Oct. 17, 1944. B. T. SETCHELL 2,360,726

ANTENNA SYSTEM

Filed June 25, 1942

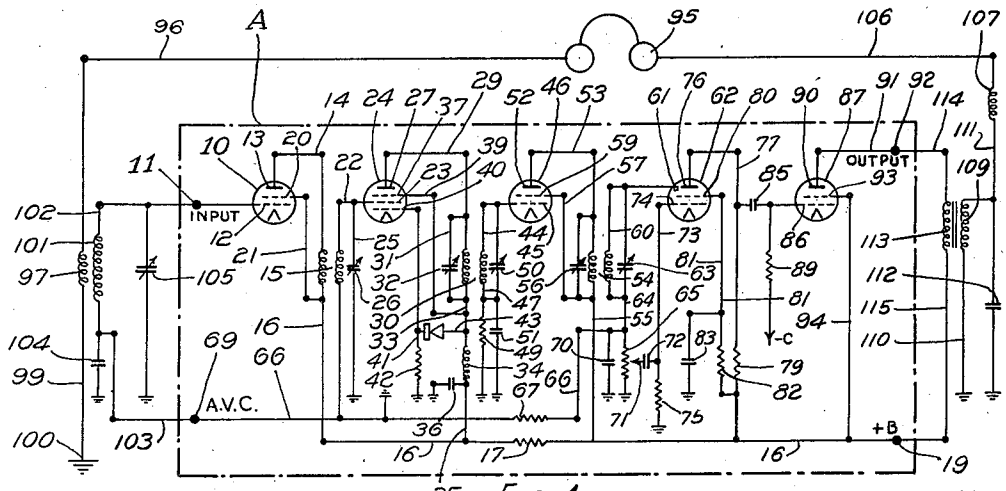


FIG. 1

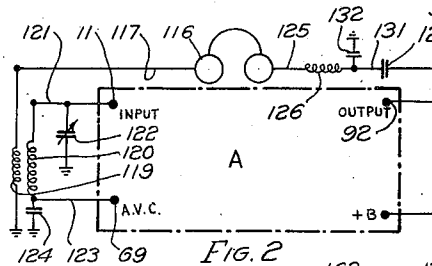


FIG. 2

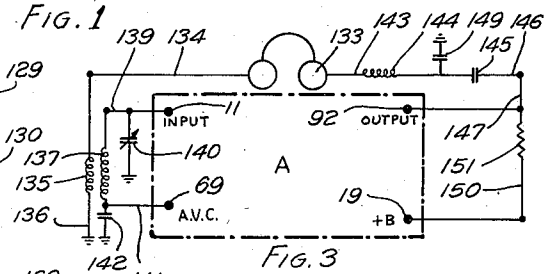


FIG. 3

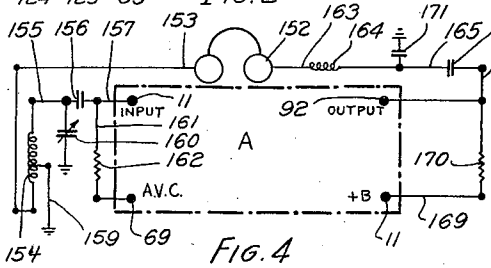


FIG. 4

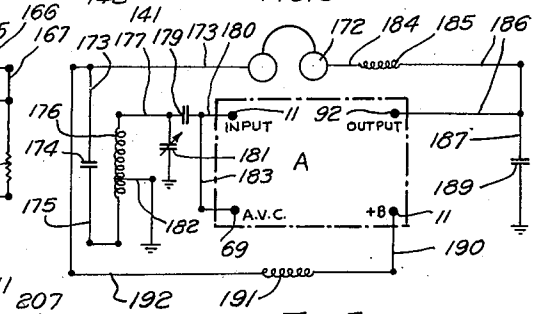


FIG. 5

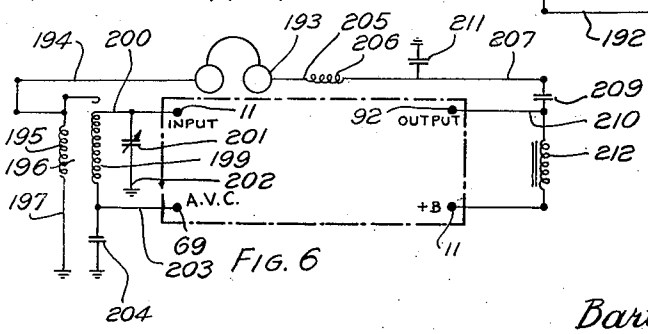


FIG. 6

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ANTENNA SYSTEM

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3 Claims. (Cl. 250—20)

My invention relates to an improvement in antenna systems, wherein it is desired to employ the ear-phones or speaker unit of a radio receiving set as the antenna for the set.

In the use of portable receiving sets, difficulty has been experienced in providing an antenna which will be effective for its prescribed purpose, and yet which will not interfere with the simple portability of the set. For example when radio receiving sets are carried continuously it has been common practice to either carry an upwardly projecting metal rod or "buggy-whip" type antenna, or to carry loops, coils, or lengths of antenna wire to be attached in any desired position on the carrier's person.

It is the object of the present invention to provide a radio receiving set which requires no antenna other than the ear phones or speaker unit used in conjunction with the set. As a result no extra antenna wire is required and the problem of attaching a suitable antenna to the carrier is obviated.

I have found that if the ear-phones or speaker unit are separated from the output plate terminal by a suitable inductance capable of allowing audio frequencies to pass through and capable of stopping or choking radio frequencies, the ear-phones or speaker unit may be used as the radio aerial. As a result no extra antenna is required.

A feature of the present invention lies in the provision of an antenna coil which is designed for best reception after the type of phones or speaker and the length of phone cord used has been selected. This antenna coil is connected to the phones or speaker which in turn are connected in any suitable manner with the output from the last tube of the radio receiver through the radio frequency choke coil. The B-battery connection to the plate of the output tube is so arranged that this battery will not short circuit through the phones. This result may be attained either by connecting the positive B-battery terminal to the plate through the primary of an output transformer, or by placing a condenser in the circuit between the positive B-battery terminal and the ground.

A further feature of the present invention lies in the provision of a capacitor between the output plate and the radio frequency choke which will permit the by-passing of radio frequencies without substantially affecting audio frequencies.

These and other objects and novel features of my invention will be more clearly and fully set forth in the following specification and claims.

In the drawing forming a part of my specification:

Figure 1 illustrates diagrammatically a receiving set circuit embodying the use of ear-phones or a speaker unit as the aerial.

Figure 2 is a diagrammatic view showing a slightly different output circuit from that illustrated in Figure 1.

Figure 3 is a diagrammatic view showing another modified form of construction showing the use of a resistor in the output circuit in place of an output coil.

Figure 4 is a diagrammatic view showing a modified form of input circuit.

Figure 5 is a view similar to the remaining figure, showing another modified form of input and output circuit.

Figure 6 is a diagrammatic view showing still another arrangement of input circuit.

The circuit illustrated in Figure 1 of the drawing comprises a radio receiving set which is outlined in general by a broken line and indicated by the letter A. This radio receiving set is illustrated only to show one type of circuit which may be used to embody the principles of the present invention and it should be understood that any other type of receiving set could be substituted for that illustrated.

The radio receiving set A is illustrated as comprising an input tube 10 which may be of the 1T4 type, and the input terminal 11 is connected to the grid 12 of the tube 10 by a suitable conductor. The plate 13 of the tube 10 is connected by conductor 14 to one coil of the radio frequency transformer 15, the other terminal of which coil is connected by conductor 16 through the resistor 17 to the positive terminal 19 of the B-battery supply. The grid 20 of the tube 10 is connected by conductor 21 to the B-battery positive terminal 19 through the conductor 16 and resistor 17. The tube filament is connected to a suitable source of current supply.

The other coil of the radio frequency transformer 15 is connected by conductor 22 to the grid 23 of the mixer tube 24 which may be of the 1R5 type. A conductor 25 connected to the conductor 22 passes through a variable condenser 26 to the ground. The plate 27 of the tube 24 is connected by conductor 29 to one terminal of one coil of the intermediate frequency transformer 30. A conductor 31 including a variable condenser 32 extends between the ends of this coil of the transformer 30. The other coil terminal is connected by conductor 33 through the inductance coil 34 and conductor 35 to the con-

ductor 16 leading through the resistor 17 of the positive terminal of the B-battery. The conductor 16 is connected to the ground through a condenser 36.

The grid 37 of the tube 24 is connected by conductor 39 to the conductor 33. The grid 40 is connected by conductor 41 through the resistor 42 to the ground. A detector crystal 43 is connected between the conductor 33 and the conductor 40.

The other coil of the transformer 30 is connected by conductor 44 to the grid 45 of the intermediate frequency tube 46 which may be of the 1T4 type. The other terminal of this coil is connected by conductor 47 through a resistor 49 to the ground. A variable condenser 50 is connected between the conductors 44 and 47. The conductor 47 is connected to the ground through a condenser 51.

The plate 52 of the tube 46 is connected by conductor 53 to one terminal of one intermediate frequency coil of the intermediate frequency transformer 54. The other terminal of this coil is connected by conductor 55 to the positive B-battery terminal 19. A variable condenser 56 is connected between the ends of this intermediate frequency coil and the conductor 55 is connected by a conductor 57 to the grid 59 of the tube 46.

The other coil of the transformer 54 is connected by conductor 60 to the diode 61 of the tube 62 which may be of the 1S5 type. A variable condenser 63 is connected between the terminals of this coil. The other coil terminal is connected by a conductor 64 through the variable resistor 65 to the ground. The conductor 64 is also connected by conductor 66 through the resistor 67 to the automatic volume control terminal 69. The conductors 64 and 66 are separated from the ground by the condenser 70.

The variable arm 71 of the variable resistor 65 is connected through the condenser 72 and the conductor 73 to the grid 74 of the tube 62. The conductor 73 is connected through the resistor 75 to the ground. The plate 76 is connected by conductor 77 through the resistor 79 to the positive B-battery terminal 19. The grid 80 of the tube 62 is connected by conductor 81 through the resistor 82 to the positive B-battery terminal 19. The conductor 81 is separated from the ground by a condenser 83.

The conductor 77 is connected through the condenser 85 to the grid 86 of the output tube 87 which may be of the 1S4 type. The grid 86 is connected through the resistor 89 to the negative terminal of the C-battery supply. The plate 90 of the tube 87 is connected by the conductor 91 to the output terminal 92. The grid 93 is connected by the conductor 94 to the positive B-battery terminal 19. The filaments of all of the various tubes are connected to a suitable current supply.

As was previously pointed out the radio receiving unit outlined by the broken line in Figure 1 of the drawing is merely illustrative of one form of receiver which may be used, and any suitable receiver may be substituted therefor, as will be clearly understood. The input terminal 11 to the grid of the input tube, the output terminal 92 connected to the plate of the output tube 87, and the positive B-battery terminal 19 are the only essential connections to the various input and output circuits which will be later described. The automatic volume control terminal 69 is ordinarily desirable, but may in some instances not be required.

The ear-phones 95 are connected by conductor 96 through the antenna coil 97 to the conductor 99 leading to the ground connection 100 to the coil 101 of the input transformer, which is connected by conductor 102 to the input terminal 11 and is connected by conductor 103 to the A. V. C. terminal 69. The conductor 103 is connected through the condenser 104 to the ground. The conductor 102 is connected through the variable condenser 105 to the ground.

The other phone cord or conductor 106 is connected to the radio frequency choke 107, the other terminal of which is connected to the coil 109 of the output transformer, and the other terminal of which is connected by conductor 110 to the ground. The conductor 111 between the choke coil 107 and the transformer coil 109 is connected through the conductor 112 to the ground.

The other coil 113 of the output transformer has one terminal thereof connected by conductor 114 to the output terminal 92 and has its other terminal connected by conductor 115 to the positive B-battery terminal 19.

It will be noticed that one terminal of the phones 95 passes through the antenna coil 97 to the ground, while the other terminal thereof is connected through the radio frequency choke 107 to the secondary of the output transformer, the opposite terminal of which is grounded. The antenna coil 97 is designed for best reception after the length of the phone cords and the type of phones to be used has been selected. The radio frequency choke is any type of inductance coil of such inductance as to allow audio frequencies to pass through and to choke or stop radio frequency passage. The radio frequencies are bypassed to ground through the capacitor 112 which will not substantially affect audio frequencies.

I have found that with this arrangement the head phones 95 may be effectively used as an aerial and that no other antenna is required. Thus the necessity for a separate aerial is entirely obviated.

In Figure 2 of the drawing I show a slightly different form of output circuit from that above described. In this form of construction the head phones 116 are provided with one cord or conductor 117 leading through the antenna coil 119 to the ground. The other coil 120 of the antenna transformer has one terminal connected by conductor 121 to the input terminal 11 leading to the grid of the input tube. A variable condenser 122 is connected between the conductor 121 and the ground. The other terminal of the coil 120 is connected by conductor 123 to the A. V. C. terminal 69. This conductor 123 is connected through the condenser 124 to the ground. Thus the input circuit is similar to that shown in Figure 1.

The other phone cord 125 is connected through the radio frequency choke coil 126 which is isolated by the condenser 127 from the conductor 129 leading through the inductance coil 130 to the positive B-battery terminal 19. The conductor 131 between the choke coil 126 and the condenser 127 is connected to ground through the condenser 132.

In this construction it will be noted that one phone cord extends through the antenna coil which is properly designed for the particular head phones and length of phone cord used. The other phone cord 125 is connected through the choke coil 126 to the output terminal of the receiving set passing through the condenser 127. The condenser 127 prevents the short circuiting

of the B-battery through the head phones, while the choke coil 126 prevents radio frequencies from entering the phones. The condenser or capacitor 132 permits the by-passing of radio frequencies to the ground and is so designed as to not materially affect audio frequencies.

Another form of output connection is illustrated in Figure 3 of the drawing. In this arrangement the phones or sound reproducer 133 are connected by a conductor 134 to one terminal of an antenna coil 135, the other terminal of which is grounded as illustrated at 136. The cooperating coil of the antenna transformer, designated by the numeral 37, has one terminal thereof connected by the conductor 139 to the input terminal 11 of the radio receiver A. This conductor 139 is connected through the variable condenser 140 to the ground, the other terminal of the coil 135 is connected by the conductor 141 to the automatic volume control terminal 69. This conductor 141 includes a connection through the condenser 142 to the ground. Thus the input circuit is identical to that illustrated in Figures 1 and 2. The other phone lead 143 is connected through a radio frequency choke coil 144 to the conductor 145. A condenser 146 is provided between the conductor 145 and the conductor 147, which leads to the output terminal 92 of the radio receiving set. A capacitor 149 is connected between the conductor 145 and the ground. The conductor 150 leads through a resistor 151 to the positive B-battery terminal 19.

It will be noted in this circuit that the B-battery voltage is supplied through the resistor to the output plate and this circuit is segregated from the ear-phone circuit by means of the condenser 146. The radio frequency choke coil 144 is so designed as to allow audio frequencies to pass therethrough while choking or stopping radio frequencies. The capacitor 149 permits the by-passing of the radio frequencies to the ground.

In Figure 4 of the drawing I disclose another modified form of circuit which could be used. In this circuit the phones or sound reproducer 152 and one phone cord or lead 153 which is connected to one end of an inductance coil 154, the other of which is connected to a conductor 155 leading to the input terminal 11. The condenser 156 is provided between the conductor 155 and the conductor 157 secured to the input terminal.

Connected intermediate the ends of the coil 154, I provide a lead 159 which is grounded. The conductor 155 is also connected through a variable condenser 160 to the ground.

When automatic volume control is used in the radio receiving set the conductor 157 is connected by a conductor 161 through the resistor 162 to the A. V. C. terminal 69. In case no automatic volume control is provided the condenser 156, the conductor 161, and the resistor 162 are eliminated, the conductor 155 extending directly to the input terminal 11.

The other phone cord or lead 163 is connected to the radio frequency choke coil 164, the opposite terminal of which is connected by conductor 165 to one side of the condenser 166. The other side of the condenser is connected by conductor 167 to the output terminal 92 of the radio receiving set A. The conductor 167 is also connected by a conductor 169 through a resistor 170 to the positive terminal of the B-battery.

It will be noted that in this circuit the B-battery is connected through the resistor 170 to the output plate of the radio receiving set and this positive battery terminal is segregated from the ground by means of the condenser 166. The radio frequency choke coil 164 is so constructed as to pass audio frequencies and to choke or stop radio frequencies. A capacitor 171 is connected between the conductor 165 and the ground capable of by-passing radio frequencies without materially affecting the audio frequencies. Thus the radio frequencies are prevented from entering the phones or speaker 152.

In order to illustrate a variety of specific connections which may be made, Figure 5 illustrates another modified arrangement. In this circuit the phones or speaker unit 172 have one phone cord or lead 173 which is connected to one side of the condenser 174, the other side of which is connected by conductor 175 to one end of the antenna coil 176. The other terminal of the coil 176 is connected by conductor 177 to one side of the condenser 179, the other terminal of which is connected by conductor 180 to the input terminal 11 of the radio receiving set. The conductor 177 is connected to the variable condenser 181, the opposite terminal of which is grounded. A tap 182 to an intermediate point on the coil 176 is also grounded. The conductor 180 is connected by the conductor 183 to the A. V. C. terminal 69.

In the event that the radio receiving set does not include automatic volume control it is obvious that the condenser 179 and the conductor 183 may be eliminated, the conductor 177 being directly connected to the input terminal 11.

The other phone cord or lead 184 from the phones 172 is connected to one end of the radio frequency choke coil 185, the other terminal of which is connected by the conductor 186 to the output terminal 92 of the radio receiving set. A conductor 187 connected to the conductor 186 is electrically connected to one terminal of the condenser 189, the other terminal of which is grounded.

In order to supply the B-battery current to the output plate 92 I provide a conductor 190 connected to one terminal of the radio frequency choke coil 191, the other terminal of which is connected by conductor 192 to the conductor 173 leading to the first described phone terminal. Thus in this construction the phones are maintained at B-battery potential and the short circuiting of the B-battery is prevented by the condensers 174 and 189.

In this circuit it will be noted that the output plate is connected to the phones through the radio frequency choke coil 185 which will allow the passage of audio frequency, but which will choke or stop radio frequencies. Because of the fact that the phones are at B-battery potential, it is also essential to have a second radio frequency choke coil 191 between the positive terminal 11 of the B-battery and the phones or second reproducer 172. The capacitor or condenser 189 allows the by-passing of radio frequencies to the ground.

In Figure 6 of the drawing still another modified form of circuit is illustrated. In this arrangement the phones 193 have one lead 194 therefrom connected to one terminal of the antenna coil 195 forming a part of the input transformer 196. The other terminal of the antenna coil 195 is connected by conductor 197 to the ground.

One terminal of the other coil 199 of the input transformer 196 is connected by conductor 200 to the input terminal 11 of the radio receiving set A. The conductor 200 is also connected to the variable condenser 201, the terminal of which is grounded at 202.

The other terminal of the coil 199 is connected by conductor 203 to the A. V. C. terminal 69 of the radio receiving set. A condenser 204 is connected to the conductor 203 and the other terminal of this condenser is grounded.

The other lead 205 from the phones 193 is connected to the radio frequency choke coil 206, and the other terminal of this coil 206 is connected by conductor 207 to one terminal of the condenser 209. The opposite condenser terminal is connected by conductor 210 to the output terminal 92 of the radio receiving set A. A capacitor 211 is connected to the conductor 207 and the other terminal of the capacitor is grounded. The conductor 210 is connected through a suitable inductance 212 to the B-battery terminal 11 of the radio receiving set. In this arrangement the output plate is supplied from the positive B battery terminal through the inductance coil 212, and this circuit is segregated from the second reproducer circuit by the condenser 209. The radio frequency choke coil 206 allows the passage of audio frequency waves, while choking or stopping the radio frequency waves. These radio frequencies may be by-passed to the ground by the capacitor 211.

In the foregoing description numerous illustrative circuits have been described for the purpose of illustrating that a considerable number of specific hook-ups could be used, while still employing the second reproducer and the leads thereto as an antenna. It should be noted that all of the circuits have certain features in common. In the first place the ear-phones are connected in such a way that the radio frequency waves are prevented from passing into the ear-phones or other sound reproducer. In the second place a capacitor is provided for by-passing radio frequency waves. In the third place the B-battery circuit to the plate of the output tube is so arranged that the short circuiting of the B-battery through the second reproducer circuit is prevented.

For the purpose of simplicity I have used the term sound reproducer in the claims in place of calling for ear-phones or a speaker unit. While ear-phones are ordinarily used with the portable sets for which this arrangement is particularly adapted, speakers are sometimes used, and such speaker could be used in place of the ear-phones described. For this reason the term sound reproducer is meant to designate any sound reproducer element, such as ear-phones or a speaker unit.

In accordance with the patent statutes, I have described the principles of construction and operation of my antenna systems, and while I have endeavored to set forth the best embodiment thereof, I desire to have it understood that these are only illustrative of a means of carrying out my invention, and that obvious changes may be made within the scope of the following claims without departing from the spirit of my invention.

I claim:

1. A radio receiving system comprising in combination, a receiver having a radio frequency input circuit including an antenna coil having coupled primary and secondary portions, detecting and amplifying tubes, and an audio frequency out-put circuit including an out-put transformer, ear phones, a radio frequency choke coil connected in series between one terminal of the ear phones and one terminal of the out-put transformer secondary, the other terminal of said secondary being grounded, a by-pass circuit connected to said one terminal of said out-put transformer secondary, including a capacitor of a size to by-pass radio frequencies and not to by-pass audio frequencies, and said choke coil being of proper size to separate the radio and audio frequencies and to prevent the radio frequencies from being grounded or by-passed to ground through the secondary of the out-put transformer or the capacitor, and means connecting the other terminal of said phones to one terminal of the antenna coil primary portion, the other terminal of the said primary portion being grounded, whereby radio frequency potentials impressed upon the named circuit elements and connections are applied to said receiver input circuit through said secondary portion.

2. In a radio receiving system having a radio frequency input side and an audio frequency out-put side, an antenna transformer having a primary winding arranged to transmit radio frequency signalling impulses to the input side, an out-put transformer connected to the audio frequency out-put side, ear phones having one terminal thereof connected in series through a radio frequency choke coil to one terminal of the out-put transformer secondary, the other terminal of this transformer secondary being grounded; a by-pass connected to said one terminal of said transformer secondary and ground and including a capacitor capable of by-passing radio frequencies and not by-passing audio frequencies, said choke coil constructed to stop radio frequencies from being grounded or by-passed to ground through the secondary of the out-put transformer or the capacitor; and means connecting the other terminal of said ear phones to one terminal of the primary winding of said antenna transformer, the other terminal of said primary winding being grounded, thus completing both radio frequency and audio frequency circuits.

3. In a radio receiving system having a radio frequency input side and an audio frequency out-put side, an antenna transformer having a primary winding arranged to transmit radio frequency signalling impulses to the input side, an out-put transformer connected to the audio frequency output side, sound reproducing means having one terminal thereof connected in series through a radio frequency choke coil to one terminal of the out-put transformer secondary, the other terminal of this transformer being grounded; a by-pass connected to said one terminal of said transformer secondary and ground and including a capacitor capable of by-passing radio frequencies and not by-passing audio frequencies, said choke coil constructed to stop radio frequencies from being grounded or by-passed to ground through the secondary of the out-put transformer or the capacitor; and means connecting the other terminal of said sound reproducing means to one terminal of the primary winding of said antenna transformer, the other terminal of said primary winding being grounded, thus completing both radio frequency and audio frequency circuits.

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