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ALL WAVE RADIO RECEIVING SYSTEM

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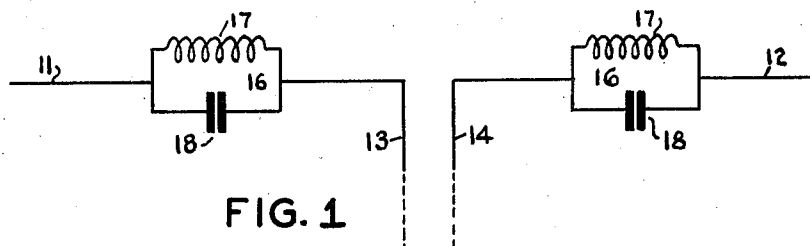


FIG. 1

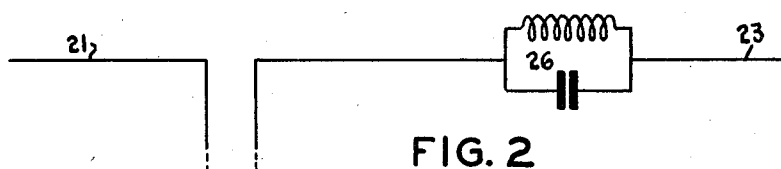


FIG. 2

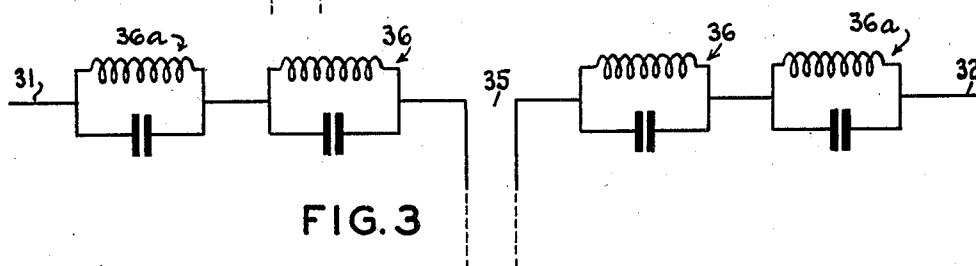


FIG. 3

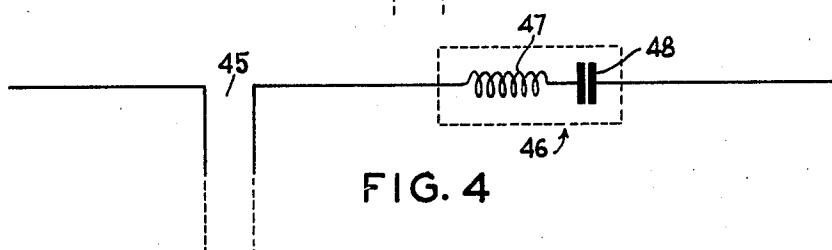


FIG. 4

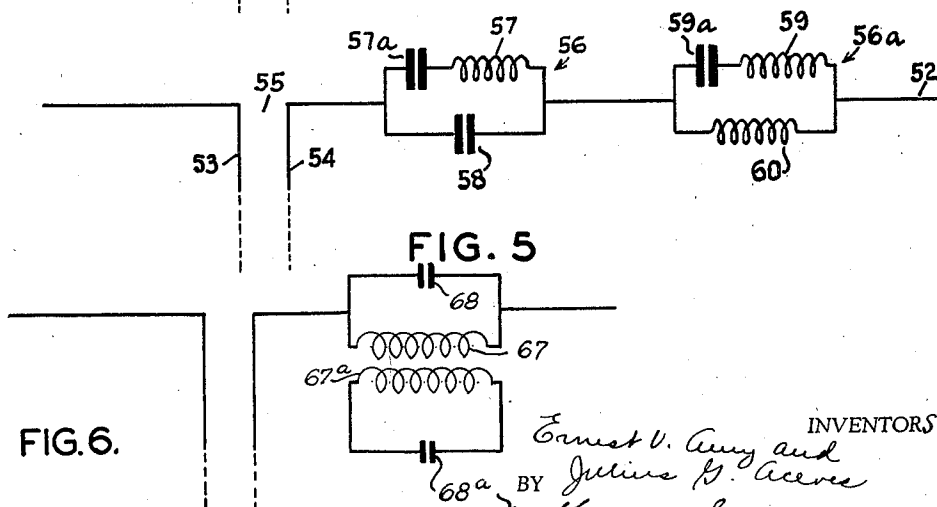
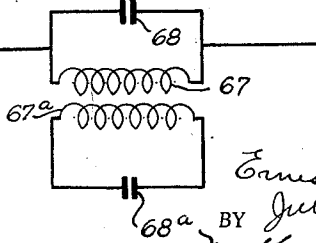


FIG. 5

FIG. 6.



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ALL WAVE RADIO RECEIVING SYSTEM

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6 Claims. (Cl. 250—33)

Our invention relates to antenna systems for use with radio receivers and more particularly to a system whereby optimum antenna conditions are automatically obtained for each of a plurality of selected frequency bands.

The application is a continuation-in-part of our copending application for United States Letters Patent Serial No. 758,234, filed December 19, 1934.

Our invention is especially applicable to antenna systems of the so-called dipole type, whether symmetrical or unsymmetrical, and whether comprising one or more arms, as well as to dipole antenna systems that are also capable of operation as T-antennas, such as shown in said application Serial No. 758,234. The invention is also applicable to the so-called "spider" or multiple type of antenna.

Radio receivers of the so-called "all-wave" type are provided with appropriate circuits and frequency or wave band selectors enabling the proper reception of signals broadcast on short waves (very high frequencies) and long waves (lower frequencies known as the American broadcast band) as well as in the intermediate channels. For a signal of a given frequency there is an optimum length of antenna that will deliver maximum signal voltage to the radio receiving set.

For reception of signals of the lower frequency bands (longer wave lengths) it is most practical to use an ordinary L or T type of antenna. At higher frequencies, quarter-wave antennae or half wave dipole type antennae are preferable for maximum signal pick-up. For the great diversity of frequencies corresponding to wave lengths of several hundred meters to a fraction of a meter, different lengths of antenna are necessary for maximum response at any selected wave length. In general, it is not practical to have a plurality of antennae of different lengths for each of these frequency bands, and if only one antenna is used, it follows that the efficiency of signal energy pickup will be impaired for certain frequencies. This is especially true in the case of antennae of the dipole type, in connection with which this invention will be described by way of example.

For this type of antenna, when the total length of the dipole is an odd multiple of one-half of the wave length to be received, reception is a maximum. Likewise, for an even multiple of half-wave lengths, reception or response is a minimum.

If one dipole is adjusted to receive efficiently a

given frequency, it follows that it will have a very poor pick-up for a signal of twice this frequency (or one-half of the wave length). Accordingly, it would be a desirable improvement if the antenna length could be automatically adjusted to optimum value, in practice at least, for the more important frequency bands or channels to be received.

It is one object of our invention to provide the antenna with frequency-selective means to adjust automatically the electrical effective length of the antenna for each of two or more frequency bands.

It is another object of our invention to provide an antenna capable of operating as a dipole or doublet antenna and providing maximum signal pick-up for two or more frequency bands.

It is still another object of our invention to provide an antenna system, for the reception of standard radio broadcast signals, which includes therein one or more means to limit the effective length of the antenna for most efficient reception of one or more short-wave bands.

It is a further object of our invention to provide an antenna system composed of a plurality of series arranged antenna sections connected to radio receiving apparatus by means of a single transmission line.

It is a still further object of our invention to provide an antenna system having means therein for sectionalizing the antenna and blocking the passage of selected frequency bands but allowing other frequencies to pass without substantial attenuation.

It is an even further object of our invention to provide an antenna system comprising a single doublet and a two wire transmission line with means to give the effect of a plurality of doublets connected to a radio receiver.

It is an even further object of our invention to provide in a symmetrical or asymmetrical doublet any number of automatic dividers for sectionalizing one or both arms of the said doublet.

The term "divider" as employed herein refers to an impedance placed at some point or points in the arm or arms of a doublet, or any other type of antenna, which has the effect of adjusting the electrical length of said antenna by virtue of changes of said impedance with frequency.

Other and further objects of our invention will be apparent to those skilled in the art and will, in part, be developed in the following specification taken in conjunction with the accompanying drawing in which,

Figure 1 is a diagrammatic illustration of a

symmetrical doublet or dipole antenna, each arm of which has two effective lengths;

Fig. 2 is a diagrammatic illustration of an asymmetrical doublet, in which only one arm has provision for limiting the effective length thereof;

Fig. 3 is a diagrammatic illustration of a doublet, each of the arms of which comprises a plurality of sections each responsive to a particular wave band.

Fig. 4 is a diagrammatic illustration of an asymmetrical doublet with a modified form of divider.

Fig. 5 is a diagrammatic illustration of a doublet, provided with another modified form of divider.

Fig. 6 is a diagrammatic illustration of a doublet with still another modified form of divider to provide a broader selectivity.

The showing of the simple doublet type of antenna in the several figures of the drawing is by way of example only, but it should be noted that in an antenna capable of acting as either a doublet or as a T type of antenna, the automatic dividers hereinafter described do not interfere with the effective transfer of energy from voltages developed between the antenna and ground, or a counterpoise. Likewise it should be noted that one or more radio receivers, each tuned to receive the same or even different frequencies, may be operated from the same antenna having our present invention incorporated therein.

Referring now to Fig. 1, the doublet comprises a pair of arms 11 and 12 connected to a pair of conductors 13 and 14 constituting a transmission line or lead-in to which the radio receiving apparatus is to be connected in any well known manner, neither the apparatus nor the connections being indicated anywhere in these drawings.

No particular form of transmission line or lead-in is described. The lead-in may be either the parallel conductor type or the twisted pair type or the two conductor type with one wire grounded. Also well known noise reducing arrangements may be used in the antenna system.

Each of the antenna arms is provided with a divider 16. The dividers 16 are alike in this case, and each one comprises an inductor 17 and a condenser 18 in parallel or loop circuit arrangement with each other. The unit is designed to be anti-resonant at a particular frequency, in this example, 60 megacycles (5 meters), so that it has an "infinite" impedance at that frequency and therefore will produce the same effect as an insulator or a blocking element placed at the points 16 (Fig. 1) for signals of a frequency of 60 megacycles. At 30 megacycles, however, the impedance of the divider is very low and therefore it will act substantially as a solid conductor closing the gaps at points 16 and allowing the whole length of the doublet to be effective to pick up electromagnetic waves of this frequency, or in fact, of any other frequency not close to the anti-resonant frequency of the divider.

As an example of determining the location of a divider, assuming that the over-all length of each of the arms 11 and 12 is to give maximum response to signals in the ten meter band (30 megacycles) and it is desired to also receive with maximum response signals in the five meter band (60 megacycles) then according to our invention at a distance approximately 1.25 meters from the gap 15 of the doublet both the antenna wires 11 and 12 are severed and a divider, or fre-

quency-selective impedance, one form of which is indicated at 16, is connected therein as shown. The distance of 1.25 meters is chosen as this is the proper length in an arm of a half-wave length doublet most effective for reception in the five meter channel, corresponding to one-quarter wave length of five meters, of 60 megacycles. Thus constructed, the doublet will give maximum response for both of the bands.

Of course, the dividers or filters may be designed to be anti-resonant for any selected frequency desired. The proper selection of electrical constants in the design of the divider, namely: the inductance, capacity and resistance, will determine the broadness of the band for which the divider acts as an antenna length-limiting device.

Figure 2 shows an asymmetrical doublet with only one arm provided with an automatic length-limiting device, or "divider." In this figure, the arm 21 is of some chosen length suitable for reception of say 43 megacycles (7 meters approximately) while arm 22 may be much longer, for example 12.5 meters for best reception of 50 meter signals (6 megacycles). A divider 26 of proper constants inserted in arm 22 at 1.75 meters ($\frac{1}{4}$ wave length of 7 meters or 43 megacycles) will have the same effect as severing the wire at this point, and thus constitute a second arm of a dipole for 7 meters the other one of which is arm 21. In this example, the divider has an anti-resonant frequency of 43 megacycles.

Figure 3 shows an antenna comprising a plurality of sections connected in series so that the antenna provides maximum response for several different selected frequencies. The antenna is shown as comprising the arms 31 and 32 separated by gap 35, although the dipole may be of the continuous wire type without a gap, as is well known in the art. At the appropriate distance from the gap, electrical or physical, each arm has inserted therein a divider having "infinite" impedance at a chosen frequency, say 60 megacycles (5 meters) for example, but low impedance to both lower and higher frequencies. Thus the section from the gap 35 to each of the dividers 36 is electrically equivalent to a length of 1.25 meters, or one quarter wave, for maximum response for five meters. Also at the appropriate distance from the gap each antenna arm 31 and 32 has inserted therein a second divider 36a having high impedance at a chosen frequency, for example, to 30 megacycles (10 meters).

It has already been explained that the dividers do not interfere with the passage of frequencies other than the narrow band for which it is designed to be effective as a limiting device; hence in Fig. 3 the antenna from the gap to the dividers 36a will respond to frequencies in the ten meter band as if there were no dividers at 36. The antenna of Fig. 3 in its full length may be especially adapted for reception of a third frequency band, as for the twenty-five meter band. Accordingly, there is provided the full effect of a plurality of separate dipole antennae using only one pair of wires and one transmission line.

As an example the electrical constants of units 36 which we have found satisfactory for use in the system of Fig. 3, are a coil having an inductance of 0.265 microhenry and a shunting condenser with a capacity of 26.5 micro-microfarads. At 60 megacycles (five meters) each di-

vider will have an impedance of 10,000 ohms if the effective resistance of the unit is one ohm, corresponding to a value of "Q" of 100 where "Q" is the ratio of reactance to resistance, as is well known in the art.

Dividers 36a, designed to make the antenna section therebetween responsive most efficiently to 30 megacycles (ten meter band), may be made of an inductance of 0.53 microhenry and a capacity of 53 micro-microfarads, so that the unit will have an impedance of about 10,000 ohms to 30 megacycles (ten meters) if the resistance is one ohm. In both cases the impedance is negligible at the longer wave lengths or lower frequencies. For example, at 10 megacycles the impedance is approximately 38 ohms, whereas at 30 megacycles it was 10,000 ohms.

As stated above, the properties of electrically limiting the length of an antenna wire by means of frequency selecting units, such as those previously described or subsequently disclosed, are not limited to dipole antennae. They may be used in Zeppelin or Marconi or other type aerials without modification of the principles involved.

Figure 4 shows another form of divider in which the inductor and condenser are connected in series with each other. Although in this figure only one arm of the doublet is provided with divider, as would be the case of an asymmetrical doublet, the use of dividers on both arms is understood to be expedient, as in the asymmetrical dipoles. The divider 46 is composed of an inductor 47, with a condenser 48 in series with it and both constituting a unit placed at the correct distance from the gap 45. In this case, the condenser and inductor are such that their combined reactance is very low, or actually zero for the frequency for which the whole length of the doublet is designed to operate, whereas for some other predetermined frequency or frequencies, the reactance of the inductor and condenser is sufficiently high so as to effectively limit the length of the arm to the distance 45 to 46. A number of dividers of this type may be used in the same arm or arms of a doublet in the same manner as described in connection with Fig. 3, and in both arrangements there may be an unequal number of dividers in the respective arms as would be the case with an asymmetrical doublet.

If with the system of Fig. 4 it be required, for example, to receive very efficiently a frequency of 12 megacycles and with a fair degree of efficiency some neighboring frequencies, such as 15 megacycles, and 60 megacycles was also an important frequency to be received, then if the constants of the inductor 47 and condenser 48 are such that their respective reactances at 12 megacycles are equal to each other and to 200 ohms, the combined reactance of the divider would be 90 ohms at 15 megacycles, which is a low value to permit reception at this frequency with a fair degree of efficiency, but its value at 60 megacycles would be 960 ohms which will effectively limit the length of the arm for this frequency to the distance from the gap to the divider, which in this example should be 1.25 meters. As is well known in this art, the actual length of the antenna wire is subject to a slight correction because of the differences in velocities of a radio wave in space and in a wire, and effects, etc. The length of the wire is also affected to some extent by the presence of an insulator and the same principle may apply to the

effect of the location of the dividers in the antenna.

Figure 5 shows still other forms of dividers. In this figure the antenna comprises arm 52 and an associated transmission line 53 and 54. Spaced appropriately from the gap 55 are two dividers 56 and 56a designed for maximum and minimum impedance characteristics. Unit 56 comprises a parallel circuit in one leg of which is inductance 57 and condenser 57a and in the other leg of which is a condenser 58. Unit 56a also comprises a parallel circuit but in this case one leg has inductance 59 and condenser 59a therein while the other leg includes inductance 60. These units may be designed for special cases where one or more bands should be received with particularly high efficiency.

Figure 6 illustrates a modified form of divider, in which there is a coupled circuit for the purpose of broadening the width of the band affected by the divider. It comprises an inductor 67 shunted by a condenser 68, having in mutual inductive relation thereto another inductor 67a shunted by condenser 68a. Both primary and secondary circuits are tuned to substantially the same frequency, but when the coupling is loosened the band is narrower than when the coupling is tightened, as is well known in the art. If desired, the coupling may be arranged to be adjustable by the radio receiver user.

Of course, if the inductor coil is of such dimensions that its distributed capacity is sufficient for the purposes hereinbefore set forth, no separate condenser will be required.

As is also known in this art, when an antenna is adjusted to deliver maximum voltage at a particular frequency, the same antenna will respond satisfactorily for a narrow range of frequencies on either side of the particular frequency, but for frequencies beyond that narrow band there is a noticeable drop in efficiency of the antenna. The present invention enables the antenna to be arranged to give maximum response at the selected frequencies beyond the narrow band.

For example, the ordinary doublet used for the reception of signals from certain important foreign stations has been found to be most satisfactory when having a length in the neighborhood of 30 feet on a side, but such an antenna does not give the best response for television signals such as are broadcast on other frequencies. However, with dividers in one or both arms of such an antenna so that the length of the antenna is properly adjusted, the same can be made sharply responding for television, or other signals.

It may be pointed out that the principles hereinbefore set forth are also applicable to other commercial uses such as the reception of facsimile transmission signals.

Thus from the foregoing examples it will be seen that we have provided an antenna which may be used with a maximum efficiency at several frequency bands by electrically limiting the lengths of parts of the antenna so that signals will induce substantially the same voltage as if the wire was actually severed at the point where the blocking units are located. On the other hand, these frequency selective antenna dividers have substantially no effect on frequency bands sufficiently separated from those for which they are intended to act as such.

Other modifications may be made in the construction and arrangement of parts and the cir-

cuits shown within the spirit and scope of our invention, and such modifications are intended to be covered by the appended claims.

We claim:

1. An antenna system comprising an antenna capable of operating as a dipole antenna, a lead-in, and means connected to the system for rendering a portion of said antenna effective to deliver maximum signalling voltages for a particular frequency, said means comprising a series arranged capacitor and inductor shunted by a capacitor.

2. An antenna system comprising an antenna capable of operating as a dipole antenna, a lead-in, and means connected to the system for rendering a portion of said antenna effective to deliver maximum signalling voltages for a particular frequency, said means comprising a series arranged capacitor and inductor shunted by an inductor.

3. An antenna system comprising an antenna capable of acting as a dipole antenna, a lead-in, an adjustable means connected in circuit with said antenna and arranged to render a portion thereof effective to deliver maximum signalling voltages for a particular frequency, said means comprising a pair of tuned circuits with means for adjusting the coupling therebetween.

4. An antenna system for use with radio receivers arranged to receive a plurality of different radio frequency bands greater than fifteen hundred kilocycles, said system comprising a dipole antenna normally having maximum response for certain bands of said frequencies, a pair of lead-in conductors connected thereto and to a radio receiver, and a filter section comprising an inductance and a capacity arranged to have a high impedance for a selected narrow band of said frequencies intermediate to the bands for which the antenna normally provides maximum response, the filter section being connected in each arm of said dipole at a point sub-

stantially one-quarter wave length of the mid-frequency of said selected band from the connection of the lead-in to said dipole, so that the antenna also provides maximum response for said selected frequency band.

5. An antenna system for use with radio receivers arranged to receive a number of different radio frequency bands greater than fifteen hundred kilocycles, said system comprising a dipole antenna normally having maximum response for certain bands of said frequencies, a pair of lead-in conductors connected thereto and to a radio receiver, and a filter section comprising an inductance and a capacity arranged to be anti-resonant for a selected narrow band of said frequencies intermediate the bands for which the antenna normally provides maximum response, the filter section being connected in each arm of said dipole at a point substantially one-quarter wave length of the mid-frequency of said selected band from the connection of the lead-in to said dipole, so that that portion of the dipole between said filter sections also provides maximum response for said selected frequency band.

6. An antenna system for use with radio receivers arranged to receive a number of different radio frequency bands greater than fifteen hundred kilocycles, said system comprising an antenna of the dipole type, a pair of lead-in conductors connected thereto and to a radio receiver, and a filter section connected in each arm of the antenna between the lead-in connection and the terminus of each arm, said section comprising an inductance and a capacity element arranged in resonant relationship and so that the antenna provides maximum response for separate frequency bands other than the frequency bands for which the entire antenna normally provides maximum response.

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