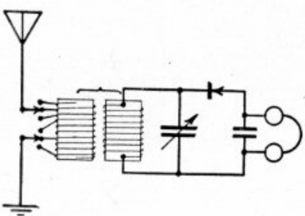


(17)

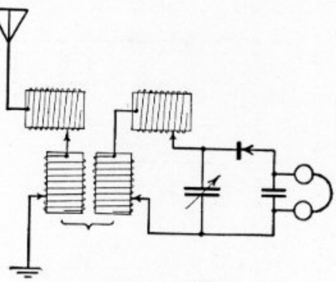
16. This is a simple loose coupler circuit showing a variable primary or antenna inductance inductively coupled to a secondary or closed circuit inductance of fixed value. A detector, fixed condenser and telephones complete the receiving system. Such a receiver is commonly referred to as having an aperiodic or untuned secondary, since it has but one possible value of inductance and no tuning condenser. The tuning is done by varying the primary inductance and the untuned secondary responds to all wavelengths to which the primary may be tuned. Altho the closed circuit has a high damping factor due to the absence of a condenser across the inductance terminals, it responds to different wavelengths with varying degrees of efficiency. The more nearly the wavelength of a desired transmitter approaches the natural period of the secondary of the loose coupler, the greater will be the transfer of energy from the antenna system to the detector circuit. By changing the inductive relation between the primary and secondary coils sharp tuning is secured. This feature is the greatest advantage of the two circuit tuner over the single coil type.

17. In this diagram we have a loosely coupled receiving tuner with two tuned or periodic circuits. The wavelength of the antenna circuit is varied by changing the value of the variable primary inductance and the secondary may be placed in resonance with it by a selection of the proper values of the closed circuit inductance and variable tuning condenser. In cases like this where both circuits may be tuned to the frequency of an incoming signal, maximum transfer of energy between the circuits occurs and the loudest response in the telephones results. By altering the coupling between the two coils varying degrees of selectivity in tuning may be obtained.

Before the vacuum tube came into use this circuit was considered the best that could be used. In fact, at present it is surpassed by no other crystal detector circuit and is the fundamental wiring diagram of the best equipment used at sea



(18)

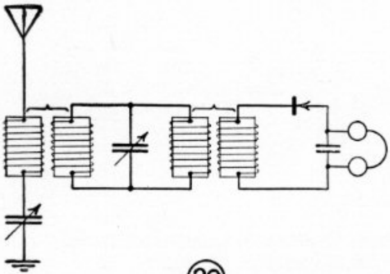


(19)

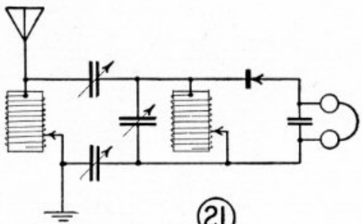
18. This circuit depicts the usual crystal detector, telephones and stopping condenser, connected to a loosely coupled two circuit tuner whose secondary inductance is of fixed value while the primary is varied by means of units and tens switches. A tuner of this type is usually built so that the coupling between the coils is varied by rotating the secondary inside the primary tube, and is commonly referred to as a vario coupler. It is a simple matter to vary the inductance of the antenna coil by either a slider or switches, but since the closed circuit winding is arranged to be rotated, mechanical difficulties make variations in the inductance of the secondary practically out of the question. For that reason all of the tuning in the secondary circuit is accomplished by means of the variable condenser shunted across the winding.

19. In this figure a system for increasing the wavelength of a receiving outfit is shown. A

second inductance or loading coil is connected in series with the primary of the receiving transformer to increase the inductance and therefore the wavelength of the antenna circuit. Where a tuned secondary is desired it is essential that a second loading inductance be placed in the closed oscillatory circuit. It should be noted that it is so placed that the secondary condenser is wired across the secondary inductance and loading coil rather than across the secondary alone. As in the case of circuit 11 the loading coils should be placed at right angles to the loose coupler windings so that they will least affect the tuning when they are not in use.



(20)

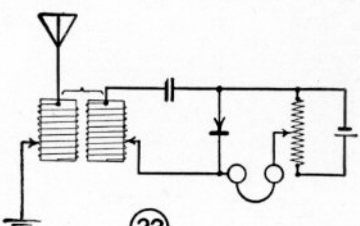


(21)

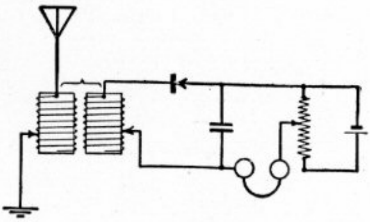
20. The circuit here shown is that of an extremely selective loosely coupled receiving tuner having three circuits. The antenna circuit includes a variable condenser and an inductance which is inductively coupled to a coil of an intermediate circuit. The intermediate circuit is tuned to resonance with the antenna circuit by means of a variable capacity, and has a second inductance which is variably coupled to the detector circuit. In this case the detector circuit is aperiodic.

Altho seldom used by experimenters, this three circuit tuner has found considerably favor in commercial radio service. For about ten years some of the largest steamships afloat have employed this circuit in the form of the well known Marconi Multiple tuner and some operators favor it.

21. Here we have a two circuit tuner employing electro-static coupling between the tuned circuits. The open circuit is tuned by means of a variable inductance while variations in the wavelength of the closed circuit are accomplished by the variable secondary inductance and the variable condenser. Coupling between the circuits is varied by changing the capacities of the two variable condensers connected between the ends of the two inductances. In a commercial form the shafts of the two are mechanically coupled so that both may be varied by a single knob. This circuit is used in some of the U. S. Navy outfits, both in this way and combined with electro-magnetic coupling.



(22)

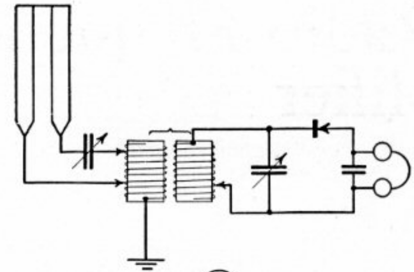


(23)

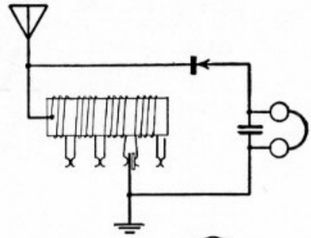
22. This circuit employs a simple loosely coupled tuner but varies from the arrangements previously considered in that a local battery is used. With some detectors, such as carborundum, signal strength is greatly improved by employing a direct current potential of the correct polarity in series with the crystal and the telephones. This is due to the fact that the crystal detector works by virtue of its unilateral conductivity which is more pronounced at certain voltages than at others. To obtain the correct potential a poteniometer of at least 500 ohms is shunted across the battery in the manner shown, and variations of the voltage applied to the detector and telephones are permitted.

23. Another potentiometer diagram is here shown. The principle upon which this circuit functions is practically identical to that employed in circuit 22. It differs in that the stopping condenser is shunted across the telephones and potentiometer, and the secondary inductance is included in the local battery circuit. While found in some high class commercial equipment this circuit in most cases is less desirable on account of the click caused in the telephones by making and breaking the battery circuit when the inductance is varied.

A potentiometer circuit of the kind shown in diagram 22 or 23 is essential where electrolytic detectors are used.



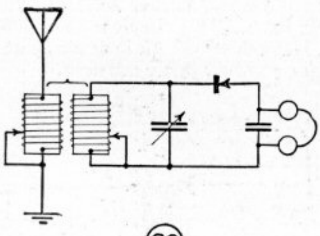
24



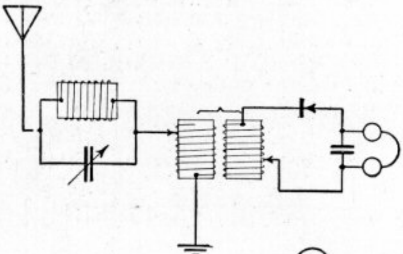
25

24. A type of antenna not previously referred to is illustrated in this circuit. It is termed a loop antenna but must not be confused with the coil type or directional loops, for it is as efficient as the ordinary aerial and is no more directional. Such an antenna with its attendant tuning arrangement was championed by De Forest in the early days of wireless development and found considerable favor among experimenters at that time.

25. The principle of the dead-end inductance switch is illustrated in this figure. A single circuit receiver is shown only for the sake of simplicity, the dead-end system being applicable to inductances of any circuit, regardless of its complexity. The idea of the device is to remove the unused portions of the inductance from the active part of the circuit so as to minimize absorption and resultant losses. This is quite important where tuners of long wavelength ranges are used, for in these instruments the natural period of the whole winding is very often equal to the wavelength of a signal tuned in on a fractional part of the inductance. Such a condition increases the resistance of the winding enormously, and if efficient reception is to be conducted it is imperative to use a dead-end device for breaking up the inductance into sections to keep the natural period away from the useful wavelengths.



26



27

26. Here the end of the inductance, which is usually free, is connected to the variable contact so that the unused portion of the coil is always shorted. To the man who has given little attention to radio frequency circuits but who is familiar with alternating current theory, it would appear that this method would seriously impair the efficiency of the outfit, but as a matter of fact it is used in some of the most popular regenerative tuners. However, there is no doubt but that there are losses due to an arrangement of this kind for the inductance of the coil is reduced while the resistance per turn remains the same. The object of shorting is to prevent the unused inductance from forming an oscillatory circuit whose natural period might be near the wavelength of a desired signal and thereby absorb a considerable amount of energy.

27. This circuit gives a method of reducing interference from signals on a wave differing in length from that of a desired station. This is accomplished by placing an inductance shunted by a condenser in the antenna circuit and tuning them to the frequency of the interfering signal. This simple tuned impedence or radio frequency trap oscillates at the period of the undesired transmitter so that the current flowing in each half is practically equal and opposite in linear direction. Theoretically this neutralizes the current at this wavelength at the point where the receiving tuner is connected, thereby preventing those impulses from travelling thru the primary of the transformer to the ground. The system is quite effective where the interference is caused by an undamped wave transmitter, but does not eliminate as great a portion of damped wave signals.

A Three Stage Radio Frequency Amplifier

An instrument of the laboratory type designed to cover a wavelength range of 150 to 500 meters.

By M. B. Sleeper

The Radio Frequency Amplifier

ALTHO experimenters have always been eager to apply all forms of new developments to their wireless outfits as soon as their appearance was made known, radio frequency amplification has, up to the present time, been kept from the majority due to the lack of reliable information on the subject. Before the war the system of increasing the strength of radio signals before they were detected was unknown to the average amateur. He had left the crystal for the audion and had added an audio frequency amplifier, but in most cases the radio frequency amplifier had never been heard of. During 1917 and 1918 the host of radio experimenters who were in the military and naval services were rapidly picking up advanced information on methods of amplifying radio signals with the vacuum tube and most of them left for their private stations with all sorts of data on audio frequency circuits but the radio frequency amplifier for short waves was considered next to the impossible with the tubes that were on the market.

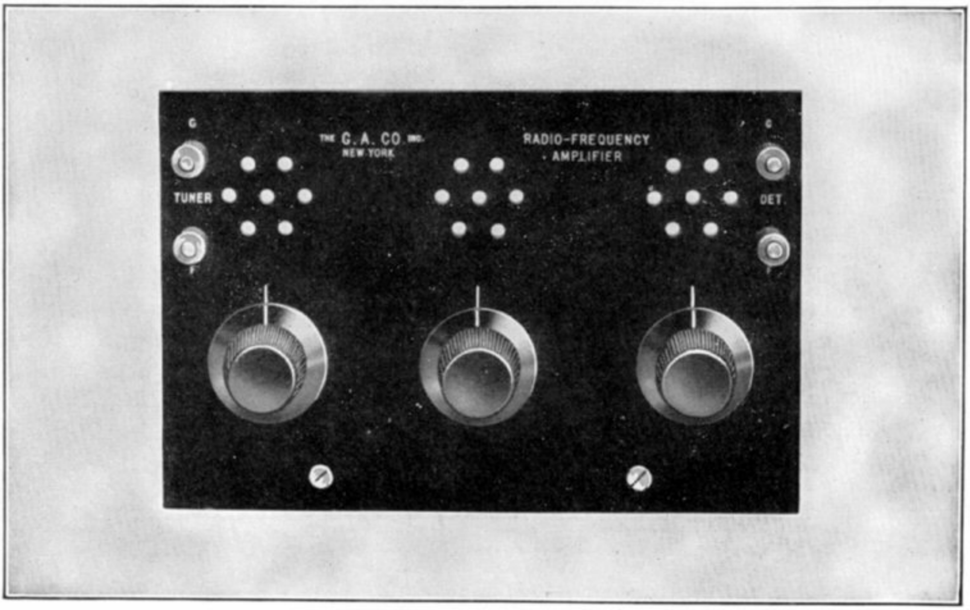


Fig. 1. For the first time a three-step radio frequency amplifier design is available to the Experimenter who builds his own equipment

Many carried on experiments in an effort to develop a radio frequency amplifier that would operate successfully on amateur wavelengths, but it was generally conceded that a practical system was out of the question until vacuum tubes of lower internal capacities could be brought out. It was possible to construct an efficient instrument by employing variable high frequency impedences between the tubes, but this was seldom attempted since it greatly complicated the operation of the set. Each tuned impedance or radio frequency trap had to be adjusted to resonance with the tuner, and the tuning was extremely critical. Resistance coupling on long wavelengths worked out well, but while this did not help the experimenters directly, Armstrong made use of it in developing his system of short wave radio frequency amplification, by increasing the wave of incoming signals to a length that could be amplified by the practical radio frequency resistance coupled amplifier. Details of his super autodyne receiver were published in nearly all wireless periodicals and many advanced experimenters constructed apparatus of that type, but it proved to be too expensive and too complicated an outfit for the average radio enthusiast. In short, it was not as practical an arrangement as the amateur demanded.

To those who are now entering the game it probably seems that if any great amount of experimental work had to b done to develop the radio frequence amplifier, it was almost a waste of time, since to-day we can show them an instrument which is not only practical but is equally as simple in both construction and operation as the audio frequency amplifier.

The G. A. Three-Stage Amplifier

In Fig. 1 is shown the front view of a recent product of the G. A. laboratory. It is a complete three-stage radio frequency amplifier mounted on a panel measuring only 5 by 7½ inches On the front four terminals are provided to accommodate a tuner at the left of the instrument and a detector at the right. In addition to the binding posts the panel supports the three filament rheostats while above them the tube peep-holes are located. The panel is held in an upright position by means of a 6 by 7½ inch L. P. F. base which is fastened to it by two brackets of ⅜ inch angle brass. The base carries three new type radio frequency amplifying transformers, the vacuum tube sockets and battery terminals. The arrangement is clearly shown in Fig. 2 which displays the rear of the instrument.

The amplifier is simple, rugged and neat, while the expense of construction is but a few dollars greater than the detector and two stage amplifier previously described. The two instruments used together form a compact detector and five stage amplifier which can hardly be surpassed for efficiency.

The Panel and Base

The first step in the construction of the three stage radio frequency amplifier is the laying out of the L. P. F. panel and base. Since both are of standard sizes, no cutting is required and the corners form such perfect right angles that even squaring is unnecessary. Locate all holes by intersecting lines scribed on the reverse side of the panels, obtaining measurements from the scale drawing in Fig. 3 which is exactly half size. After the drilling has been done the panel may be grained if the builder prefers that sort of finish, but in most cases this will not be attempted since the L. P. F. comes with a smooth surface carrying a very high polish. Such a finish reflects the images of the knobs and binding posts and thus adds to the beauty of the instrument. Unlike hard-rubber the surface of L. P. F. will not take an electrical charge and attract dust particles when wiped off with a cloth.

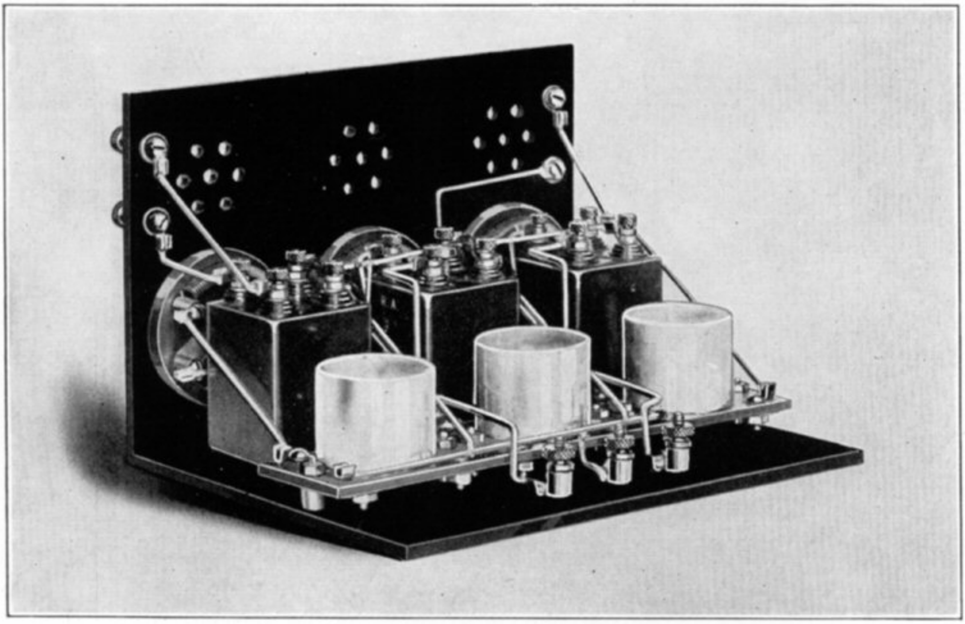


Fig. 2. Here is the amplifier ready to connect and operate — an instrument that can be assembled readily with simple tools

Assembling and Wiring

The next step is to make the angle brass brackets which hold the front panel to the base. Two 1 in. lengths are cut from a stock 12 in. piece of ⅜ in. angle brass and two No. 27 holes are drilled in each. One hole is placed on each side of the angle, 5/32 in. from the edge and 5/16 in. in from opposite ends. This brings the centers of the holes ⅜ in. apart. The two brackets are secured to the L. P. F. by means of ½ in. F. H. 6-32 nickel plated screws and nuts. Before anything else is added the angle made by the front and base should be tested with a square and corrected if it is not a perfect right angle.

Now secure the rheostats to the panel using ½ in. F. H. 6-32 nickel plated screws and nuts. The rheostats come drilled with two holes for screws but since the shaft passes thru both the rheostat base and panel, one screw and nut to each is found quite sufficient, and it makes alignment less difficult where the holes are not drilled perfectly accurate. Have all of the rheostats turned so that the terminals are toward the right hand end of the amplifier in order to make wiring as simple as possible. Next put the four binding posts on the panel with a small copper soldering lug fitted to each. Assemble the three battery terminals on the base using flat head 8-32 screws in place of the round heads supplied. In this case the lugs are clamped under the binding posts on top of the base with nickel plated washers between them and the L. P. F.

take particular care to keep it straight. Use the smallest amount of flux and solder possible to make a firm joint, but be sure that the solder adheres to both the busbar and the lug.

Assuming that the amplifier is completed as far as shown in Fig. 4, the amplifying transformers are now mounted. When purchasing radio frequency amplifying transformers be sure to state where the transformer is to be used, for one which works efficiently in a one stage amplifier will only work well in the step next to the detector when a multi-stage amplifier is used. The G. A. Company went to a considerable expense in experiments for determining the best construction of transformers for use in amplifiers two and three stages from the detector. Arrange the transformers in their respective places, fasten a soldering lug under each terminal and secure them to the

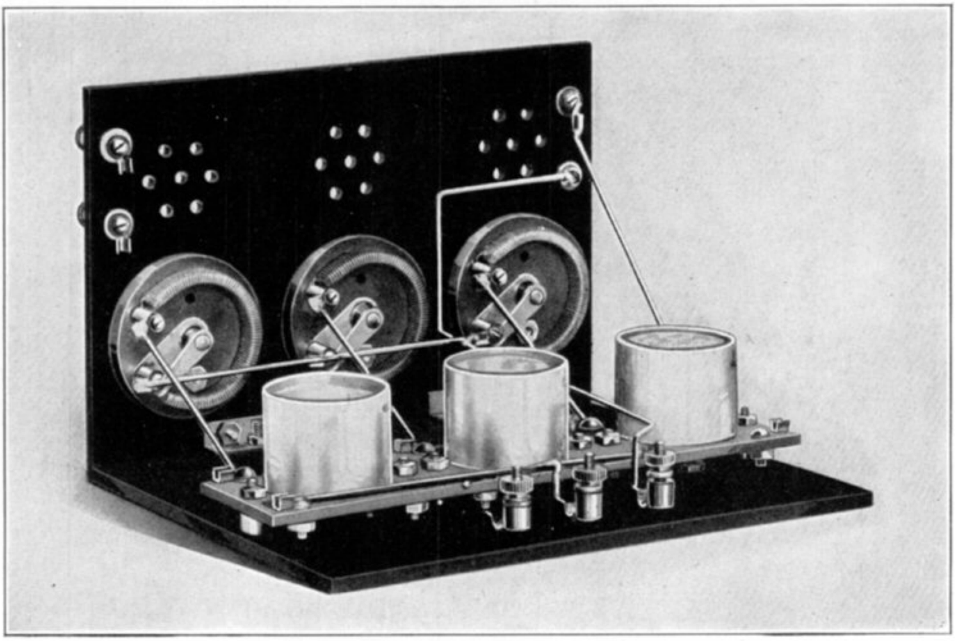


Fig. 4. To facilitate wiring, the leads shown in place in this illustration are soldered before the transformers are mounted

The sockets are held down by ¾ in. 6-32 F. H. screws and nuts with polished nickel brass pillars supporting them 5/16 in. above the base. These spacers are supplied with each socket. All three should be turned so that their filament terminals are toward the right hand end of the instrument, as shown in Fig. 4. Here we see exactly how the binding posts, brackets, rheostats and sockets are mounted. Before the transformers are mounted the filament or A battery circuit should be completely wired in the manner depicted in Fig. 4. The rheostats are fitted with soldering lugs, and square tinned copper busbar is used for the conductors. Make sharp bends in the wire where changes in direction are required but otherwise

base with the primary posts turned toward the input side of the instrument. All P-2 terminals are connected together and wired to the positive B battery binding post which is the one nearest to the right of the instrument. P-1 of each transformer is connected to the plates of their respective tube sockets. The secondary of the last amplifying transformer is wired directly to the output or detector terminals of the amplifier. In case of the other two, S-1 goes to the negative side of the filaments while the S-2 terminals are connected to the grids of the second and third stage tubes. The method of wiring will be more clearly understood by referring to Fig. 2 which shows the rear of the completed three-stage unit.

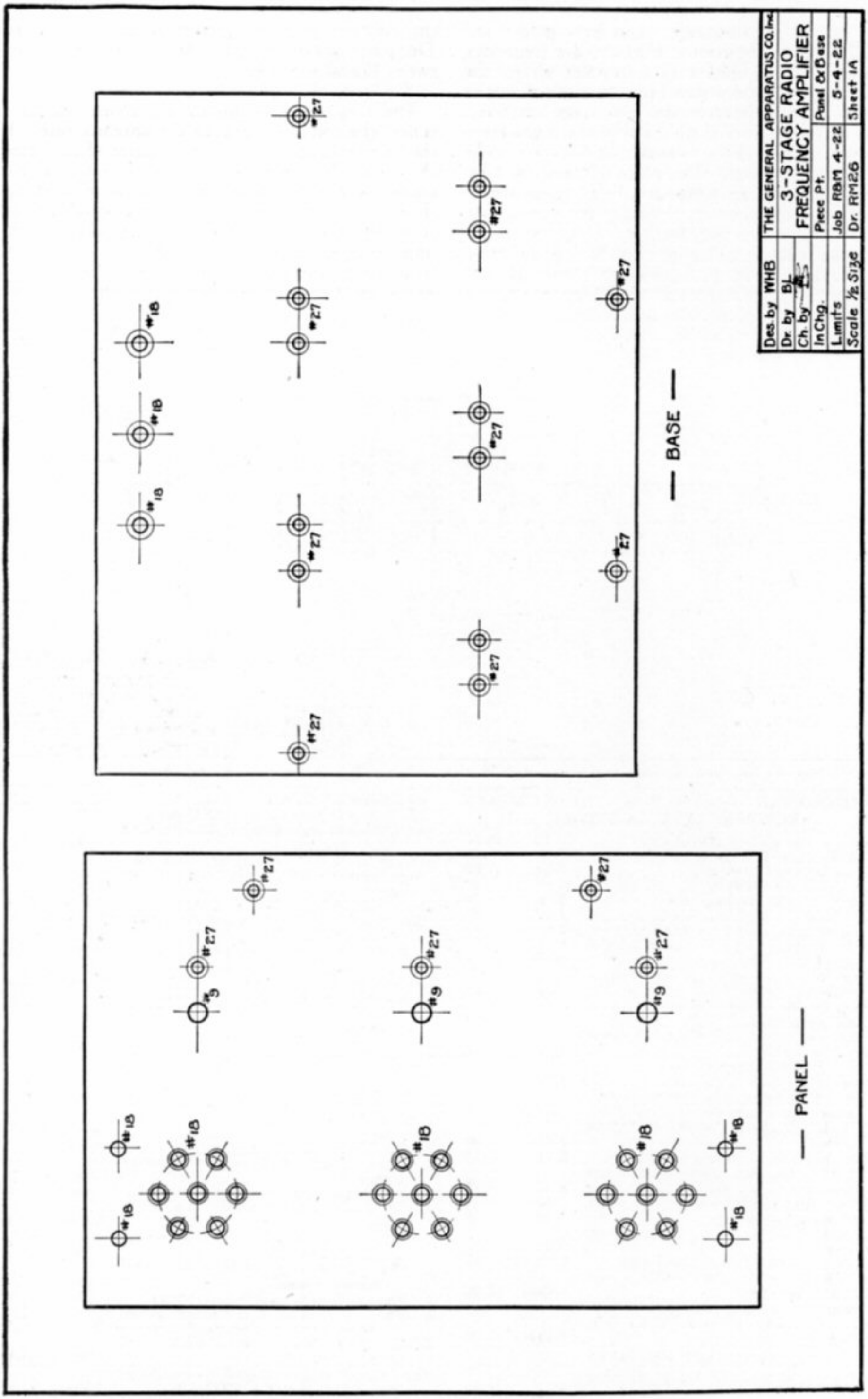


Fig. 3. The panels are of standardized sizes, bringing the work down to a matter of laying out from half-size drawings and drilling the holes

Operation of the Amplifier

Altho most of us have gained the impression that a radio frequency amplifier is a complex affair, the operation of this instrument is even simpler than a detector and two stage amplifier. Since all tubes are of the hard type the rheostats—the only possible adjustments—do not have to be regulated carefully. The plate voltage on each step is the same, so no tapped B-Batteries are required. Simply connect the negative side A-Battery to the binding post farthest to the left on the base, the positive of the A-Battery and the negative of the B-Battery to the center terminal, and the positive of the B-Battery to the third post. The potential of the plate battery should be between 45 and 135 volts.

The two input terminals are connected to a tuner, the top one going to the antenna side. If the tuner includes a plate inductance of any kind that must be connected to the detector in the usual manner if oscillation or regeneration is desired. The grid condenser terminal of a vacuum tube detector control panel is connected to the upper output binding post, while the ower one is wired to the filament of the detector tube.

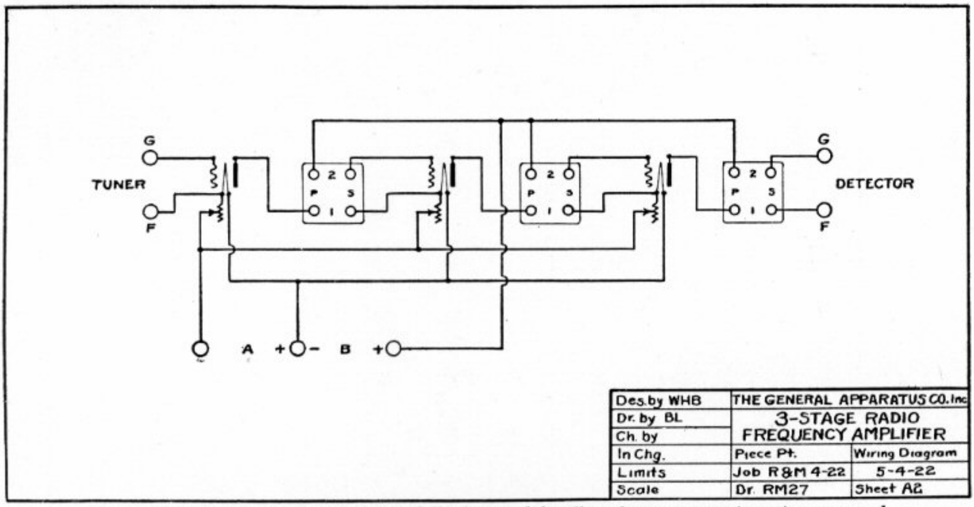


Fig. 5. Because the amplifier is so carefully designed, hardly a dozen connecting wires are used

STANDARDIZED PARTS FOR THE COMPACT RECEIVER, TYPE GA-STD-A34

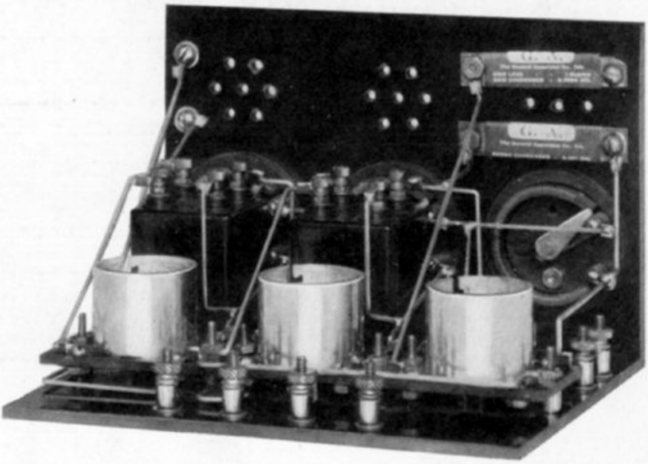
1—Mahogany cabinet 5x7 ½x6 ins.	1 lb.	$4.95
1—L.P.F. panel 5x7 ½x3/16 ins.	8 oz.	.99
1—G.A. filament rheostat	5 oz.	1.15
1—GA-STD-A1 vacuum tube socket	4 oz.	.80
8—GA-STD-A10 binding posts	5 oz.	.80
1—GA-STD-A4 grid leak condenser	1 oz.	.50
1—Pkg. of 20 small copper soldering lugs	2 oz.	.25
3—2 ft. lengths square tinned copper bus bar	6 oz.	.18
1—Pkg. of 10 1 in. F.H. 6-32 nickel plated screws	3 oz.	.14
1—Pkg. of 10 ¼ in. R.H. 6-32 nickel plated screws	3 oz.	.11
1—Pkg. of 10 ½ in. F.H. 6-32 nickel plated screws	3 oz.	.12
1—Pkg. of 10 6-32 nickled nuts	2 oz.	.08
1—Pkg. of 10 7/16 in. brass washers	3 oz.	.07
1—Pkg. of 10 ½ in. No. 6 F.H. nickel plated wood screws	3 oz.	.12
1—1 ft. length ¼ in. phosphor bronze ribbon	3 oz.	.05
1—1 ft. length 3/16 in. round brass rod	8 oz.	.12
1—GA-STD-A8, 50 division dial and knob for 3/16 in. shaft	9 oz.	1.25
1—Brass collar and set screw, 3/16 in. hole	3 oz.	.15
2—Coil mounting pillars	3 oz.	.16
1—Length GA-Lite tubing, 3 in. diameter	5 oz.	.32
1—¼ lb. spool No. 21 enameled wire	6 oz.	.37
COMPLETE SET OF PARTS AS LISTED ABOVE	6 lbs.	12.06
The compact receiver completely constructed, ready to use, Type GA-STD-A34	6 lbs.	22.50

AUXILIARY SUPPLIES

Moorhead A-P Electron relay (detector tube)	8 oz.	5.00
Moorhead A-P Amplifier tube	8 oz.	6.50
GA-STD-A11 plate battery, 22 ½ volts	2 lbs.	1.75
GA-STD-A12 plate battery, 45 volts with 22 ½ volt tap	4 lbs.	3.20
Witherbee, 6 volt, 40 ampere-hour storage battery, new type, charged and ready to use	14 lbs.	12.00
Deveau Gold Seal 2,200 ohm phones	1½ lbs.	8.00

STANDARDIZED PARTS FOR THE THREE-STAGE AMPLIFIER, TYPE GA-STD-A27

1—L.P.F. panel 5x7 ½x3/16 ins.	8 oz.	.99
1—L.P.F. panel 6x7 ½x3/16 ins.	10 oz.	1.18
3—G.A. filament rheostats	15 oz.	3.45
3—GA-STD-A1 vacuum tube sockets	12 oz.	2.40
1—GA-STD-A25 R.F. amplifying transformers for first stage from detector	6 oz.	5.00
1—GA-STD-A30 R.F. amplifying transformer for second stage from detector	6 oz.	5.00
1—GA-STD-A31 R.F. amplifying transformer for third stage from detector	6 oz.	5.00
7—GA-STD-A10 binding posts	4 oz.	.70
2—Pkgs. of 20 small copper soldering lugs	2 oz.	.50
1—1 ft. length ⅜ in. angle brass	3 oz.	.20
4—2 ft. lengths square tinned copper bus bar	8 oz.	.24
1—Pkg. of 10 ½ in. F.H. 6-32 nickel plated screws	3 oz.	.12
1—Pkg. of 10 ¾ in. F.H. 6-32 nickel plated screws	3 oz.	.13
1—Pkg. of 10 6-32 nickel plated nuts	2 oz.	.08
1—Pkg. of 10 8-32 F.H. nickel plated screws for battery binding posts	3 oz.	.16
COMPLETE SET OF PARTS AS LISTED ABOVE	5 lbs.	23.89
The three stage amplifier complete, ready to use, Type GA-STD-A27	5 lbs.	39.60



G. A. Standardized

Laboratory Type Tube Control Units

THE finest parts and materials are combined in an inexpensive form, assembled with the most perfect workmanship in G. A. Laboratory Type detectors and radio frequency and audio frequency amplifiers. Polished L. P. F. is used for the front panel, base and tube sockets. New type rheostats, with their brass bearings for the shafts, control the filament current. Recent changes are incorporated in the audio frequency transformers, and the radio frequency transformers represent the very latest developments from the G. A. Laboratory.

On the single units, the front panels measure 2½ by 5 ins., and the bases 2½ by 6 ins. The detector and two-step audio and three-step radio frequency amplifier are, on front panels, 7½ by 5 ins., with bases measuring 7½ by 6 ins. Binding posts are furnished on the detector and two-step unit for connection to a tickler coil.

As for the prices, there is no comparison with other models which compare in either material as workmanship—a detector at $5.95, a detector and two-step at $28.90 cannot be equaled in any other types.

GA-STD-A5 detector control unit . . . . . . Postage 10c.	$ 5.95
GA-STD-A6 amplifier control unit . . . . . . Postage 20c.	$13.95
GA-STD-A26 radio frequency amplifier unit . Postage 20c.	$13.95
GA-STD-A23 detector and two-step audio amplifier Postage 35c.	$28.90
GA-STD-A27 three-step radio frequency amplifier Postage 35c.	$39.60

The General Apparatus Co., Inc.

88 PARK PLACE NEW YORK CITY

In the center of New York's radio district. Dealers coming to the City are invited to make the G. A. their headquarters. Every courtesy and convenience is at their disposal