May 4, 1943. W. H. NEWBOLD 2,318,516

HIGH FREQUENCY ANTENNA SYSTEM

Filed Dec. 14, 1940 4 Sheets-Sheet 1

Fig. 1.

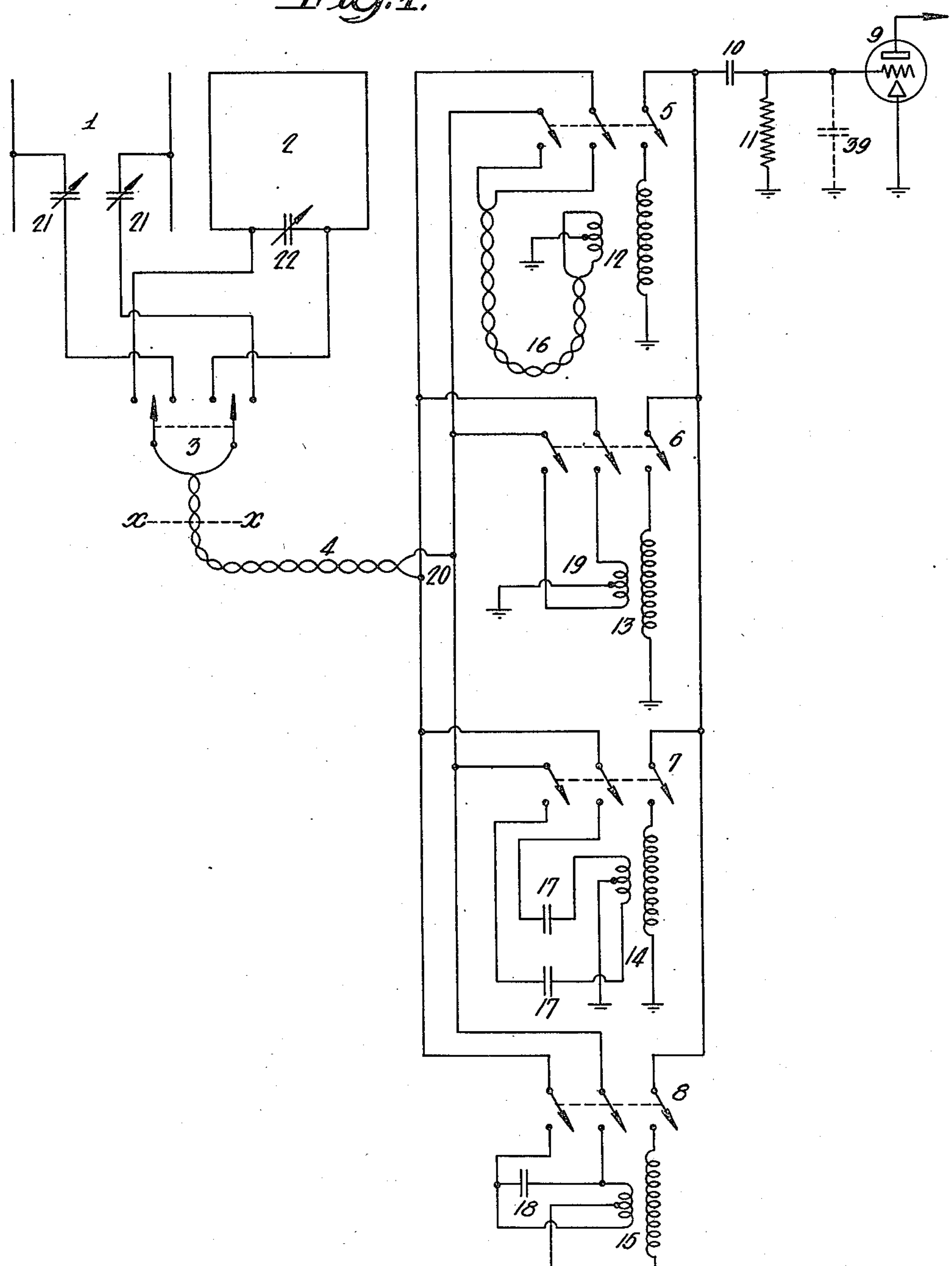

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Fig. 2.

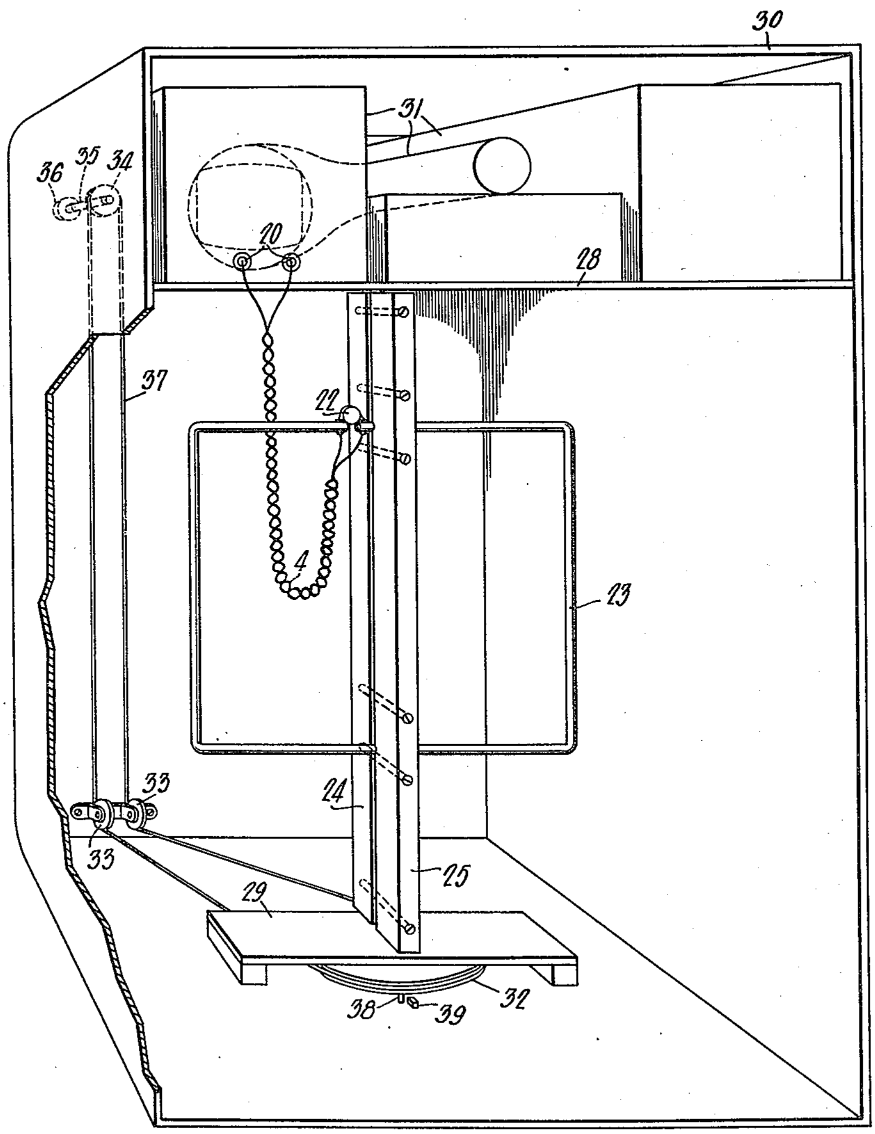

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Fig. 4.

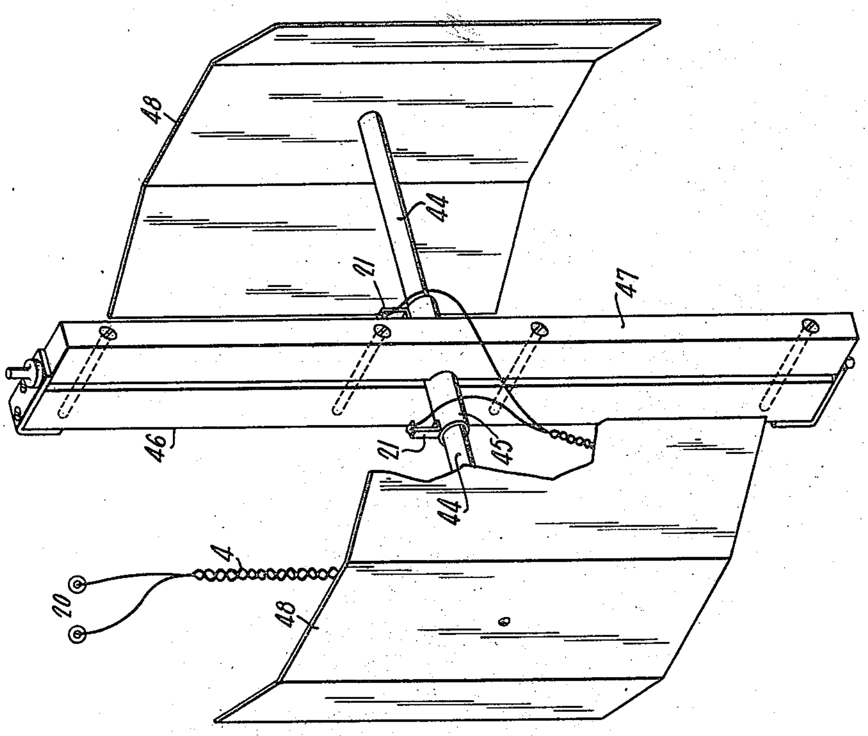
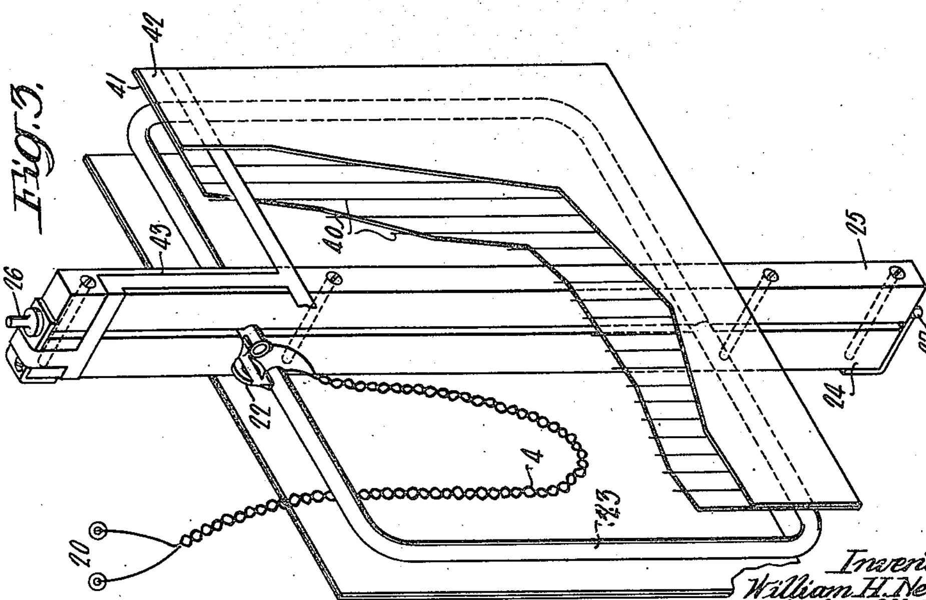


Fig. 3.



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HIGH FREQUENCY ANTENNA SYSTEM

Filed Dec. 14, 1940 4 Sheets-Sheet 4

Fig. 5.

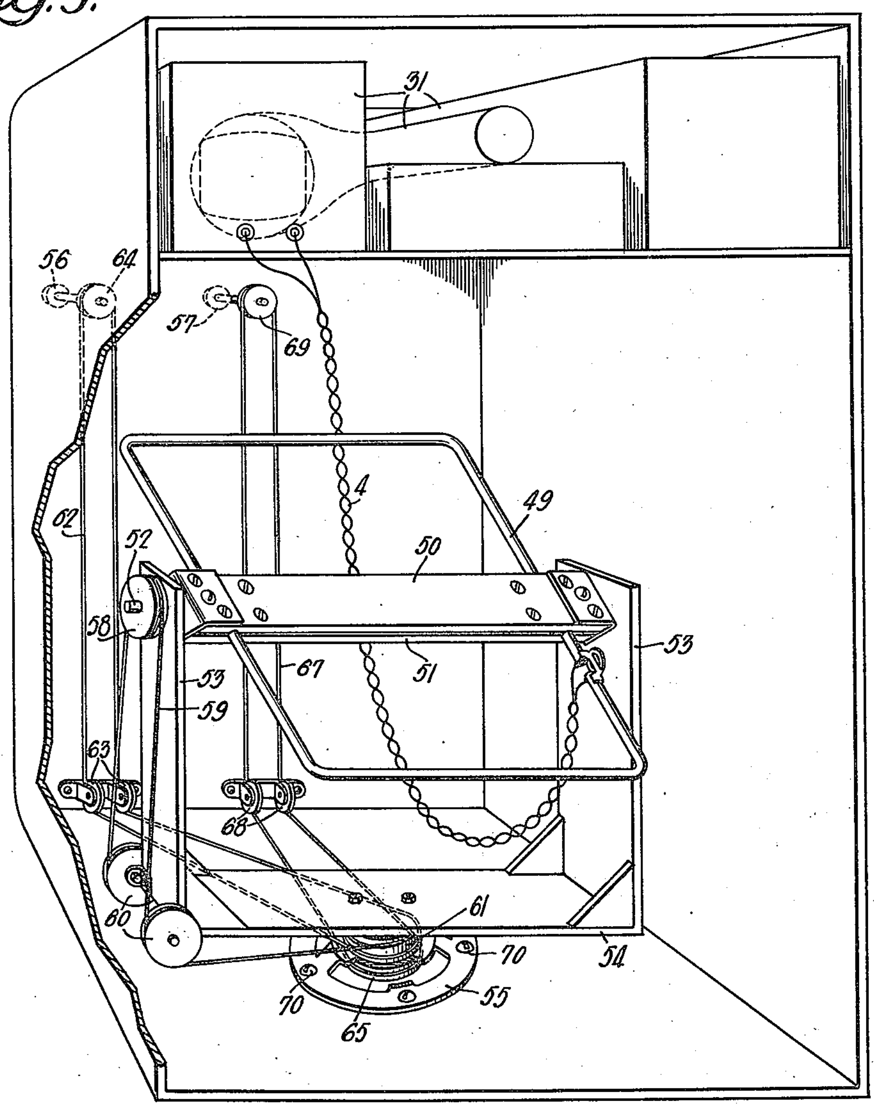


Fig. 7.

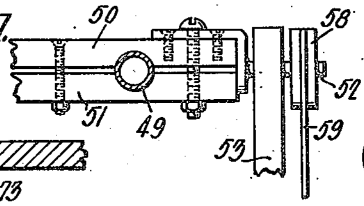


Fig. 8.

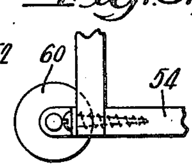
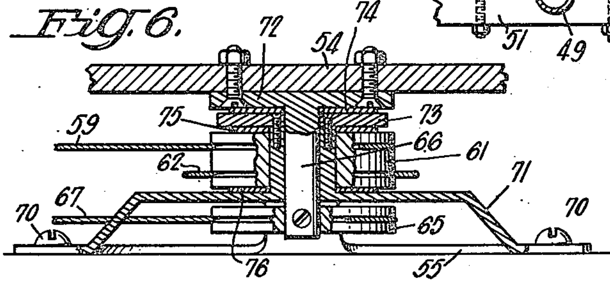


Fig. 6.



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2,318,516

UNITED STATES PATENT OFFICE

2,318,516

HIGH FREQUENCY ANTENNA SYSTEM

William H. Newbold, Langhorne, Pa., assignor to Philco Radio and Television Corporation, Philadelphia, Pa., a corporation of Delaware

Application December 14, 1940, Serial No. 370,213

19 Claims. (Cl. 250—20)

This invention relates to antenna or signal collecting systems, and more particularly to directive antenna systems for the reception of signals of high frequencies of the order for example of those presently employed in television transmission, and to antenna systems which are sufficiently small to be contained in the cabinet which houses the other apparatus customarily used in receiving such signals and rendering them sensibly perceptible.

It has been the general practice prior to this invention to use, in conjunction with television receivers, elaborate outdoor antenna systems connected to the receiving equipment through a transmission line of from twenty to thirty feet or even more in length. For example one form of such antenna consists of a half-wave dipole disposed upon the roof of or proximate to the dwelling house or other building in which the receiver is located and connected to the receiver by means of a length of twisted-pair transmission line. Such an antenna has numerous disadvantages, not the least of which are that its structure is obtrusive and unsightly to such an extent as to detract greatly from the appearance of the premises upon which it is located and also that the cost of erecting the structure is large by comparison with the cost of the receiving apparatus itself, ranging usually from fifty to one hundred dollars for a single installation.

Such antenna systems have the further disadvantage that, although they may be adjusted at the time of installation for most favorable reception of a single station, they cannot thereafter readily be readjusted in order to obtain optimum reception from another and differently located station. For the same reason advantage cannot be taken of the directional properties of such a system to minimize the effect of interfering sources such for example as diathermy machines and the like which have been found to have a particularly deleterious effect upon television transmissions.

Accordingly it is one object of the present invention to provide an efficient high frequency antenna system in which the antenna is of sufficiently small overall dimensions to permit it to be included within a cabinet such as is customarily used to house the receiving equipment in conjunction with which the antenna is to be used, thus avoiding the disadvantages of the large outdoor antennas heretofore used in respect of both unsightliness and high cost of installation.

Another object of the invention is to provide a directional receiving antenna system adapted to be employed for the reception of high frequency signals such as those used in television transmission, and disposed within the cabinet housing the receiving equipment so as to be readily controllable by the person using such equipment in order to obtain optimum reception of any one of a plurality of stations and in order to permit the elimination of the effect upon the receiver of interference from sources such as diathermy machines and the like.

Still another object of the invention is to provide a high frequency receiving antenna system adapted to be tunable to any one of a group of channels of substantially the same band-width and to be tuned in each case so that the band which the system is adapted to transmit is not appreciably changed in tuning from channel to channel and corresponds substantially to the width of the band of frequencies to be received in each channel.

Other objects and advantages will be pointed out in the course of the explanation of a specific embodiment of the invention and certain variations thereof. Although the scope of the invention will be understood to be subject only to the limitations imposed by the appended claims, the specific embodiment above mentioned, both as to its organization and mode of operation will best be understood by reference to the following description and the accompanying drawings in which:

Figure 1 is a schematic circuit diagram illustrating one embodiment of the invention and certain of its variations;

Fig. 2 is a rear view in perspective of the cabinet housing a television receiver and a directional loop antenna system in accordance with the invention;

Fig. 3 is a detailed perspective view showing the structure of a shielded loop antenna for use in a circuit in accordance with the invention;

Fig. 4 is a detailed perspective view showing the structure of a dipole antenna for use in a circuit in accordance with the invention;

Fig. 5 is a perspective view showing a loop antenna of the kind shown in Fig. 2 mounted in the cabinet housing a television receiver so as to be rotatable about horizontal as well as vertical axes, whereby the plane of the loop may be oriented for the optimum reception of signals in any direction;

Fig. 6 is a detailed cross sectional view showing the support, bearing and pulley structure used in the arrangement of Fig. 5;

Fig. 7 is a detailed view showing the bearing and pulley used to support the loop in the apparatus of Fig. 5; and

Fig. 8 is a detailed view showing the manner of attachment of the pulleys to the lower corner of the cradle in the apparatus of Fig. 5.

Referring now to Fig. 1 which shows a circuit diagram of an embodiment of the invention, 1 and 2 represent respectively a dipole and a loop, either of which may be used in the system according to the invention. The structural details of one form of each of these types of signal collector will be set forth more fully hereinafter. Suffice it for the present to say that either is sufficiently small in respect to its physical dimensions to be contained within the cabinet which houses other receiving equipment. In every case, therefore, the effective length of either the dipole or the loop will be less than one-half wave length of the highest frequency at which the system is adapted to operate. Practically, of course, it will be understood that either one and not both of these signal collectors will be used in a given receiver. Since, however, the antenna circuit arrangement may be the same in both cases except for constants, both have been shown in Fig. 1 and accordingly there is provided a double pole switch 3 by means of which either may be connected to the rest of the coupling system.

To the common terminals of the switch 3 one end of the twisted pair transmission line 4 is connected. It should be understood that other well known types of transmission line may be used, as for example coaxial or open wire lines which would introduce less loss. However the twisted pair line has proven entirely satisfactory in most embodiments. The other end of the line is connected to two terminals of each of a plurality of triple gang switches 5, 6, 7, and 8. The third terminal of each of the said switches may be connected to the grid of a space discharge tube 9 through a coupling condenser 10 and grid leak 11. The tube 9 represents any suitable means adapted to utilize the signal collected by the dipole 1 or the loop 2, depending upon which is used, and may for example be a radio frequency amplifier or a frequency converter tube in a television receiver or the like. The power supply and output circuits of this tube have not been shown inasmuch as they do not materially influence the operation of the circuit which is the subject of the invention. It will be understood that this tube may be followed by the usual circuits employed in a television or other receiver of high frequency signals.

The operation of any one of the switches 5, 6, 7, or 8 will serve to connect between the free end of the transmission line 4 and one side of the coupling condenser 10 one of the antenna coupling transformers 12, 13, 14 or 15 and additional tuning means in the primary circuits thereof adapted to modify the effective length and characteristics of the transmission line section 4 whereby the antenna circuit is adapted to be tuned to receive signals in a particular channel. This additional tuning means may consist either of a further section of transmission line as shown at 16 or of lumped reactive elements such as those shown at 17 and 18. For one channel the primary circuit is adapted to be tuned solely by means of the transmission line 4 as shown at 19 and without the use of any additional tuning means. The transformer secondary circuits are likewise tuned to a frequency within the channel to be received, and since this can most readily be done by designing the transformer so that the inductance appearing across its secondary terminals resonates with the input capacity of the following amplifier stage at the desired frequency, it has been found convenient to provide a separate transformer for each channel to be received. The primary and secondary circuits of the several transformers are tuned in accordance with well-known principles applicable to tuned coupled circuits to give the required response over the desired band of frequencies in each channel. This will be explained more fully hereinafter.

The circumstances which permit, and the advantages to be derived from tuning the antenna circuit in the system just described will now be set forth. First it is to be noted that in the case of the half-wave dipole antenna it is impossible to tune the antenna circuit for relatively narrow band response to signals within a single channel. This is due to the low value of Q inherent in such an antenna which, in fact, is such as to permit its use over a wide range of frequencies to receive signals in a number of different channels. For example it has been customary to use a single dipole antenna for receiving signals in several different channels located in the frequency range from 50 to 108 megacycles used for television. Since the antenna is not tuned it obviously cannot pick up all signals with optimum efficiency.

It has been found that the use of an antenna of relatively smaller dimensions not only permits the inclusion thereof within the cabinet housing the other receiving equipment, but it likewise permits the antenna circuit to be tuned so as to give a substantially uniform response over a relatively narrow but sufficiently wide band of frequencies. This is by reason of the fact that the smaller antenna can be constructed so as to have a relatively high value of Q. In other words, considering the problem from the viewpoint of the theory of coupled circuits, it is necessary to provide sufficient damping in either the primary or secondary circuits or both to give the required band width. With a large antenna more damping is provided by the antenna alone than is required to give the desired band width for a single six megacycle television channel. However in the case of a small antenna the value of Q may be made such as to provide the necessary damping for a six megacycle channel. Although additional damping may be added to give the desired band width, it is preferable to construct the antenna so that substantially the entire primary circuit resistance is the radiation resistance of the antenna, since when this condition obtains, the antenna will operate at maximum efficiency. In constructing the antenna with this end in view it should be remembered that in the case of the loop, increasing the area thereof increases the radiation resistance, while increasing the diameter of the conductor of which the loop is formed decreases its inductance. Likewise in the case of the dipole, increasing its length increases its radiation resistance, while the addition of capacitive loading at the ends of the dipole decrease the capacitive reactance. In general therefore it will be desirable to make the loop or dipole as large as is permissible in view of the available space in the cabinet and then to make the diameter of the loop conductor or the loading of the dipole just sufficient to give the desired value of Q.

It should also be pointed out that the bandwidth will be somewhat affected by the length of the transmission line connecting the antenna to the transformer primary. In general the effect of using a greater length of transmission line between the antenna and the transformer will be to produce a more sharply resonant primary circuit than when a shorter length of line is used. Since the transmission line section 4 in Fig. 1 is always connected in the primary circuit regardless of which transformer is in use, this section should be chosen of such length as will cooperate with the antenna to give the desired band width. This, however, is not the only consideration involved in the choice, for the line must be of sufficient length at least to tune the primary circuit.

In the case of a loop antenna it will be desirable to have the effective electrical length of the circuit including the antenna, the transmission line 4, the tuning means, and the primary winding of the transformer substantially equal to an integral number of half-wave lengths, while in the case of a dipole the electrical length of the circuit should equal an odd number of quarter wave-lengths at the frequency to be received. In referring to "effective electrical length" it will be convenient to regard the length as being the electrical "distance" from the midpoint of the loop or the tips of the dipole to the midpoint of the transformer primary. This, of course, is only one-half the electrical distance around the complete circuit but, for the purposes of this specification and the appended claims, it will be convenient to adopt this definition. In the case of the loop this will make the midpoint of the loop conductor and the center point on the transformer primary winding voltage nodal points. If the effective electrical length of the loop antenna is less than one quarter wave-length, as is the case in the embodiment herein described, the voltage maximum point of the circuit will be somewhere along the transmission line 4, for example at the point x—x as indicated in Fig. 1. In this case all points on the antenna will be at relatively low potentials and shielding problems will be considerably simplified. It will be found that capacitive pickup by the loop, which has an undesirable effect upon its directional characteristics and should therefore be avoided, may be reduced to a satisfactory minimum by using a transmission line comparatively free from capacitive pickup, such as a twisted pair or coaxial line, by grounding the centers of the transformer primaries to effect a balanced system with reference to ground, and by using an electrostatic screen surrounding at least those portions of the loop which are at high potential. The structure of the screen which may be used will be discussed in more detail when consideration is hereinafter given to the structure of the loop.

When an antenna in the form of a dipole is used, the electrical length of which is less than one-quarter wave-length it will be desirable to employ a sufficient length of line to render the overall electrical length of the circuit equal to a quarter wave-length. Then the ends of the dipole elements will be at maximum potential and the voltage node will again obtain in the transformer primary. Of course, if the length of the transmission line necessary to make the electrical length of the circuit one-quarter wave-length is not sufficient to span the distance between the antenna and the switching means, a longer section may be used which may be such as will make the circuit an odd number (three for example) of quarter waves in length. However consideration must be given to the fact that as the length of the line is increased, its resonances tend to become sharper and may have an undesirable effect upon the width of the frequency band which the circuit will transmit. This sharpening may to some extent be compensated for by increasing the dissipation of the line or by adding resistance externally. The same considerations apply in the case where a loop antenna is employed and a length of transmission line is used such as will make the circuit of electrical length equal to an integral number of half wave-lengths greater than one. In general it is desirable to use as short a length of line as will conveniently connect the antenna to the primary terminals of the transformer and provide the desired tuning. In the tuning process, of course, the effective electrical length of this line will be kept substantially constant and in consequence of this, as the tuning of the circuit is varied from one channel to another, the band-width will remain substantially constant.

As hereinbefore indicated in the general discussion of the embodiment of the invention shown in Fig. 1, a plurality of tuning means are provided for connecting the end 20 of the transmission line 4 to the primary windings of the transformers 12, 13, 14 and 15. By these means the effective electrical length of the transmission line 4 may be varied to tune the several primary circuits to different frequencies for the reception of signals in different channels. Such tuning means may consist either of additional lengths of transmission line or of lumped reactive elements capable of modifying the effective length of the line. Referring, for example, to Fig. 1 there is shown a length of transmission line 16 which by operation of the switch 5 may be connected between the free end 20 of the transmission line 4 and the primary of the transformer 12. If, for example, when the switch 6 is closed to connect the end 20 of the line 4 directly to the primary winding of the transformer 13, the circuit including the antenna, the line 4 and the primary of the transformer 13, is tuned to a frequency f_1, then the line section 16 may be made of such length that it will tune the circuit including the antenna, the line 4 and the primary of the transformer 12 to a frequency f_2 which may be either higher or lower than f_1. The length of line required to change the tuning from a given frequency f_1 to another frequency f_2 will differ depending upon whether a loop antenna or a dipole antenna is used. If at the frequency f_1 to which the primary circuit is tuned by the line 4 alone, the effective electrical length of the entire circuit including the antenna, the line 4 and the primary of the transformer is l_0 centimeters and if the effective electrical length of the additional line section 16 is l centimeters, the circuit including the additional line section will, in the case of the loop, be an integral number of half waves in length at any frequency f_2 given by the expression:

$$f_2=\frac{nc}{2(l_0+l)}$$

where n is an integer and $c=3\times10^{10}$ centimeters per second.

In the case of the dipole the circuit will be an odd number of quarter waves in length at any frequency f_2 given by the expression

$$f_2=\frac{nc}{4(l_0+l)}$$

where n is an odd integer. In both of these cases, it will be noted, the frequency f_2 may be either lower or higher than f_1.

Similar results may be obtained by the use of lumped reactive elements connected either in shunt or in series between the end of the line 4 and the primary winding of the transformer 14. Here the same results obtain regardless of whether the loop or the dipole is involved. For example the switch 7 is adapted upon being closed to connect condensers 17 in series between the end of the line 4 and the primary winding of the transformer 14. Such condensers will effectively shorten the electrical length of the primary circuit so as to tune it to a higher frequency than that to which it would be tuned in their absence. It will be apparent that series inductors might be employed in a similar manner effectively to lengthen the primary circuit electrically so as to tune it to a lower frequency.

The switch 8 is adapted upon being closed to connect the condenser 18 in shunt across the end of the transmission line 4 and the primary of the transformer 15. The condenser when thus connected acts effectively to lengthen the primary circuit and to tune it to a lower frequency. In the same manner, of course, a shunt connected inductor would operate to shorten the effective electrical length of the circuit and to tune it to a higher frequency.

It will of course be understood that the alternative methods just described for tuning the primary circuits of the four transformers 12, 13, 14 and 15 in the system of Fig. 1 are merely exemplary and that any desired number of circuits may be incorporated in a particular receiver each tuned by any of the aforementioned methods in order to permit the reception at will of any one of a number of channels corresponding to the number of such circuits provided.

It is also to be pointed out with reference to Fig. 1 that means may be provided at the point of connection of the antenna to the transmission line 4 for separately tuning the antenna apart from the several coupling circuits. For example there are shown adjustable condensers 21 connected serially in the leads to the dipole 1 and an adjustable condenser 22 connected serially in the loop circuit 2. Alternatively of course adjustable inductances might be used for the same purpose and the elements in either case might be connected either in shunt across the leads from the dipole or serially in the loop leads, though the arrangements as shown are preferred. By such tuning it is possible effectively to modify the electrical length of the circuit comprising the antenna and the line section 4 for all frequencies at which the system is intended to be operated. Such an adjustment is equivalent in effect to changing the effective length of the line section 4 and may be relied upon as a convenient means for accomplishing this end.

Referring now to Fig. 2 there is illustrated an arrangement of a rotatable loop antenna disposed within the cabinet of a television receiver and adapted to be used in conjunction with the circuits above described. The loop 23 in this embodiment may comprise a rectangle sixteen inches on each side formed of a single length of three-eighths inch copper tubing, which was found to have the required value of radiation resistance to yield the desired six megacycle bandwidth in accordance with the principles already set forth. It may conveniently be supported by clamping between two vertical members 24 and 25 of wood or like insulating material. The vertical member 22 is provided at each of its ends with metal bearing pins 26 and 27 (see Fig. 3). Said pins are adapted to be journaled in bearings of any satisfactory form in the shelf 28 and baseboard 29 within cabinet 30 in which are also arranged the other components 31 of a television receiver. Pinned or otherwise affixed to the lower bearing pin is a pulley wheel 32 for rotating the loop. The other apparatus for effecting such rotation may comprise the pulley wheels 33 and the pulley wheel 34 mounted on the shaft 35 adapted to be turned by a knob 36 operable from the front of the cabinet. A cord or belt 37 running over all of these pulleys permits the antenna to be rotated about its vertical axis by turning the knob 36. Such rotation may be restricted to one complete 360° turn by the cooperation of a pin 38 on pulley 32 and a stationary stop 39. The ends of the loop 23 are connected through the adjustable condenser 22 corresponding to the like numbered element in Fig. 1. The ends of the loop are likewise connected to one end of the twisted-pair transmission line 4, similarly identified in Fig. 1, the other end of which is connected to terminals 20. The latter terminals may be connected to the several switches (not shown in Fig. 2) in the manner shown in Fig. 1. The size of the loop is of course restricted only by the size of the cabinet in which it is to be included, and by reason of the fact that it is desirable that the loop should be rotatable therein in order to take advantage of its directional characteristics. Rotatability is particularly desirable since it permits the utilization of the directional characteristics known to be inherent in such a loop antenna in excluding signals from stations other than the one desired to be received and in excluding all but the direct wave from the desired station.

In order to maintain the desired directional characteristic it has been indicated that the loop may preferably be shielded to prevent electric pickup. Although the shielding has been omitted in Fig. 2 for clarity, it is shown in Fig. 3 consisting of a plurality of vertically arranged conductors 40 in planes on opposite sides of the loop. These conductors may conveniently be cemented in sandwich fashion between two sheets of heavy paper 41 and 42 which may be fastened to the vertical members 24 and 25 as shown in Fig. 3. The shield conductors 40 are preferably connected together and to a ground connection on the receiving equipment. This connection should be made as short as is feasible so as to be of low reactance and may comprise a conductive band 43 soldered to the separate conductors 40 and connected to the bearing pin 26 which in turn may be connected to a ground point on the receiving equipment on the shelf 28. As heretofore stated the fact that the maximum voltage point in the antenna circuit may be made to occur at a point on the transmission line cooperates to improve the shielding. Both this effect and the action of the shield just described cooperate to render the structure a pure magnetic pickup device.

The structure of a dipole antenna for use in connection with the circuits already described with reference to Fig. 1 is shown in Fig. 4. It comprises two horizontally disposed conductive dipole elements 44 inserted in sockets in an insulating separator 45 clamped between vertical members 46 and 47 similar to those employed in the case of the loop. In the embodiment shown the length of the dipole measured between the extremities of the elements 44 is seventeen inches. Capacitive loading was provided by means of plates 48 affixed to the ends of the rods 44. It will be noted that each of these plates comprises three sections. Each plate was twelve inches deep, the outer sections were three and one-half inches wide, and the central section was four and three-eighths inches wide. This structure was found to yield the proper values of radiation resistance and capacitive reactance for the reception of the six megacycle television channel when used in conjunction with the circuit shown in Fig. 1. The bent structure of plates 48, as shown in Fig. 4, facilitates rotation of the antenna within the cabinet. The entire unit may be mounted in the cabinet in the same manner as the loop and so as to be rotatable about a vertical axis. Electrical connections are made from the innermost ends of the dipole elements through the condensers 21, also designated in the circuit diagram of Fig. 1, to the transmission line 4.

Although it has been observed that both the loop and the dipole are made rotatable about a vertical axis in order to take advantage of their directional features in tuning out undesired signals and noise, attention should be called to the fact that in order to take the utmost advantage of these directional characteristics the loop antenna should be used where the electric waves to be received are vertically polarized and the dipole where they are horizontally polarized. It has been found in some cases that although the waves originally transmitted may have been either vertically or horizontally polarized, when they reach the receiver the polarization has been changed. This may be due to the presence of a reflected wave so that the field at any point may be the resultant of two or more waves some of which may be reflected. Under such circumstances it is no longer possible to obtain optimum reception using an antenna whose directivity is limited to a single plane. It is then desirable to provide an antenna rotatable in all directions so as to be capable of optimum reception of a wave coming from any direction and with any polarization.

An arrangement permitting such operation and employing a loop antenna is shown in Fig. 5. Here a loop 49 is clamped between two members 50 and 51 as in the embodiment of Fig. 3. It is supported so as to be rotatable about a horizontal axis by means of pins or studs, one of which is shown at 52, journaled in the uprights 53 of a cradle support 54. The latter is mounted upon a swivel base 55 so as to be rotatable about a vertical axis. A system of cords and pulleys is provided by means of which the antenna may be oriented in any desired plane. For this purpose the control knobs 56 and 57 operable from the front of the cabinet are used. The stud 52 at one end of the loop supporting members 50 and 51 is provided with a pulley 58, as shown more clearly in Fig. 7. The cord 59 passes around the pulley 58, over the pulleys 60 affixed to a lower corner of the cradle 54, as shown more clearly in the detailed drawing of Fig. 8, and then around a pulley 61 concentric with the axis of the swivel mounting 55. The latter is shown in vertical cross section in Fig. 6. The pulley 61 is adapted to accommodate a second cord 62 which passes over the pulleys 63 and around the pulley 64 attached to the end of the shaft controlled by the knob 56, thereby completing the linkage for producing rotation of the loop 49 about a horizontal axis. The pulley 65 is affixed to the shaft 66 which in turn is rigidly attached to the cradle 54. The cord 67 passes over the pulley 65 and thence over the pulleys 68 and around the pulley 69 affixed to the end of the shaft controlled by knob 57, thereby completing the linkage for effecting rotation of the cradle 54 and of the loop 49 supported therein about a vertical axis. The entire swivel support may be affixed to the base of the cabinet by means of screws 70 inserted through holes in the bracket 71 which supports the entire assembly. Attention is called to the fact that the pulley 65 is directly and rigidly coupled to the cradle 54 by means of the shaft 66 having a flange 72 which may be affixed to the cradle by bolts or other suitable means. The lower surface of the flange bears on the plate 73 affixed to the bracket 71 by screws, being separated therefrom by a washer 74. The pulley 61, on the other hand, is free to rotate on the bracket 71 and is provided with upper and lower washers 75 and 76 to facilitate such rotation. Electrical connections are made from the antenna to the receiving apparatus 31 through the twisted cable 4.

Since the loop antenna just described can be orientated in any plane by simply turning the knobs 56 and 57 it may be adjusted to the optimum reception of signals arriving from any direction and to discriminate against signals arriving from other directions whereby the undesirable effects of reflections and noise may be considerably reduced.

Wherever in the foregoing specification the symbol "Q" has been used it has been employed in its usual sense and signifies either the ratio of $\omega L/R$ when applied to an inductive circuit element having inductance L and series resistance R or the ratio of $G/\omega C$ when applied to a capacitive circuit element having capacitance C and shunt conductance G and where ω represents the angular frequency at which the measurement is made.

It will of course be understood that although the invention has been described with reference to certain embodiments, it is capable of expression in other embodiments which will occur to those skilled in the art, and it is not intended that the invention shall be restricted in scope except by the appended claims.

I claim:

1. In a receiving system for high frequency electromagnetic wave signals, an antenna system having a circuit which includes an antenna, a transmission line section and the input circuit of a coupling device, said circuit being tuned to receive signals in a certain channel and being damped so as to have the desired band-width for the reception of signals in said channel only, said damping being due principally to the radiation resistance of said antenna; a second coupling device and additional means connectable in said circuit in place of said first coupling device for tuning said circuit to receive signals in a different channel without substantially changing said band-width.

2. In a receiving system for high frequency electromagnetic wave signals, an antenna system having a circuit which includes an antenna, a transmission line section and the input circuit of a coupling device, said circuit being tuned to receive signals in a certain channel and to have an effective electrical length equal to an integral number of quarter wave lengths at a frequency within said channel and being damped so as to have the desired band-width for the reception of signals in said channel only, said damping being due principally to the radiation resistance of said antenna; a second coupling device and an additional means connectable in said circuit in place of said first coupling device for tuning said circuit

to receive signals in a different channel without substantially changing said band-width.

3. In a receiving system for high frequency electromagnetic wave signals, an antenna system having a circuit which includes an antenna, a transmission line section and the input circuit of a coupling device, said circuit being tuned to receive signals in a certain channel and being damped so as to have the desired band-width for the reception of signals in said channel only, said damping being due principally to the radiation resistance of said antenna; a second coupling device and an additional section of transmission line connectable in said circuit in place of said first coupling device for tuning said circuit to receive signals in a different channel without substantially changing said band-width.

4. In a receiving system for high frequency electromagnetic wave signals, an antenna system having a circuit which includes an antenna, a transmission line section and the input circuit of a coupling device, said circuit being tuned to receive signals in a certain channel and being damped so as to have the desired band-width for the reception of signals in said channel only, said damping being due principally to the radiation resistance of said antenna; a second coupling device and lumped reactive circuit elements connectable in said circuit in place of said first coupling device for tuning said circuit to receive signals in a different channel without substantially changing said band-width.

5. In a receiving system for high frequency electromagnetic wave signals, an antenna system having a circuit which includes an antenna, a transmission line section and the input circuit of a coupling device, said circuit being tuned to receive signals in a certain channel and being damped so as to have the desired band-width for the reception of signals in said channel only, said damping being due principally to the radiation resistance of said antenna; a second coupling device and an additional section of transmission line having an effective electrical length less than one quarter wave at a frequency within said channel connectable in said circuit in place of said first coupling device for tuning said circuit to receive signals in a different channel without substantially changing said band-width.

6. In a receiving system for high frequency electromagnetic wave signals, an antenna system having a circuit which includes an antenna, a transmission line section and the input circuit of a coupling device, said circuit being tuned to receive signals in a certain channel and being damped so as to have the desired band-width for the reception of signals in said channel only, said damping being due principally to the radiation resistance of said antenna; a second coupling device and an additional section of transmission line having an effective electrical length greater than one quarter wave but less than one half wave at a frequency within said channel connectable in said circuit in place of said first coupling device for tuning said circuit to receive signals in a different channel without substantially changing said band-width.

7. In a receiving system for high frequency electromagnetic wave signals, an antenna system having a circuit which includes a loop antenna, a transmission line section and the input circuit of a coupling device, said circuit being tuned to receive signals in a certain channel and to have an effective electrical length equal to an integral number of one half wave lengths at a frequency within said channel and being damped so as to have the desired band-width for the reception of signals in said channel only, said damping being due principally to the radiation resistance of said antenna; a second coupling device and additional means connectable in said circuit in place of said first coupling device for tuning said circuit to receive signals in a different channel without substantially changing said band-width.

8. In a receiving system for high frequency electromagnetic signals, an antenna system having a circuit which includes a dipole antenna, a transmission line section and the input circuit of a coupling device, said circuit being tuned to receive signals in a certain channel and to have an effective electrical length equal to an odd number of quarter wave lengths at a frequency within said channel and being damped so as to have the desired band-width for the reception of signals in said channel only, said damping being due principally to the radiation resistance of said antenna; a second coupling device and additional means connectable in said circuit in place of said first coupling device for tuning said circuit to receive signals in a different channel without substantially changing said band-width.

9. In a receiving system for high frequency electromagnetic wave signals, an antenna system having a circuit which includes an electrically shielded loop receiving antenna, a transmission line section and the input circuit of a coupling device, said circuit being tuned to receive signals in a certain channel and to have an effective electrical length equal to one half wave at a frequency within said channel, said circuit having a voltage maximum point located on said transmission line and being damped so as to have the desired band-width for the reception of signals in said channel only, said damping being due principally to the radiation resistance of said antenna.

10. In a receiving system for high frequency electromagnetic wave signals, an antenna system having a circuit which includes an electrically shielded loop receiving antenna, a transmission line section and the input circuit of a coupling device, said loop antenna being rotatable about a vertical axis through the plane of said loop to tune out undesirable signals in at least one direction, and said circuit being tuned to receive signals in a certain channel and to have an effective electrical length equal to a one half wave at a frequency within said channel, said circuit having a voltage maximum point located on said transmission line and being damped so as to have the desired band-width for the reception of signals in said channel only, said damping being due principally to the radiation resistance of said antenna.

11. In a receiving system for high frequency electromagnetic wave signals, an antenna system entirely contained within a cabinet housing other receiving equipment comprising said receiving system, said antenna system having a circuit which includes an antenna, a transmission line section and the input circuit of a coupling device, said antenna having an effective electrical length less than one quarter wave at the highest frequency within any of a plurality of channels to be received by said system, said circuit being tuned to receive signals in one of said channels and being damped so as to have the desired band-width for the reception of said signals in said channel only; a plurality of other coupling de-

vices and additional means alternatively connectable in place of said first coupling device for tuning said circuit to receive signals in others of said channels without substantially changing said band-width.

12. In a television receiver, a built-in directional antenna system for receiving television signals in different channels, said system comprising an antenna disposed within the cabinet housing said receiver and rotatable to tune out undesired signals in at least one direction, a plurality of coupling devices, a transmission line section for connecting said antenna to one of said coupling devices, and a plurality of means connectable in circuit between said transmission line and one of said coupling devices, each adapted to tune said circuit to a different channel without substantially changing the band-width.

13. In a television receiver, an antenna system for receiving high frequency wave signals in different channels, said system comprising an antenna disposed within the cabinet housing said receiver a support disposed within said cabinet and rotatable about a vertical axis, a second support carried by said first support and rotatable about a horizontal axis, said antenna being mounted on said second support, means operable at will to rotate said first support, other means operable at will to rotate said second support relative to said first support, said last twc means permitting said antenna to be oriented in any desired manner for the optimum reception of wave signals from a given direction and for discriminating against signals from other directions, and means for forming in conjunction with said antenna a plurality of circuits, each tuned to a different channel and each being damped, said damping being due principally to the radiation resistance of said antenna.

14. In a receiving system for high frequency electromagnetic wave signals, an antenna system comprising a circuit tuned to receive signals in a certain channel, said tuned circuit comprising a loop receiving antenna having an effective electrical length of less than one-quarter wave length, a transmission line whose electrical length is substantially equal to the difference between the length of said antenna and an integral number of half wave lengths, and the input circuit of a coupling device, all directly connected in said tuned circuit, said antenna being of such electrical dimensions compared to the other components of said circuit that, for the frequency to which said circuit is tuned, all points on said antenna are of lower potential than the point of maximum potential of said circuit.

15. In a receiving system for high frequency electromagnetic wave signals, an antenna system comprising a circuit tuned to receive signals in a certain channel, said tuned circuit comprising a dipole antenna having an effective electrical length of less than one-quarter wave length, a transmission line whose electrical length is substantially equal to the difference between the length of said antenna and an odd number of quarter wave lengths, and the input circuit of a coupling device, said components being serially connected and tuned as a whole largely by the presence of said transmission line.

16. In a receiving system for high frequency electromagnetic wave signals, having a cabinet for housing said receiving apparatus, a receiving antenna disposed within said cabinet, a transmission line section serving to connect said antenna to said receiving apparatus and being of electrical length commensurate with said antenna, and means for forming a plurality of tuned circuits, each tuned to a different frequency and each including as an integral part thereof said antenna and said transmission line section.

17. In a receiving system for high frequency electromagnetic wave signals, having a cabinet for housing said receiving apparatus, a receiving antenna disposed within said cabinet, a transmission line section serving to connect said antenna to said receiving apparatus and being of electrical length commensurate with said antenna, an adjustable reactive element connected across said transmission line at its point of connection to said antenna to modify the effective impedance of said antenna, and means for forming a plurality of tuned circuits, each tuned to a different frequency and each including as an integral part thereof said antenna and said transmission line section.

18. In a receiver for high frequency electromagnetic wave signals, a built-in antenna system for receiving said signals in different channels, said system comprising an antenna disposed within the cabinet housing said receiver, and means for forming in conjunction with said antenna a plurality of circuits, each circuit being tuned to receive signals in a different channel and each circuit being damped so as to have substantially the same effective band-width, said damping being due principally to the radiation resistance of said antenna.

19. In a television receiver, a built-in antenna system for receiving television signals in different channels, said system comprising an antenna disposed within the cabinet housing said receiver and being rotatable in any direction for the optimum reception of wave signals from any given direction and for discriminating against signals from other directions, and means for forming in conjunction with said antenna a plurality of circuits, each circuit being tuned to receive signals in a different channel and each circuit being damped so as to have substantially the same effective band-width, said damping being due principally to the radiation resistance of said antenna.

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