July 28, 1942.

N. P. CASE

ANTENNA SYSTEM

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2,291,450

FIG. 1.

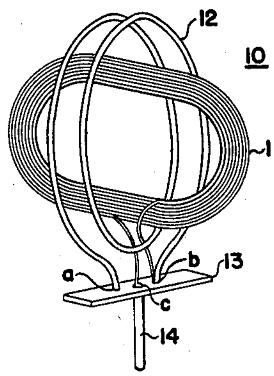


FIG. 2.

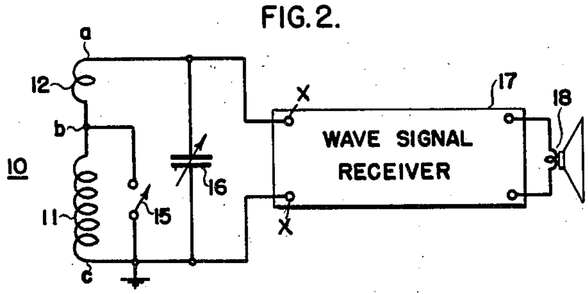


FIG. 3.

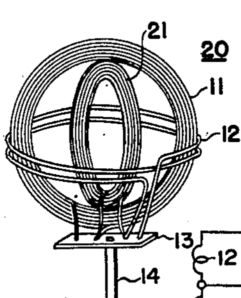
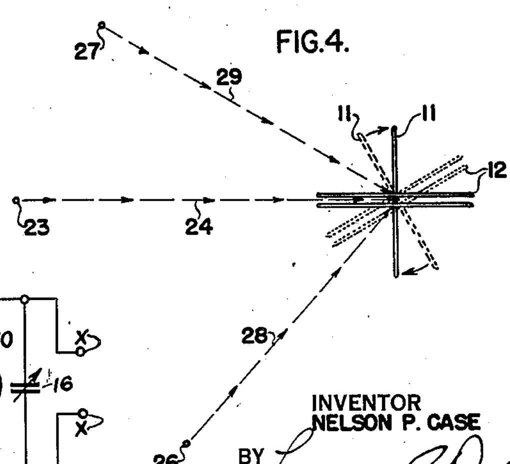


FIG. 4.



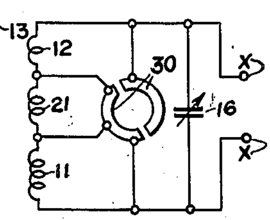


FIG 5

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ANTENNA SYSTEM

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11 Claims. (Cl. 250—33)

This invention relates to antenna systems and particularly to loop antenna systems for selectively receiving wave signals in different frequency ranges.

It is a well-known fact that a loop antenna essentially is a coil of large area. A radiated wave signal induces a voltage in the circuit of the loop antenna that varies in amplitude with the orientation of the loop antenna with respect to the wave front; that is to say, when the plane of the loop antenna is parallel to the direction of wave-signal travel and normal to the direction of the magnetic field, the wave front reaches the two sides of the coil at slightly different times, causing a phase difference in the voltages induced therein that gives rise to a resultant voltage acting around the circuit of the loop.

For receiving wave signals in two different frequency ranges, such as the so-called "broadcast" frequency range and the so-called "short-wave" frequency range, it has heretofore been proposed to utilize a single coil loop antenna tuned by a single tuning condenser and having a tap dividing the loop into two sections, each tunable by the condenser to wave signals in its respective frequency range. However, such a tapped loop antenna inherently has certain disadvantages; for example, when an unused loop antenna section is short-circuited during the operation of an active loop antenna section in its respective frequency range, the short-circuited loop antenna section acts as a shield which impairs operation of the active loop antenna section.

Another disadvantage of loop antenna arrangements of the prior art is that of undesirable sensitivity to local noise, resulting from natural and man-made electrical disturbances.

It is an object of this invention, therefore, to provide an improved loop antenna system which overcomes the foregoing undesirable features of the prior art and which is simple and economical in its parts and efficient and effective in operation.

It is another object of the invention to provide an improved loop antenna system which is selectively tunable to wave signals in different frequency ranges.

It is a further object of the invention to provide a loop antenna system comprising several antenna sections which are responsive to wave signals and are tunable to given frequency ranges and wherein one antenna section is caused to provide an interference-reducing shield for the active antenna section.

In accordance with one embodiment of the invention, an antenna system selectively operable over a plurality of carrier-wave frequency ranges comprises a plurality of antenna sections each having the property of directional response and each adapted to be tuned to carrier signals in its respective frequency range. The antenna sections are so oriented relative to each other that their respective directions of response form a relatively large angle. The system includes means for effectively selecting one of the sections to receive desired carrier signals in its respective frequency range and for conditioning another of the sections to reduce over the frequency range of the one section the intensity of received wave signals arriving at the antenna system from directions other than the direction of maximum response of the one section, whereby the other section is effective to provide an interference-reducing shield for the one section.

In accordance with a particular form of the invention, in an antenna system of the type described, antenna means selectively tunable to wave signals in three different frequency ranges comprises three loop antenna sections each directionally responsive to wave signals in its respective frequency range. The loop antenna sections are disposed in planes having relatively large angles to each other, one of the planes intersecting the line of intersection of the other two planes at a large angle. The antenna means includes means for tuning one of the loop antenna sections to desired wave signals in its respective frequency range, and means for rendering others of the loop antenna sections effective to absorb carrier-signal energy over the frequency range of the one antenna section, whereby the other loop antenna sections effectively provide an interference-reducing shield for the one loop antenna section.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the accompanying drawing, Fig. 1 is a perspective view of an antenna system embodying the present invention; Fig. 2 is a circuit diagram, partly schematic, of a wave-signal receiver including the antenna system of the invention; Fig. 3 is a perspective view of another antenna system comprising a modified form of the invention; Fig. 4 is a plan view illustrating the operation of the invention; and Fig. 5 is a circuit diagram of an antenna system embodying the antenna of Fig. 3.

Referring now more particularly to Fig. 1 of the drawing, there is illustrated, in an antenna system 10, antenna means adapted to be selectively tunable to wave signals in different frequency ranges. This means comprises a plurality of loop antenna sections, specifically an antenna section 11 of relatively high inductance and an antenna section 12 of relatively low inductance, each responsive to wave signals in its respective frequency range and mounted on any suitable support 13 for rotation about a vertical spindle 14. The antenna section 11 consists of a coil of a plurality of turns responsive to modulated carrier-wave signals in the broadcast range of frequencies, for example. The antenna section 12 is arranged on the outside of the section 11 in a plane substantially at right angles thereto and consists of two turns of metal tubing, such as copper, to provide a coil responsive to modulated carrier-wave signals in a higher frequency range, for example. The two sections 11 and 12 of the antenna 10 are connected in series relation and are provided with a common terminal *b* and end terminals *a* and *c*.

Referring now to Fig. 2 of the drawing, there is represented a circuit diagram, partly schematic, of a complete wave-signal receiver including the antenna system of the invention. The common terminal *b* of the loop sections 11 and 12 is coupled through a normally open switch 15 to a terminal *c* of the antenna section 11 for short-circuiting the latter, as desired. The antenna sections 11 and 12 are coupled through terminals *a* and *c* to a conventional tuning condenser 16 to form the tunable input circuit of a wave-signal receiver 17 of any suitable type, such as a super-heterodyne receiver, the output of which is delivered to a sound-reproducing unit 18.

In considering the operation of the present invention, reference is had to Fig. 4 of the drawing, it being assumed that the switch 15 is closed to short-circuit the section 11 and that the receiver is tuned to any desired station 23, the antenna 10 being in the position indicated by dotted lines with respect to the direction of travel 24 of the desired signals from the station 23. In this position of the antenna 10, the selected section 12 is not in a position parallel with direction of travel 24 of the desired signals and intercepts but a fraction of the available signal strength; while the nonselected section 11 is not in a position normal to the wave front so that it also intercepts and effectively partially absorbs the desired wave signals. Hence, the output of the receiver is even lower than it would be were the nonselected antenna section 11 not present. However, as the antenna 10 is adjusted about its axis of rotation to orient the selected section 12 so that its plane is parallel to the direction of travel 24 of the desired wave signal in its frequency range, the signal pick-up of the selected section 12 increases and the absorption by the nonselected section 11 simultaneously decreases so that the output of the receiver increases rapidly to a maximum value. Thus, the nonselected section 11 imparts to the selected section 12 a sharply-directional characteristic so that the selected section may be readily adjusted as nearly in parallel relation with the direction of travel of the desired signals as is consistent with conditions of reception, for example, noise interference. In such position of the antenna 10, with the plane of the selected short-wave antenna section 12 in substantially parallel relation to the direction of travel 24 of the wave signal, a maximum signal voltage is induced therein, the short-circuited section 11 being disposed in a vertical plane substantially parallel to the signal-wave front, that is to say, at right angles to the direction of travel of the wave signal. In this way, the nonselected section 11 not only does not impair operation of the selected section 12 but reduces undesirable interference, particularly noises arising from nearby sources and interfering signals from other directions, such as signals radiated from stations 26 and 27 having directions of travel 28 and 29, respectively, angularly related to the plane of the selected section 12.

When one antenna section is active and properly oriented with respect to the direction of travel of the desired wave signals, the nonselected section effectively shields the active section from all undesirable interference originating from stations in directions different from the source of desired signals, except that no reduction is effected in the interference produced by an undesired station located exactly 180 degrees from the desired station. Coupling between the selected and nonselected sections is maintained at a minimum by virtue of their physical relation with respect to each other. The shielding effect of the nonselected section is due primarily to its action as a trap for noise which might otherwise interfere with the desired signals to which the selected section is properly tuned and oriented.

For broadcast band reception, the switch 15 is left open and the operation of the system is similar to that described above except for the absence of the directional and shielding effects. However, if such effect is necessary or desired, it may be obtained by short-circuiting the antenna section 12 during operation with the broadcast band section 11.

From the foregoing description of the invention, it will be seen that the condenser 16 comprises means for tuning one of the loop antenna sections, for example the antenna section 12 of lower inductance, to wave signals in a desired frequency range and the switch 15 comprises means for effectively short-circuiting the other loop antenna section, for example the antenna section 11 of higher inductance, to condition such other loop section 11 to reduce over the frequency range of the one section 12 the intensity of received wave signals arriving at the antenna system from directions other than the direction of maximum response of the one section 12, whereby the other loop-antenna section 11 effectively provides an interference-reducing shield for the one loop antenna section 12.

Referring to Fig. 3, a modified form of the invention is embodied in the antenna system 20 which comprises a loop antenna section 21 in addition to the two sections 11 and 12 corresponding to those of antenna system 10 and lying in a plane perpendicular to the planes of both such antenna sections. As thus arranged, the sections 11 and 21 lie in substantially vertical planes and the section 12 lies in a substantially horizontal plane. The section 21 is selectively tunable to wave signals in a different frequency range from that of either of sections 11 and 12. The circuit arrangement of the modification of Fig. 3, as represented in Fig. 5, is essentially similar to that of Fig. 2 and similar circuit elements are designated by similar reference characters. In this modification, the switch 30 is of a conventional construction which is effective selectively to connect any one of the loop-antenna sections 11, 21, and 12, across the tuning condenser 16 while, at the same time, shorting out of circuit the remaining two antenna sections. The operation of this embodiment will be understood from the detailed description of that of the embodiment of Figs. 1 and 2 without further elaboration here except to point out that the loop antenna sections are series-connected and progressively increase in inductance, each of the three antenna sections being responsive and tunable to a separate individual frequency range. The circuit arrangement is such that the two sections not being used in the reception of a desired signal wave are short-circuited to provide interference-reducing shields for the active sections used in the reception of the desired signal wave. However, when a high-frequency section is active, a nonadjacent low-frequency section need not be physically shorted; for example, when the highest-frequency section 12 is active, the inherent capacitance of the lowest-frequency section 11 effectively short-circuits it at frequencies within the high-frequency range.

When the loop antenna sections 11, 12, Fig. 1, or 11, 12 and 21, Fig. 3, are so oriented relative to each other that their respective directions of response form a relatively large angle as described, the selected section has a maximum directional response in the direction of the plane in which it lies due to the effect of a nonselected section or sections in providing maximum shielding effect for undesired wave signals arriving at the antenna section from a direction forming a large angle with the direction of arrival of desired wave signals.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An antenna system selectively operable over a plurality of carrier-wave frequency ranges comprising, a plurality of antenna sections each having the property of directional response and each adapted to be tuned to carrier signals in its respective frequency range, said antenna sections being so oriented relative to each other that their respective directions of response form a relatively large angle, and means for effectively selecting one of said sections to receive desired carrier signals in its respective frequency range and for conditioning another of said sections to reduce over the frequency range of said one section the intensity of received wave signals arriving at said antenna system from directions other than the direction of maximum response of said one section, whereby said other section is effective to provide an interference reducing shield for said one section.

2. An antenna system selectively operable over a plurality of carrier-wave frequency ranges comprising, a plurality of loop-antenna sections, each having the property of directional response and each adapted to be tuned to carrier signals in its respective frequency range, said loop-antenna sections being so oriented relative to each other than their respective directions of response form a relatively large angle, and means for effectively selecting one of said loop sections to receive desired carrier signals in its respective frequency range and for conditioning another of said loop sections to reduce over the frequency range of said one section the intensity of received wave signals arriving at said antenna system from directions other than the direction of maximum response of said one section whereby said other loop section is effective to provide an interference-reducing shield for said one loop section.

3. In an antenna system, antenna means selectively tunable to wave signals in different frequency ranges comprising, a plurality of loop antenna sections each responsive to wave signals in its respective frequency range, at least two of said loop antenna sections being disposed in planes substantially at right angles to each other, means for tuning one of said two loop antenna sections to wave signals in a desired frequency range, and means for conditioning the other of said two loop antenna sections to reduce over the frequency range of said one section the intensity of received wave signals arriving at said antenna system from directions other than the direction of maximum response of said one section, whereby said other loop antenna section effectively provides an interference-reducing shield for said one loop antenna section.

4. In an antenna system, antenna means selectively tunable to wave signals in different frequency ranges comprising, a pair of loop antenna sections of different inductance each responsive to wave signals in its respective frequency range, said loop antenna sections being disposed in planes substantially at right angles to each other, means for tuning the loop antenna section of lower inductance to wave signals in a desired frequency range, and means for conditioning the loop antenna section of higher inductance to reduce over the frequency range of said antenna section of lower inductance the intensity of received wave signals arriving at said antenna system from directions other than the direction of maximum response of said antenna section of lower inductance, whereby said loop antenna section of higher inductance effectively provides an interference reducing shield for said loop antenna section of lower inductance.

5. In an antenna system, antenna means selectively tunable to wave signals in different frequency ranges comprising, a pair of series-connected loop antenna sections of different inductance each responsive to wave signals in its respective frequency range, said loop antenna sections being disposed in planes substantially at right angles to each other, means for tuning the loop antenna section of lower inductance to wave signals in a desired frequency range, and means for effectively short-circuiting said loop antenna section of higher inductance, whereby said loop-antenna section of higher inductance effectively provides an interference-reducing shield for said loop-antenna section of lower inductance.

6. In an antenna system, antenna means selectively tunable to wave signals in different frequency ranges comprising, a pair of loop antenna sections connected in series one of which is responsive to wave signals in a broadcast frequency range and the other of which is responsive to wave signals in a higher-frequency range, said loop antenna sections being disposed in planes substantially at right angles to each other, means for tuning one of said loop antenna

sections to wave signals in a desired frequency range, and means for effectively short-circuiting the other of said loop antenna sections, whereby said other loop antenna section effectively provides an interference-reducing shield for said one loop antenna section.

7. In an antenna system, antenna means selectively tunable to wave signals in three different frequency ranges comprising, three loop antenna sections each responsive to wave signals in its respective frequency range, said loop antenna sections being disposed in planes at right angles to one another, means for tuning one of said loop antenna sections to wave signals in a desired frequency range, and means for effectively short-circuiting the others of said loop antenna sections, whereby said other antenna sections effectively provide an interference-reducing shield for said one loop-antenna section.

8. In an antenna system, antenna means selectively tunable to wave signals in three different frequency ranges comprising, three series-connected loop antenna sections of progressively increasing inductance each responsive to wave signals in its respective frequency range, said loop antenna sections being disposed in planes at right angles to one another, means for tuning one of said loop antenna sections of lower inductance to wave signals in its respective frequency range, and means for effectively short-circuiting at least one of the loop antenna sections of higher inductance than said one section, whereby said one section of higher inductance effectively provides an interference-reducing shield for said one section of lower inductance.

9. In an antenna system, directionally adjustable antenna means selectively tunable to wave signals in different frequency ranges comprising, a plurality of loop antenna sections, each responsive to wave signals in its respective frequency range, at least two of said sections being disposed in vertical planes substantially at right angles to each other, said sections being rotatable about a vertical axis for orienting a selected one of said sections so that its plane is parallel to the direction of travel of desired wave signals in its frequency range, means for tuning the selected section to wave signals in the desired frequency range, and means for effectively short-circuiting the other of said two sections, whereby, in orienting the selected section with respect to the direction of travel of the desired wave signals, said other section effectively partially absorbs the desired wave signals when the selected section is not exactly oriented, thereby to impart a sharply-directional characteristic to the selected section and the effect of said other section on the selected section being such, when the selected section is properly oriented, that the said other section provides an effective interference-reducing shield for the selected section.

10. In an antenna system, antenna means selectively tunable to wave signals in three different frequency ranges comprising, three loop-antenna sections each directionally responsive to wave signals in its respective frequency range, said loop-antenna sections being disposed in planes having relatively large angles to each other, one of said planes intersecting the line of intersection of the other two planes at a large angle, means for tuning one of said loop-antenna sections to desired wave signals in its respective frequency range, and means for rendering the others of said loop-antenna sections effective to absorb carrier-signal energy over the frequency range of said one antenna section, whereby said other loop-antenna sections effectively provide an interference-reducing shield for said one loop-antenna section.

11. In an antenna system, directionally-adjustable antenna means selectively tunable to wave signals in different frequency ranges comprising, three loop-antenna sections each responsive to wave signals in its respective frequency range, two of said sections being disposed in vertical planes substantially at right angles to each other and the third of said sections being disposed in a substantially horizontal plane, said vertically-disposed sections being rotatable about a vertical axis for orienting a selected one of said vertically-disposed sections so that its plane is parallel to the direction of travel of desired wave signals in its frequency range, means for tuning a selected one of said sections to desired wave signals in its respective frequency range, and means for rendering the others of said sections effective to provide an interference-reducing shield for said selected section, whereby, in orienting said selected section with respect to the direction of travel of the desired wave signals, at least one of the non-selected sections effectively partially absorbs the desired wave signals when the selected section is not exactly oriented, thereby to impart a sharply-directional characteristic to said selected section.

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