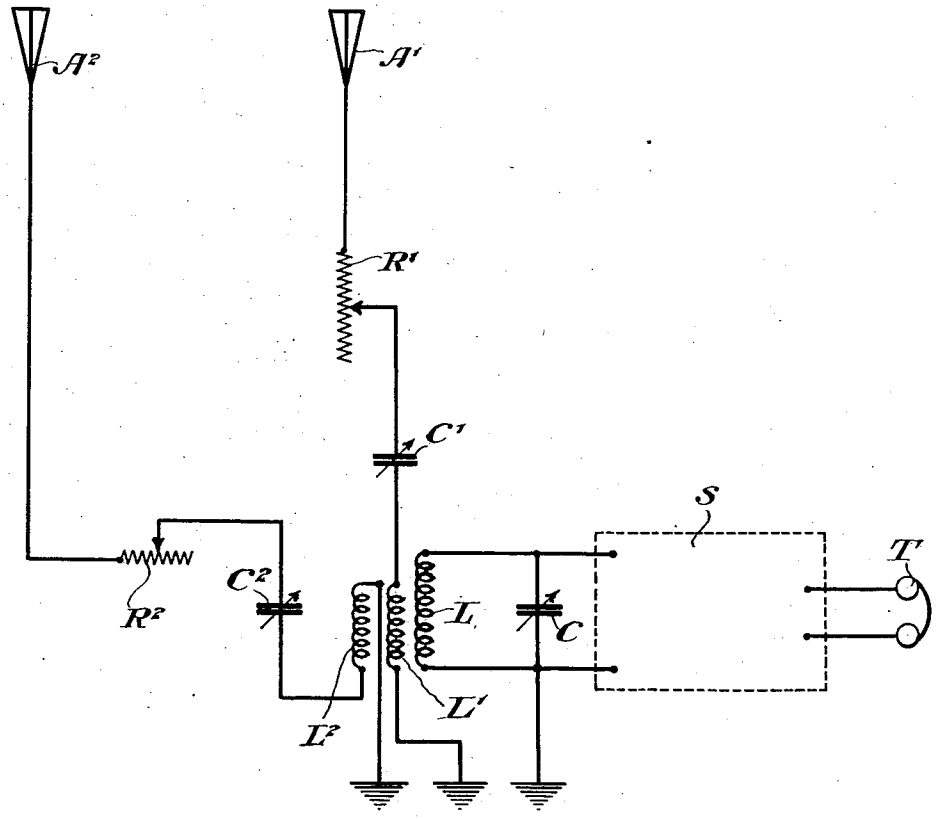
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RADIO RECEIVING SYSTEM

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RADIO RECEIVING SYSTEM

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My invention relates to the reduction or substantial elimination of undesirable noises in a radio receiving system caused by local electrical disturbances, for example, those due to operation of motors, sign flashers, or the like.

In accordance with my invention, two antenna systems of substantially different sensitivity for distant signals are differentially coupled to the receiving apparatus, and are adjusted to be of substantially equal sensitivity to local disturbances.

More specifically, one, and preferably both, of the antenna systems includes capacity adjustable to effect substantially equal magnitudes of the currents in the antenna systems due to the local disturbances, and preferably, adjustable resistance is included in one or both of the antenna systems to effect exact phase opposition of the local disturbance currents.

My invention further resides in the methods and features of combination hereinafter described and claimed.

For an understanding of my invention reference is made to the figure of the drawing which schematically shows the elements of my invention as used with any conventional type of radio receiver.

Specifically referring to the drawing, the receiving set S may be of any of the usual and well known types, utilizing for example one or more stages of tuned radio frequency amplification, a detector and usually one or more stages of audio amplification, or it may be of the superheterodyne type, utilizing the principle of double detection and amplification at an intermediate frequency. The sound-reproducing device T may be a loud speaker, telephone receiver, or the like.

Heretofore many arrangements have been proposed for eliminating or reducing the noise due to atmospherics, but in general they have been unsatisfactory, and particularly are not effective when the undesired noises are caused by local disturbances, for example, by household appliances as vacuum cleaners, electric fans, or the like, or nearby external sources of electrical disturbances, as trolley or electric railroad lines, etc.

In accordance with my invention, in addition to the normal antenna A1 there is utilized an additional or auxiliary antenna A2 which is constructed or disposed to be a materially poorer collector of distant signals than the normal antenna A1. For example, and particularly when the receiver S is for reception of signals in the present broadcast range from about 550 to 1500 kilocycles, the antenna system A1 may be about 30 ft. high and from 50 to 75 ft. long, whereas the antenna A2 should be as low as possible and from 25 to 50 feet long. These values are, of course, by way of example only. The input coil L of the receiving set S is coupled to the normal antenna system A1 by the coil L1, and to the auxiliary antenna system A2 by the coil L2. The coils L1 and L2 are preferably closely magnetically coupled to each other, and substantially equally coupled to the input inductance L.

For the dimensions of antenna systems above given and the working frequency range of the receiving set, the coils L1 and L2 may have an inductance of about 15 microhenries, and the coil L an inductance of approximately 300 microhenries. It will be understood that these values, though not critical, will differ for antenna systems of materially different dimensions and for receiving sets working on frequencies materially different from the broadcast range. The step-up ratio, approximately 1 to 20, afforded by the above values, permits tuning of the input coil, when desirable, by a variable condenser C without substantial detuning effect by the capacities of the antenna systems, and without undue loss in the transfer of signal energy from the antenna systems to the receiver. Condenser C, therefore, may be ganged with other tuning or variable condensers of the receiver without need for auxiliary adjustable devices.

Further, the coils L1, L2 are so poled that the antenna systems are differentially coupled to the input inductance L. This reverse poling may be effected for example either by connections to proper terminals of the coils or by winding the coils in opposite directions.

The condensers C1 and C2 are adjustable

condensers connected in series with the inductances L1 and L2 in the separate antenna systems. In the system specifically described each of the condensers may be adjustable from 10 to 200 micro-microfarads. The resistances R1 and R2, which are not always necessary, may have a maximum value of the order of 1000 ohms for example, and are each connected in series in the separate antenna systems.

A preferred method of adjusting the various units or elements of the antenna systems to minimize or eliminate the noise due to local disturbances is to first adjust the resistances R1 and R2 to a low or substantially negligible value; then, after setting the condenser C1 to its maximum value, the series condenser C2 in the auxiliary antenna system is adjusted until the incoming undesired noise in the telephone or loud speaker is reduced to a zero or minimum value. If this cannot be effected within the range of adjustment of condenser C2, then the capacity of condenser C1 of the normal antenna system is slightly reduced and the operation repeated. A balance point will be found which can be readily identified, for upon either an increase or decrease in the value of condenser C2 in the auxiliary antenna system an increase in noise will result. If under the conditions of balance, the noise level is of minimum but not zero value, either or both of the resistances R1 or R2 are adjusted to add resistance to the antenna systems. These resistances are not always required. Once the balance has been determined, it is not ordinarily necessary to change the adjustment of the condensers, or resistances, unless the constants of the antennas are modified. The condensers C1 and C2 are indicated as variable only to procure final and permanent adjustments of their capacities suited for the particular antenna system. The effect of the condensers C1 and C2 is to procure substantial equality of the effective heights or responsiveness of the antennae A1 and A2 with respect to local disturbances.

Local electrical disturbances which produce undesirable noises are picked up by both the normal and auxiliary antenna systems. By the foregoing adjustments, the currents in the coils L1 and L2 resulting from the electrical disturbances are made substantially equal and opposite so that the magnetic fields of coils L1 and L2 cancel or oppose and do not produce local disturbance currents in the input coil L of the receiver. For substantially complete elimination of the noise, the disturbing currents in the coils L1, L2 must not be only exactly equal and opposite, but must be in exact phase opposition. The currents in their effect upon the input coil L are in opposition by virtue of the reverse poling of the coils L1, L2; they are made equal by adjustments of the capacities C1, C2, and can be brought into exact phase opposition by adjustment of the resistances R1 and R2.

Although the antenna systems have been exactly balanced with respect to the effect of local electrical disturbances of the character above described, the receiving set S responds to more distant signals since the normal antenna A1 is a materially better collector of distant signals than the auxiliary antenna A2. The effectiveness of the normal antenna is materially higher for distant signals, whereas for local disturbances, the pick-up of the auxiliary antenna is preferably greater and by reason of the adjustments above described is made equal. The adjustments have little effect upon the relative sensitivity of the antennas for distant signals. Because of the different ratios of effectiveness for distant signals and local disturbances, distant signals are received with substantially complete freedom from noises due to the local electrical disturbances which as a rule have relatively powerful but quite restricted fields of influence.

What I claim is:

1. In a radio system differentially coupled to two antenna systems including series condensers, the method of reducing noises due to local disturbances which comprises adjusting the relative values of said condensers until both an increase and decrease in value of one of them effects an increase in the noise.

2. In a radio system differentially coupled to two antenna systems each including a series combination of resistance and capacity, the method of reducing noises due to local disturbances which comprises adjusting the relative values of said condensers, while said resistances are of low value, until both an increase and decrease in value of one of them effects an increase in the noise, and thereafter adjusting the values of said resistances to effect substantially exact phase opposition of the local disturbance currents in said systems.

3. In a radio receiving system in which a receiver is differentially coupled to two antenna systems, for one of which the ratio of its effective height regarding signal to its effective height regarding local disturbances is different from the like ratio for the other antenna system, the method of reducing the effect of the local disturbances which comprises permanently adjusting capacity in series with that antenna system having the higher of the aforesaid ratios to a magnitude for which the local disturbances are balanced by adjustment of a capacity in series with the other antenna system to such magnitude that variation therefrom causes an increase in the effects of the local disturbances.

4. In a radio receiving system in which a

receiver is differentially coupled to two antenna systems, for one of which the ratio of its effective height regarding signal to its effective height regarding local disturbances is different from the like ratio for the other antenna system, the method of reducing the effect of the local disturbances while substantially maintaining the signal strength, which comprises permanently adjusting capacity in series with that antenna system having the higher of the aforesaid ratios to substantially the maximum magnitude for which the local disturbances are balanced by adjustment of a capacity in series with the other antenna system to such magnitude that variation therefrom causes an increase in the effects of the local disturbances.

5. In a radio receiving system in which a receiver is differentially coupled to two antenna systems, for one of which the ratio of its effective height regarding signal to its effective height regarding local disturbances is different from the like ratio for the other antenna system, the method of reducing the effect of the local disturbances, which comprises permanently adjusting capacity in series with that antenna system having the higher of the aforesaid ratios to a magnitude for which the local disturbances are balanced by adjustment of a capacity in series with the other antenna system to such magnitude that variation therefrom causes an increase in the effects of the local disturbances, and adjusting the resistances of said antenna systems to such relative magnitudes that the currents in said systems due to local disturbances are substantially in phase.

6. In a radio receiving system in which a receiver is differentially coupled to two antenna systems, for one of which the ratio of its effective height regarding signal to its effective height regarding local disturbances is different from the like ratio for the other antenna system, the method of reducing the effect of the local disturbances while substantially maintaining the signal strength, which comprises permanently adjusting capacity in series with that antenna system having the higher of the aforesaid ratios to substantially the maximum magnitude for which the local disturbances are balanced by adjustment of a capacity in series with the other antenna system to such magnitude that variation therefrom causes an increase in the effects of the local disturbances, and adjusting the resistances of said antenna systems to such relative magnitudes that the currents in said systems due to local disturbances are substantially in phase.

7. A radio receiving system comprising two antenna systems, for one of which the ratio of its effective height regarding signal to its effective height regarding local disturbances is different from the like ratio for the other antenna system, a radio receiver, means for differentially coupling said receiver to said antenna systems, a capacity in series with each of said antenna systems, said capacities having such magnitudes that the effects of said local disturbances upon said receiver are balanced, the magnitude of the capacity in series with that antenna system having the higher of the aforesaid ratios being such that the effect of the local disturbances upon said receiver would increase for change in either sense of the magnitude of the capacity in series with the other of said antenna systems.

8. A radio receiving system comprising two antenna systems, for one of which the ratio of its effective height regarding signal to its effective height regarding local disturbances is different from the like ratio for the other antenna system, a radio receiver, means for differentially coupling said receiver to said antenna systems, a capacity in series with each of said antenna systems, said capacities having such magnitudes that the effects of said local disturbances upon said receiver are balanced, the magnitude of the capacity in series with that antenna system having the higher of the aforesaid ratios being such that the effect of the local disturbances upon said receiver would increase for change in either sense of the magnitude of the capacity in series with the other of said antenna systems, and a resistance in series with at least one of said antenna systems of a magnitude such that the currents in said antenna systems due to the local disturbances are substantially in phase.

9. A radio receiving system comprising two antenna systems, for one of which the ratio of its effective height regarding signal to its effective height regarding local disturbances is different from the like ratio for the other antenna system, a radio receiver, means for differentially coupling said receiver to said antenna system, a capacity in series with each of said antenna systems, said capacities having such magnitudes that the effects of said local disturbances upon said receiver are balanced, the capacity in series with that antenna system having the higher of the aforesaid ratios having the maximum magnitude for which variation in magnitude of the capacity in series of the other antenna system causes increase in the effects by the local disturbances.

10. A radio receiving system comprising two antenna systems, for one of which the ratio of its effective height regarding signal to its effective height regarding local disturbances is different from the like ratio for the other antenna system, a radio receiver, means for differentially coupling said receiver to said antenna system, a capacity in series with each of said antenna systems, said capacities having such magnitudes that the effects of said local disturbances upon said

receiver are balanced, the capacity in series with that antenna system having the higher of the aforesaid ratios having the maximum magnitude for which variation in magnitude of the capacity in series of the other antenna system causes increase in the effects by the local disturbances, and a resistance in series with at least one of said antenna systems of a magnitude such that the currents in said antenna systems due to the local disturbances are substantially in phase.

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