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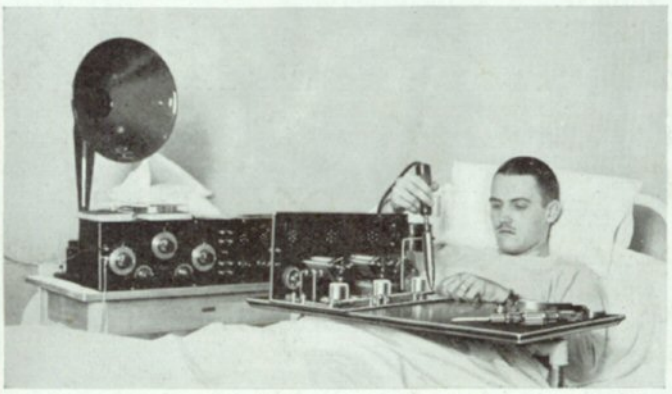

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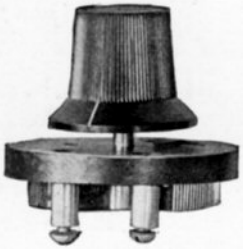

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A Two-Step Amplifier

An elaborate instrument which may be easily constructed at a comparativeiy small expense.

By M. B. Sleeper

The Amplifier in General

THE two stage audio frequency amplifier presented in this article was designed primarily for use with a 150 to 600 meter regenerative receiver described in the December 1921 issue of Radio and Model Engineering and in Design of Modern Radio Receiving Sets, No. 1. It is mounted upon a front panel measuring 7½ by 7½ inches which gives it the exact height of the short wave regenerative receiver. It is enclosed in a mahogany cabinet fitted with a hinge cover to permit convenient access to the interior for removing and replacing vacuum tubes. As seen from the accompanying figures, the instrument is exceptionally compact in the arrangement of its parts and the lay-out of both the front and base panel is perfectly symmetrical. The various parts are so arranged that the leads between them are very short which not only makes the wiring a simple operation, but gives the interior of the amplifier a neat appearance. The design of the transformers used as well as the new type of audion sockets add greatly to the beauty and scientific appearance of the instrument. It is safe to say that the mechanical and elecrtical design is of the finest possible. Jacks are provided for each stage of the amplifier as well as for the input, which makes it possible for the operator to use a detector alone by plugging the telephones in the jack at the extreme left. The two input binding posts are mounted at one end of the front panel while three terminals for the A and B batteries are found at the opposite end. One binding post serves for both the positive of the filament battery and the negative of the plate battery. The base panel upon which most of the parts are mounted is securely fastened to the front panel by two brass angle brackets so that the instrument may be removed from the cabinet without disturbing the connections in any way. It was for the purpose of providing this convenience that the battery terminals were not located at the rear of the cabinet.

Although the amplifier appears to be a rather elaborate instrument it is really a very simple piece of apparatus to build unless the construction of the cabinet is attempted. The case is made of ⅜ inch mahogany with all corners carefully mortised and glued. In order to prevent warping it is necessary to make the cover in three pieces, a main section with the grain running from left to right with two strips across each end. For the same purpose vertical strips one inch in width form the front edge of the sides of the cabinet. It is this construction that makes the building of the box so difficult and for that reason it is recommended that the experimenter purchase the cabinet already made unless he has adequate shop facilities and at least a fair knowledge of cabinet making.

Fig. 1. An elaborate receiving outfit which includes the amplifier described in this article

The Panel and Base

With the question of the cabinet settled, the laying out and drilling of the front panel and base are next in order. Both are of 3/16 inch L. P. F., the former measuring 7½ by 7½ inches, and the latter 5 by 5 inches. The panels may be purchased in these sizes at a cost no greater than the price charged for material from which they may be cut, and the builder will gain by obtaining panels with perfectly straight edges and square corners. This eliminates a phase of the work which really amounts to more than it would seem. In Fig. 4 a scale drawing of the two panels is shown with all of the holes located and their sizes given by numbers appearing beside them. For the smaller holes the numbers represent the size of drill to be used, while for the larger ones the diameter in inches is given. Concentric circles indicate that the holes are to be countersunk to accommodate F. H. machine screws. Locate the holes on the panels by measurements made upon the drawings which must be doubled, since the cut is exactly half size. The position of the holes should be determined by the intersection of scriber lines on the reverse side of the panels. At these points a centerpunch should be used so that the drill may be started in the exact place the holes are to be located.

Fig. 2. Front view of the amplifier

Assembling and Wiring

The two panels are held together by brass brackets which are 1 inch lengths of 3/8 inch angle brass, drilled with a No. 27 hole on each side. The distance between the two holes is 3/8 inch. These pieces may be purchased already cut to size, drilled and nickeled, at a price which does not exceed that of a one foot length of the stock. The brackets are held to the panels by 5/8 inch 6-32 F. H. machine screws and nuts. The angle made by the two should be tested before any of the parts are assembled so that anything other than a right angle can be easily corrected.

Five nickel plated binding posts are next put in their proper places on the front panel with a copper lug at the rear of each. Copper soldering lugs are placed under the terminals of two rheostats which are next added. They are held to the front panel by 5/8 inch F. H. 6-32 screws and nuts. Single closed circuit telephones jacks are used at the left and center while an open circuit jack is used in the output circuit of the last

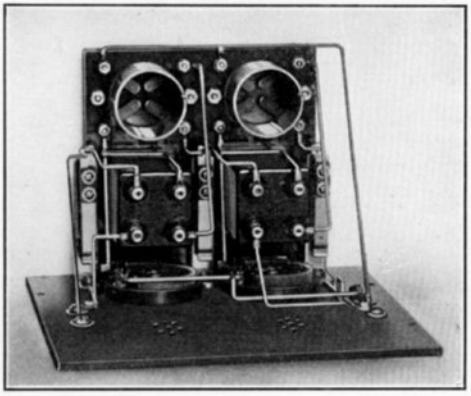

Fig. 3. Top view which should assist in wiring

tube. Two vacuum tube sockets are next placed at the rear of the base panel where they are secured by ¾ inch F. H. 6-32 screws and nuts. They should be so arranged that both filament terminals are toward the left hand end of the instrument. Before the transformers are mounted the A battery circuit should be wired. The lower battery terminal is connected to the blades of the two rheostats, while the ends of the resistances go to the nearest filament terminals of their respective sockets. The rear filament posts are connected together and to the center terminal on the front panel. The frames of the second and third jacks are wired together and to the positive plate battery binding posts to complete the wiring which would be interfered with by the presence of the amplifying transformers. They can now be mounted to the base in such a way that both primary terminals are at the left. This completes the assembly, leaving nothing but the wiring which should be carried out in accordance with the diagram given in Fig. 5. Considerable help in this work may be gained by reference to Figs. 3 and 6. It will be noted that while single circuit jacks are used between the detector and first stage amplifier, and between the first nd second stages of amplification, the primaries of the transformers are removed from the circuit when not in use. In most instruments heretofore designed, this was accomplished through the use of a more expensive double circuit jack which made the wiring more complicated than that used in this amplifier.

Notes on Operation

Almost any make of amplifier tube may be employed as there is clearance enough to provide for Western Electric Amplifier or others of large diameter. A six volt storage bat-

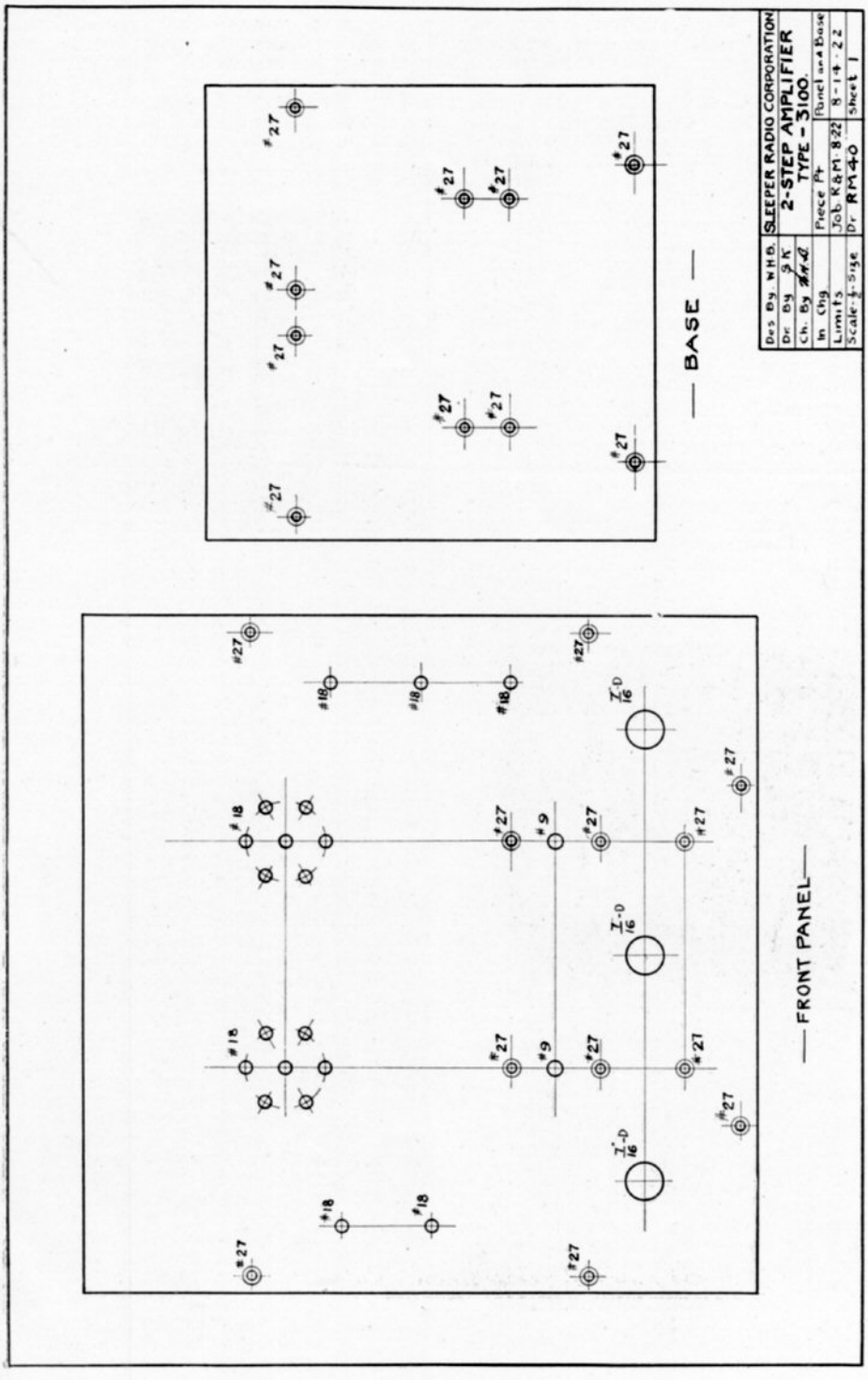

Fig. 4. One-half scale drawing of front and base panels

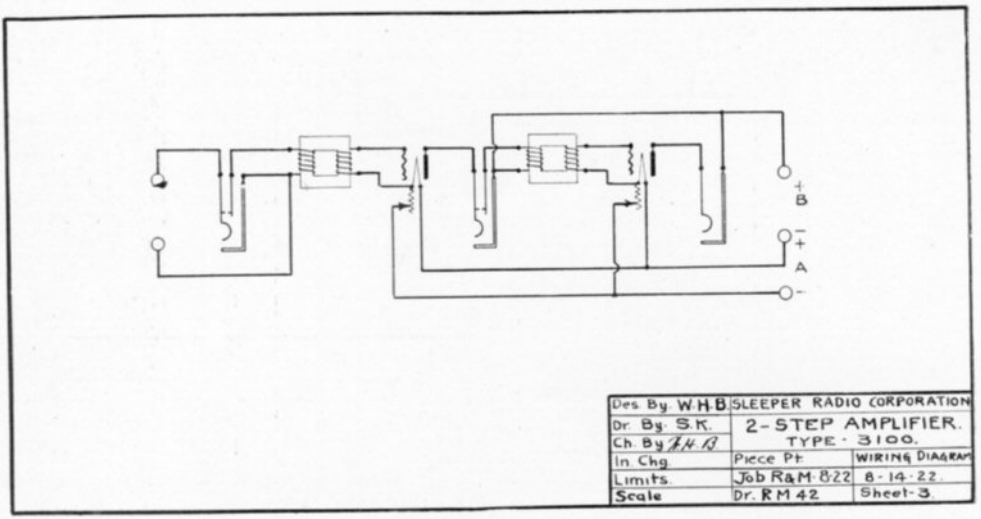

Fig. 5. Wiring diagram of the amplifier.

tery is used to light the filaments, while a potential of forty-five to one hundred volts may be used for the plates. The input termiuals are connected to the telephone binding posts of the detector with which the instrument is to be used. It will work equally well with a crystal or audion detector, making the amplifier an ideal instrument to be used for obtaining stronger signals from the Aeriola Jr., Aeriola Sr., and other well known receiving apparatus. It is particularly well adapted for use with the 150 to 600 meter regenerative receiver, or the single circuit compact receiver, both of which have previously been described. Fig. 1 shows the appearance of the combination of these instruments. Either head telephones or a loud speaker may be used.

It will be found that the instrument will give a surprisingly high degree of amplification and that howls which are often present in such a piece of apparatus will be entirely absent.

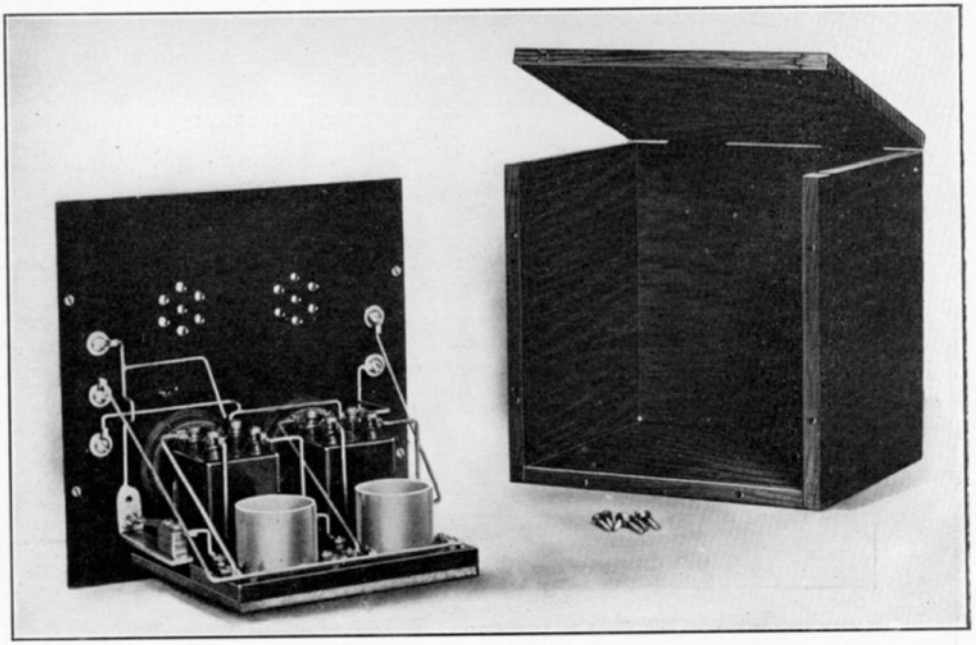

Fig. 6. The amplifier with the case removed

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EDITORIAL

London, England

YOU may be surprised to see that this editorial was written far from the home offices of R. & M. but when you stop to think about it, you will probably agree with me that in the United States we can't originate all the ideas, and if in England, where experimental radio is rapidly forging ahead, they know some things we don't, information should be made available to the readers of R & M.

Practically all I knew of radio in England I learned from the Wireless World. Therefore I hunted up Mr. Pocock, the editor, first thing. From him I learned that radio, as we know it now, is just on the threshold of developing into national popularity. Since every receiving station is licensed it is easy to keep track of the number, now approximately twenty thousand with four hundred and fifty transmitters. Two or three of the commercial companies seem determined to monopolize phone broadcasting, though none is willing to pay the expenses. Moreover, they fear foreign competition on equipment.

From Mr. Pocock, then, and others to whom he introduced me, I learned that very shortly, the government will increase the receiving station license fee from $2.25 to $4.50, one-half of which will be paid to the broadcasting stations for maintenance. Moreover, during the next two years, licenses will be granted only to stations using apparatus of British manufacture. The number of broadcasting stations will be limited to eight. Whatever changes the future may bring, this is the status on August twelfth.

The Daily Mail, a progressive London paper, has established a 1500 watt transmitter at the Hague, two hundred and seventy miles from London, but their first two Thursday night concerts have been heard by a limited number of the best equipped receivers.

There are two large factories, Marconi's at Chelmsford and Burndept's at Blackheath. The officials at both plants were most courteous and anything but secretive concerning equipment in process of development or manufacture. At Marconi's, perhaps four hundred people were employed and at Burndept's one hundred and fifty. Both factories do practically all their own work, making and finishing their own screw machine parts, wooden boxes, stampings, and engraving.

An outstanding feature of English equipment is the beautiful finish given to all the parts. Hard rubber is employed almost exclusively for insulation, though it seems to be of a grade much stronger mechanically than is supplied in the United States. Practically no moulded parts, such as dials or fittings, are employed. Everything is turned, milled, or engraved by hand. All brass parts are highly polished and lacquered, giving a much richer appearance than nickel. At the Marconi plant, however, the works manager said that they are now changing to a dull nickel similar to the finish of German silver. Lacquering is a slow process, all hand work.

Practically all apparatus is of the horizontal type, though some is made with panels sloping back. Since the tubes are on the outside access to the interior is only obtained by unfastening the panel. In general, I was as disappointed with inside as I was pleased with the outside. Some sets are most crudely wired, giving the appearance of a handful of bent hairpins daubed with shellac and paraffin. The better sets use empire tubing of different colors to indicate the circuits, or bare wire, soft drawn, equal to eighteen B. & S. gauge. If they used heavier wire and lugs instead of soldering to the ends of screws, the wiring would be much improved.

Nevertheless, we have much to learn about nicety of workmanship. Their circuits are just like ours, the single circuit regenerative receiver being the most popular type. English tubes seem much superior to ours in that they are more uniform and more sensitive. They are harder, too, requiring at least forty volts.

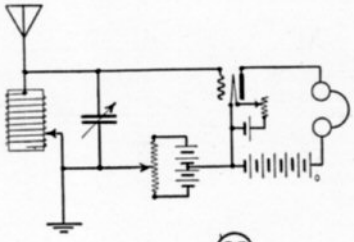
Other ideas I have picked up here and there, you will find later on in R & M. I am sorry that I cannot take the space to describe more things in detail, or to tell you about the courtesies extended to me by engineers of the Marconi Co. Mr. Burnhan and Phillips of the Burndept Co. or Mr. Pocock and Brewster of the Wireless World.

M. B. SLEEPER,
Editor.

101 Receiving Circuits

Fifth Installment

By W. H. Bullock



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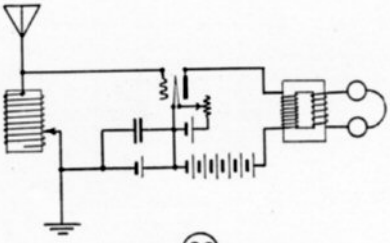
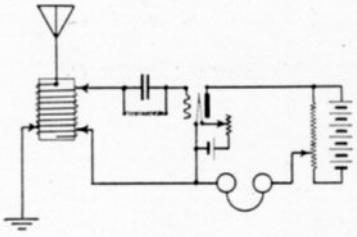


(39)

38. By the use of a C or grid circuit battery, a grid condenser may be dispensed with. A dry cell is shunted by a potentiometer which may be adjusted to place a desired charge upon the grid. In this way it is possible to operate the tube at a point in its characteristic curve where the positive alternations of incoming energy will affect the plate current to a greater degree than the negative alternations. This reproduces the received oscillations in the plate circuit in a distorted form which may be heard in the telephones at a tone corresponding to the audible rates of variation in the high frequency energy. Systems of this kind are more frequently found in Europe than America.

39. In some cases a single cell is all that is required for operating a vacuum tube detector at a place on its characteristic curve where a grid condenser is unnecessary. In this diagram a C battery of fixed value is shown, shunted by a condenser to by-pass radio frequency current.

In the plate circuit we have the primary of a step-down transformer in the position usually occupied by the telephones. The telephones are connected to the output of the transformer so that no direct current passes thru their windings. In England where this arrangement is extensively used, it is claimed that the life of the permanent magnets of the telephones is greatly prolonged. Other advantages are that low resistance telephones may be employed, and less distortion of telephone signals is produced owing to the absence of the continual pull on the diaphragm which is caused by the plate current in the system with which we are more familiar.



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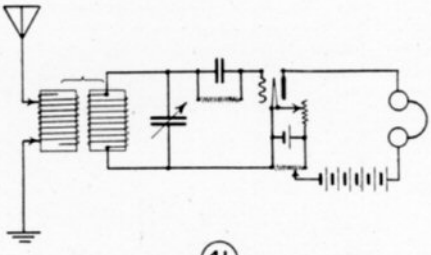
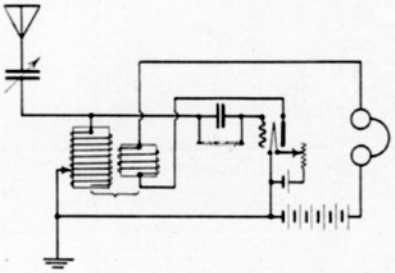


(41)

40. The purpose of this diagram is to show how a B battery potentiometer is wired in the plate circuit of a vacuum tube detector. Since most detector tubes are of the so-called "soft" variety, their adjustment is so critical that a potentiometer is often a convenient accessory. It is a non-inductive resistance of about 5,000 ohms, fitted with terminals at each end and a single variable contact which runs between them. The resistance, which is usually of carbon, is wired across the B battery, while connections for the detector circuit are made to the contact and one end of the unit. Although some current is consumed by the resistance, it is of such a small nature that the life of the plate battery will not be appreciably shortened through its use. However, a switch may be advantageously placed in the circuit to disconnect the battery from the resistance while the set is not in operation.

41. Another method of closely varying the plate potential of a vacuum tube is to employ a potentiometer in shunt with the A battery as shown in

this circuit. A commercial type instrument for this purpose consists of 200 ohms of resistance wire wound upon a circular form which is fitted with a variable contact. One end of the resistance is connected to each side of the filament battery while the sliding contact leads to the plate circuit. By this means, variations within limits of nearly six volts may be made in the plate potential. This is found sufficient for practically all tubes and has the advantage of drawing no additional current from the plate battery as the system shown in circuit 40 does.



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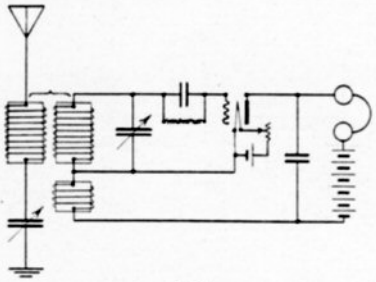
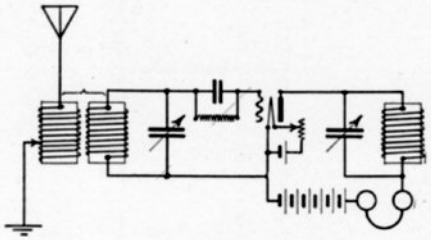


43

42. This diagram illustrates a simple regenerative circuit. A variable condenser and variable inductance are wired in series with the antenna and ground for tuning, while the coil is included in the grid circuit of a three element vacuum tube. A second inductance called a feed back, plate, or tickler coil is connected in the plate circuit of the detector and placed in inductive relation to the tuning coil. The coupling is variable to permit adjustment for various degrees of feed back. With zero coupling the circuit will function exactly the same as circuit 37, but as the coupling is increased in the proper direction the strength of the received signals will be gradually raised. This increase ceases at a point where the regeneration becomes so great that the tube produces oscillations of its own. Beyond this point, the set is in a condition which makes it an ideal continuous wave receiver if its local oscillations are adjusted to a frequency which differs from the incoming signal by some audible frequency. This produces audible signals from the inaudible undamped wave by what is known as beat reception. Where this result is obtained through the use of a separate oscillation generator the system is termed heterodyne, while autodyne is the name given to the method illustrated by this circuit.

43. The feed-back coil of a regenerative receiver may be wired next to the plate of the vacuum tube as shown in circuit 42 or adjacent to the filament as illustrated in this diagram. Where no amplifier is employed, each system is equally good as far as results are concerned but the latter has the advantage of being simpler to wire. When an amplifier is to be used and supplied from a common plate battery, the system shown in circuit 42 should be followed.

The condenser connected across the telephones and B battery is an addition which can be advantageously made to any regenerative circuit. It assists regeneration and oscillation by providing a radio frequency by-pass across the portions of the plate circuit which offer impedance to the high frequency currents. The capacity of this condenser is not limited to any definite value, but 0.001 mfds. is most frequently used.



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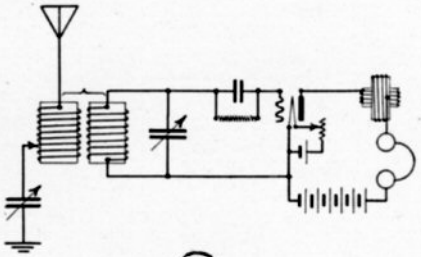
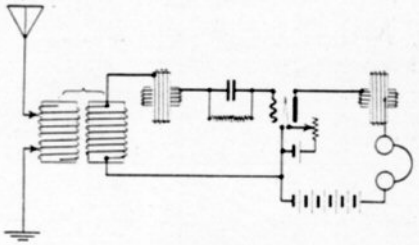


45

44. A receiving circuit may be made to regenerate or oscillate by employing a variable oscillatory circuit in the plate circuit of the detector tube. In this case the coil does not have to be electro-magnetically coupled to the input side of the tube. The arrangement is that shown in this diagram. In operation, the tuner is adjusted until maximum signal strength is obtained after which the tuned plate circuit is varied for regenerative amplification. It can be obtained in

various degrees or a condition of oscillation set up by the adjustment of the variable condenser used in the plate circuit. This adjustment will depend upon the wave length to which the input circuit of the tube is tuned. A system of this kind depends upon the internal capacity of the vacuum tube for its operation, as this provides electrostatic coupling between the plate and grid circuits.



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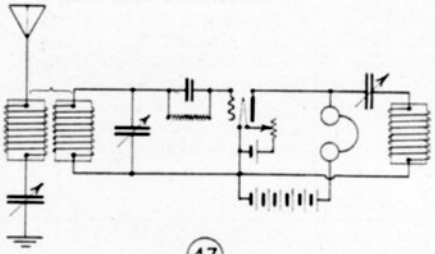
46. It will be noted that the chief difference between this circuit and the preceding one, is that a variometer instead of a variable condenser is used for tuning the grid circuit. It is a popular circuit among the advanced amateurs. The variocoupler stator is connected to the antenna and ground while the rotor is placed in series with the grid variometer and grid circuit of the detector. This comprises the tuning system, the plate variometer being used only to obtain regeneration.

There is no appreciable difference between the results obtained through the use of a variometer or variable condenser for tuning the grid circuit as is shown by the fact that we have authorities who claim advantages for each.

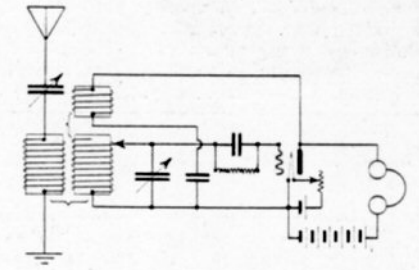
47. In this circuit regenerative amplification is

45. This circuit is very similar to the one shown in diagram 44 and its theory of operation is exactly the same. In this case, a variometer rather than an oscillatory circuit is placed in the plate system of the detector for tuning it. This method of obtaining regeneration is employed by some of the best manufacturers of radio receiving equipment and has come to be the one most widely used for short wave receivers.



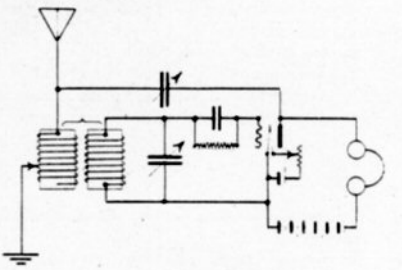
47

obtained by the use of parallel plate circuits. A low frequency circuit from the plate to the filament includes the telephones and B battery, while a radio frequency path is provided by the variable condenser and inductance. The capacity between the plate and filament of the tube, the variable condenser, and the inductance, make up an oscillatory circuit which is tuned to a frequency determined by the grid circuit for regeneration or oscillation. In a system of this sort, a condenser shunted across the telephones and plate battery, as shown in circuit No. 43, will not assist regeneration. The plate coil need not be inductively coupled to the grid circuit, but should contain a greater value of inductance than the secondary of the coupler for the reason that it has two capacities in series across its terminals.



48

48. This is another circuit where separate paths for high and low frequency currents are provided from the plate to the filament of the detector tube. The audio frequency circuit is the same as shown in the preceding diagram, but the radio frequency circuit consists of fixed values of capacity and inductance. Regeneration is obtained by varying the electromagnetic coupling between the plate and grid inductances. With the exception that this diagram shows a two circuit tuner, its operation is almost identical with that of No. 42.



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49. A simple method of obtaining regeneration is illustrated in this circuit. The system is essentially a loose coupler and audion detector with a variable condenser connected from the plate to the antenna. Tuning is accomplished in the usual way, while the coupling condenser is adjusted for the desired degree of feed-back. This method is more frequently employed for long wave reception than for short wave work.

A Laboratory Oscillator

By W. H. Bullock

Uses of an Oscillator

UNDER this heading an instrument is described which differs somewhat from those previously presented in that it is intended primarily for laboratory experiments rather than to be used directly for the transmission or the reception of radio signals. The laboratory oscillator will radiate energy at both audio and radio frequencies so for that reason it may be adapted to a large variety of uses by the ingenious experimenter. The device should be welcomed by radio manufacturers who have been in the habit of testing their outfits by signals from a buzzer, since it emits a signal which is identical in character to the radio telegraph or telephone signal encountered in actual reception. Beyond the fact that the oscillator presents this advantage it is also a great improvement over the buzzer testing system for the reason that no sound may be heard outside of the telephones. While its use permits a large variety of experiments to be conducted with apparatus requiring an oscillator, more experimenting of an interesting nature may be carried on with the instrument itself. It incorporates both low and high frequency feed-back causing the vacuum tube to oscillate at two frequencies simultaneously. In addition to laboratory uses the oscillator may be employed as a radio telegraph transmitter for distances up to ten miles. Owing to its small size it is very convenient for the local exchange of messages between amateurs who have heretofore been using only a receiving set.

Fig. 1. Front view of the self modulated oscillator

A General Description

Referring to the front view shown in Fig. 1 and the rear view in Fig. 2 the oscillator is seen to be small in size with the parts compactly arranged. The front panel measures 5 x 7½ inches and is held to a base of the same width but 6 inches deep. The material used for both is of 3/16 inch L. P. F. and the two pieces are held together by brass angle brackets. A variocoupler, filament rheostat, and variable condenser are mounted on the rear of the front panel while the base supports the vacuum tube socket and a standard odio frequency amplifying transformer. The rear of the base carries four binding posts for the filament and plate batteries. The two binding posts on the front panel are for connection to an antenna system where the oscillator is to be used as a transmitter. The knob and dial shown at the left of the front view controls the variable condenser for varying the wave length of the signal which is radiated.

The Vario-Coupler

In constructing the laboratory oscillator, the variocoupler is first considered. This consists of two separate windings, one upon an L. P. F. tube 3½ ins. in diameter by 2½ ins. in length, and the other upon a 3 in. mahogany rotor ball. The rotor is held in the stator by a ¼ in. brass shaft in two sections, while the stator is held to the panel through the use of nickel plated brass coil support pillars. An end of the rotor winding is soldered to each shaft section and connection is taken off by phosphor bronze springs bearing against the two ends of the shaft.

First drill the L. P. F. tube with two ¼ in. holes for the shaft. These must be diametrically opposite each other and midway between the ends of the tube. No. 27 holes are placed 13/16 ins. from each for fastening the shaft contact springs to the tube. In a line ninety degrees from the shaft holes two more No. 27 holes are drilled ¼ ins. in from the ends of the tube to take care of ¼ in. screws which hold terminal lugs for the stator winding. Provision is made for the coil support pillars by two No. 27 holes ¼ in. in from each end of the tube and in a line drawn through the front shaft hole parallel to the axis of the stator. The form is now ready for winding and this operation should be carried out using No. 24 S. S. C. wire. Starting 7/16 in. in from one end wind on 23 turns, leave a 3/8 in. space to clear the shaft and then wind on 23 more. Each end of the winding is soldered to one of two lugs held to the tube for this purpose. This arrangement may be more readily understood by carefully studying Fig. 2.

Before winding the rotor, four small holes must be drilled in the form to take the ends of the wire. One is drilled at each of the outside flanges and the other two are placed on each side of the center rib in such a way that they come out on the same side of the web at the inside of the ball. The winding of No. 24 S. S. C. wire is started at one of the outside holes and put on until the center rib is reached. At this point the wire is cut and the end inserted in the hole provided for it. Now change the form end for end and wind the second half in exactly the same manner. The two center ends must be twisted together and soldered, while the outside ends are left free until the coupler is assembled.

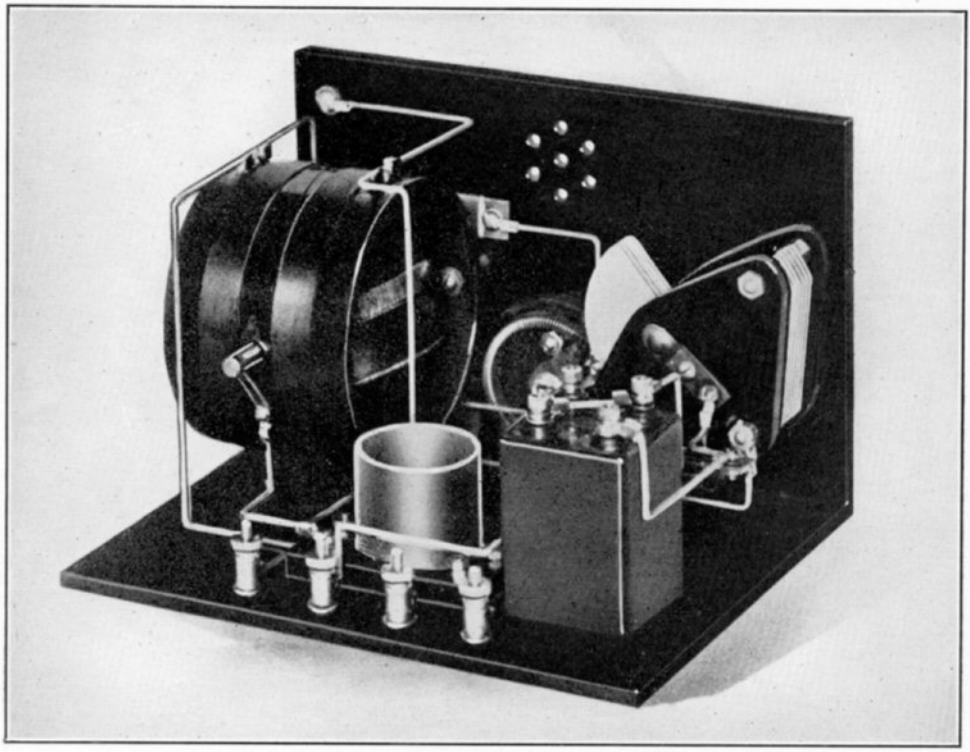


Fig. 2. Rear view showing details of assembly and wiring

The shaft contact springs are made of 13/16 in. lengths of ¼ by 1/64 in. phosphor bronze ribbon, with a No. 27 hole placed 5/16 in. from one end. Before the rotor is mounted these contact springs must be fastened to the L. P. F. tube by ¼ in. R. H. 6-32 screws and nuts. A copper lug is placed under the head of each to provide soldering terminals for the rotor winding. The two coil support pillars measure 5/8 in. in length by 5/16 in. in diameter and carry a 6-32 threaded hole through

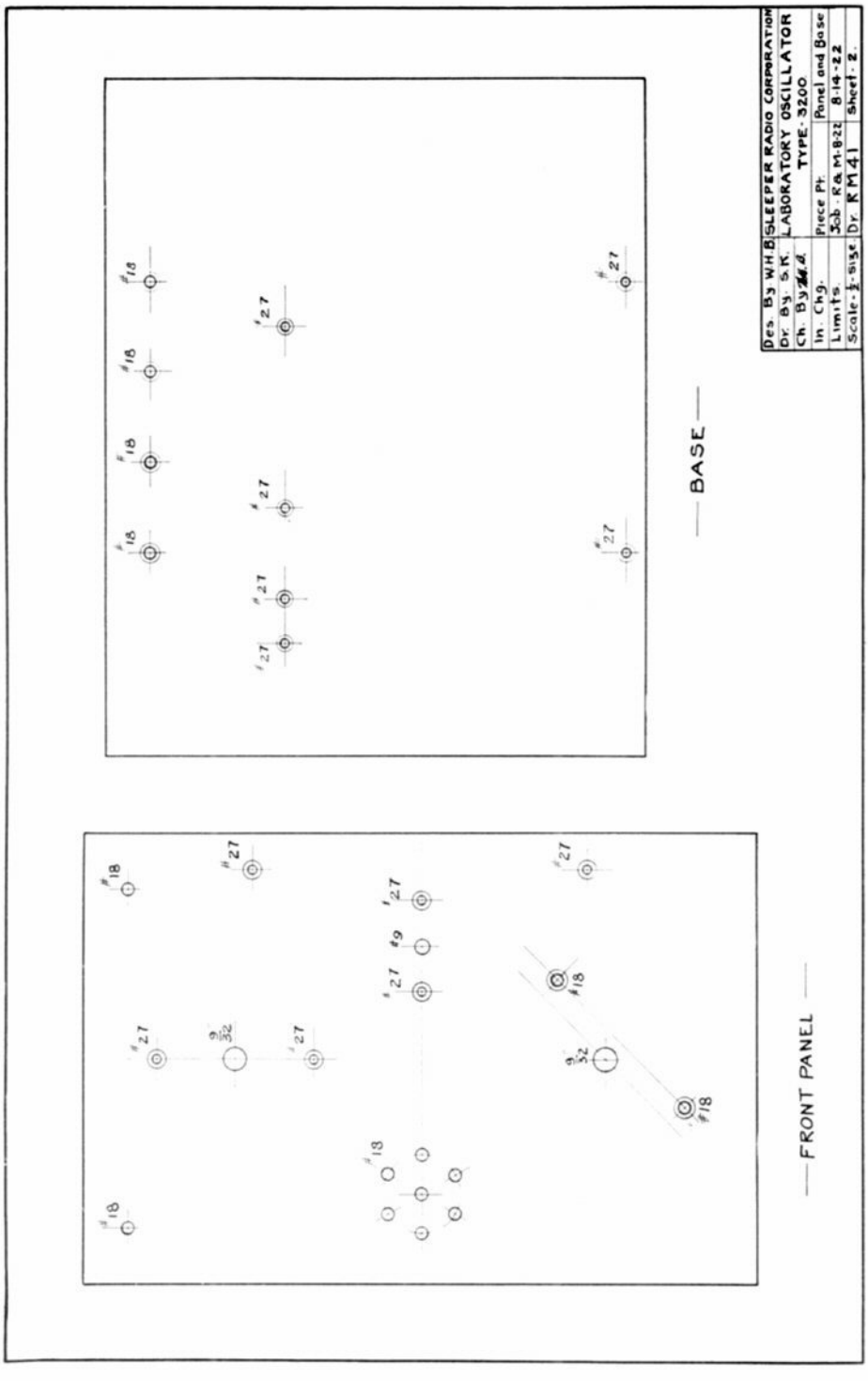


Fig. 3. One-half scale drawing of the front and base panels

their entire length. They are next assembled on the tube, being held in placed by ¼ in. R. H. machine screws. From a standard 12 in. length of ¼ in. round brass rod cut two pieces, one 3⅛ ins. long and the other 2 ins. These form the front and rear shaft sections of the variocoupler. Insert the longer one in the shaft hole between the coil support pillars just far enough to permit two fibre washers to be placed over its end. Now put the rotor in place and force the shaft into it. The rear shaft section is assembled in a similar manner with two more fibre spacing washers keeping the rotor from the back part of the tube. The free ends of the rotor winding may now be soldered to the shaft sections and the variocoupler put aside until the panels have been prepared for assembling the units.

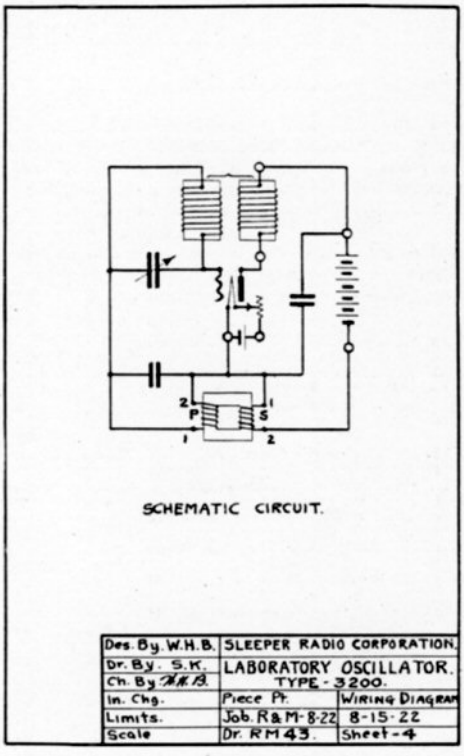


Fig. 4. The wiring diagram

Work on the Panels

As previously stated the front panel measures 5 by 7½ 3/16 ins. and the base 6 by 7½ by 3/16 ins. Both may be obtained accurately cut to size as these are standard L. P. F. panels. The holes should be laid out and drilled in accordance with the scale drawing given in Fig. 3, This is exactly one-half size so all dimensions must be multiplied by two before transferring to the work. Locate the holes on the reverse side of the panel by intersecting lines made with a sharp scriber and centerpunch each intersection before attempting to drill. This is quite necessary if accurate work is to be done. During the drilling operation the panels should be laid upon a perfectly flat surface and considerable attention given to the pressure of the drill as the hole is about to come through. Carelessness in this respect often results in the breaking out of the panel around the hole. The numbers appearing beside each hole in the drawing indicate the size of drill to be used, while concentric circles mean that the holes so marked should be countersunk. Countersinking the base panel should be done on the reverse side from that shown in the drawing which displays the upper side of the panel.

Assembling the Parts

The front and base panels are held together by two angle brackets which are 1 in. lengths of ⅜ in. angle brass drilled with a No. 27 hole in each side of the dihedral angle. The holes are ⅜ in. apart. These angle brackets may now be obtained cut to size, drilled and nickel plated at the same price charged for a one foot length of the stock, so if the builder does not have ⅜ in. angle brass at hand there is no reason for him to make the brackets. They are held to the panels by ⅜ in. F. H. 6-32 machine screws and nuts. The angle made by the two panels should be tested before the assembly is continued and the error corrected if the two do not meet at right angles.

Now mount the variocoupler at the right hand end of the front panel by two ⅜ in. F. H. screws which are turned into the coil support pillars. The filament rheostat is held in place by two ⅝ in. F. H. 6-32 screws and nuts. The 11 plate variable condenser is fitted with F. H. 8-32 machine screws which hold it to the front panel, and the addition of two nickel plated binding posts complete the parts on the vertical panel. At the center of the base panel a vacuum tube socket is held in place by ¾ in. 6-32 screws and nuts and beside it an audio frequency transformer is mounted with the F. H. screws provided for the purpose. Binding posts fitted with F. H. screws are now placed at the rear of the base with soldering lugs clamped between the lower section of the terminals and the L. P. F.

Wiring the Instrument

Before the wiring is commenced the rear view of the outfit shown in Fig. 2 and wiring diagram given in Fig. 4 should be carefully studied. Supply each terminal with a copper soldering lug and use square tinned copper bus bar for all of the wiring. It is a surprisingly simple matter to make a neat job of the wiring if the conductor is kept perfectly straight except for sharp right angle bends. When soldering to the lugs use as little flux as possible for otherwise the surplus will run about the joint when the heat is applied, presenting a dirty appearance which is difficult to move. Through the eyelets of the 0.001 mfd. fixed condensers pass ¼ in. R. H. 6-32 screws to hold copper soldering lug terminals. It has been found that this method of assembly is quite important as it has frequently happened that soldering paste ran into the condenser, forming a high resistance short when connections were soldered directly to the eyelet.

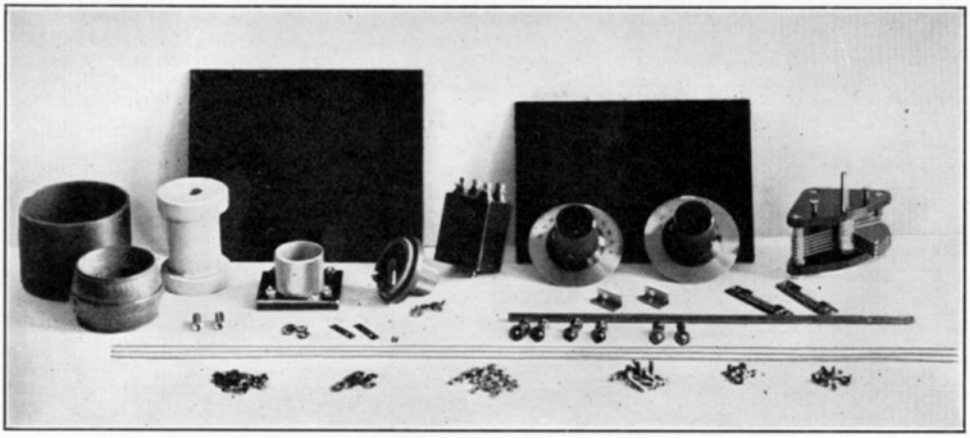


Fig. 5. Complete set of parts required for the construction of the oscillator

Notes on Operation

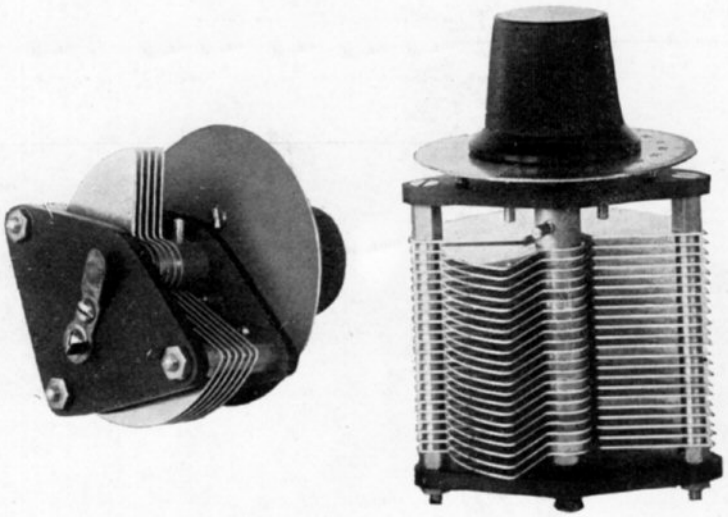
With the wiring completed the oscillator is now ready for use. Connect a six volt storage battery to the two left hand terminals on the base, with the positive toward the center. A 45 volt B battery is connected between the second pair of binding posts with the positive to the right. The terminals on the front panel need not be connected unless the oscillator is to be used as a radio telegraph transmitter, when the upper one is wired to an antenna and the lower one to the ground. In a case like this, a variable condenser should be placed in series with the ground lead to provide a means for tuning the antenna circuit. Until one becomes familiar with the oscillator it is advisable to connect a pair of telephones in series with the plate battery to determine how the instrument is functioning.

STANDARDIZED PARTS FOR TWO STAGE AMPLIFIER. TYPE 3100

Catalogue No.	Quan.	Description	Ship'g Weight	Price
A-23	1	Mahogany Cabinet, 7½ by 7½ by 6½ ins.	2 lbs.	$4.50
148	1	L. P. F. Panel, 7½ by 7½ by 3/16 ins.	1 lb.	1.50
34	1	L. P. F. Panel, 5 by 5 by 3/16 ins.	6 oz.	.66
A- 1	2	Vacuum Tube Sockets	8 oz.	1.60
A-14	2	Audio Freq. Transformers	12 oz.	10.00
A-22	2	Filament Rheostats	10 oz.	2.00
A-36	2	Single Closed Circuit Jacks	6 oz.	1.70
A-35	1	Open Circuit Jack	3 oz.	.70
A-10	5	Nickel Plated Binding Posts	3 oz.	.50
22	2	⅜ in. Angle Brackets, 1 in. long	2 oz.	.20
71	1	Pkg. of 10 ⅜ in. 6-32 F. H. Screws	3 oz.	.12
77	1	Pkg. of 10 ¾ in. 6-32 F. H. Screws	3 oz.	.13
49	1	Pkg. of 10-6-32 Nickeled Nuts	2 oz.	.08
149	1	Pkg. of 10 ¾ in. No. 6 F. H. Wood Screws	3 oz.	.13
58	1	Pkg. of 20 Small Copper Soldering Lugs	2 oz.	.25
47	3	Lengths Square Tinned Copper Bus Bar	6 oz.	.15
	1	Complete Construction Set with all difficult work done, panels drilled and engraved, etc., in display carton 7 lbs		28.00

STANDARDIZED PARTS FOR LABORATORY OSCILLATOR TYPE 3200.

Catalogue No.	Quan.	Description	Ship'g Weight	Price
31	1	L. P. F. Panel, 5 by 7½ by 3/16 ins.	8 oz.	$0.99
32	1	L. P. F. Panel, 6 by 7½ by 3/16 ins.	10 oz.	1.18
A- 1	1	Vacuum Tube Socket	4 oz.	.80
A-15	1	Variable Condenser, 0.00025 mfds. capacity	10 oz.	3.25
A-22	1	Filament Rheostat	5 oz.	1.00
A-14	1	Audio Frequency Amplifying Transformer	6 oz.	5.00
40	1	¼ lb. spool No. 24 S. S. C. Wire	8 oz.	.75
23	1	Mahogany Rotor Ball	5 oz.	.70
174	1	L. P. F. Tube, 3½ ins. diameter, 2½ ins. long	4 oz.	.75
A- 3	2	Phone Condensers	2 oz.	.70
A-20	1	100 Division Dial and Knob, ¼ in. hole	9 oz.	1.25
A-21	1	50 Division Dial and Knob, ¼ in. hole	9 oz.	1.25
A-85	4	Binding Posts with F. H. Screws	3 oz.	.40
A-10	2	Binding Posts with R. H. Screws	2 oz.	.20
22	2	⅜ in. Angle Brackets, 1 in. long	2 oz.	.20
47	3	Lengths square tinned copper Bus Bar	3 oz.	.15
20	1	1 ft. length, ¼ in. round Brass Rod	7 oz.	.15
104	2	Shaft Contact Springs	1 oz.	.08
88	4	Fibre Spacing Washers	1 oz.	.16
14	2	Coil Support Pillars	3 oz.	.16
61	1	Pkg. of 10 ¼ in. 6-32 R. H. Machine Screws, nickeled	3 oz.	.11
71	1	Pkg. of 10 ⅜ in. 6-32 F. H. Machine Screws, Nickeled	3 oz.	.12
74	1	Pkg. of 10 ⅝ in. 6-32 F. H. Machine Screws, nickeled	3 oz.	.13
49	1	Pkg. of 10-6-32 nickeled Nuts	2 oz.	.08
53	10	No. 6 Washers, nickeled	1 oz.	.04
58	1	Pkg. of 20 small Copper Soldering Lugs	2 oz.	.25
	1	Complete set of Parts for the laboratory oscillator	7 lbs.	19.35
		NOTE:—This is not furnished as a semi-finished Construction set but the variocoupler may be purchased completely assembled ready to mount Cot. No. A-100	1 lb.	3.45



Sleeper Variable Condenser

THE old saying that you can't make a silk purse out of a sow's ear holds equally true in radio. You can't make good radio apparatus out of cheap, imitation, just-as-good parts. The real experimenter makes no compromise in quality.

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Part No. A-16 Sleeper Variable Condenser, 23 Plate, 0.0005 mfd. capacity, without dial..... $3.50
Postage 15c.

Part No. A-17 Sleeper Variable Condenser, 43 Plate, 0.001 mfd. capacity, without dial..... $4.30
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