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COMBINED MULTI-POLARIZATION LOOPSTICK AND WHIP ANTENNA

Filed June 1, 1971 2 Sheets-Sheet 1

FIG. 1

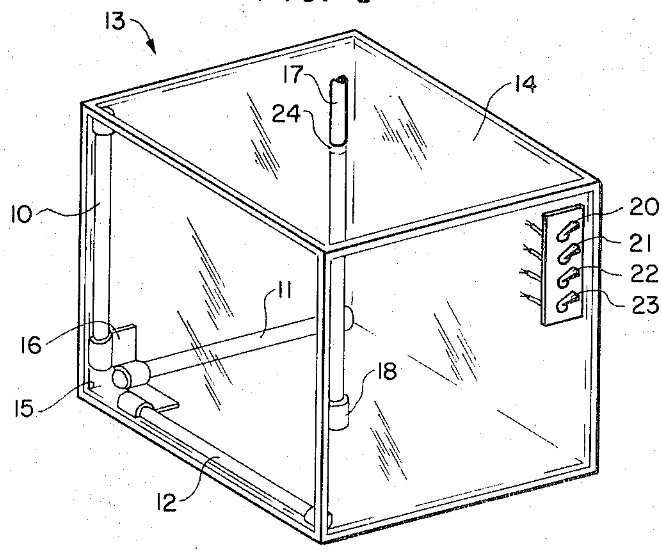

FIG. 2

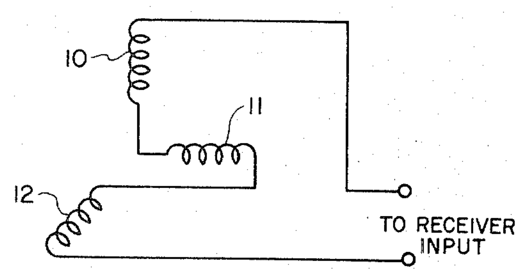

FIG. 3

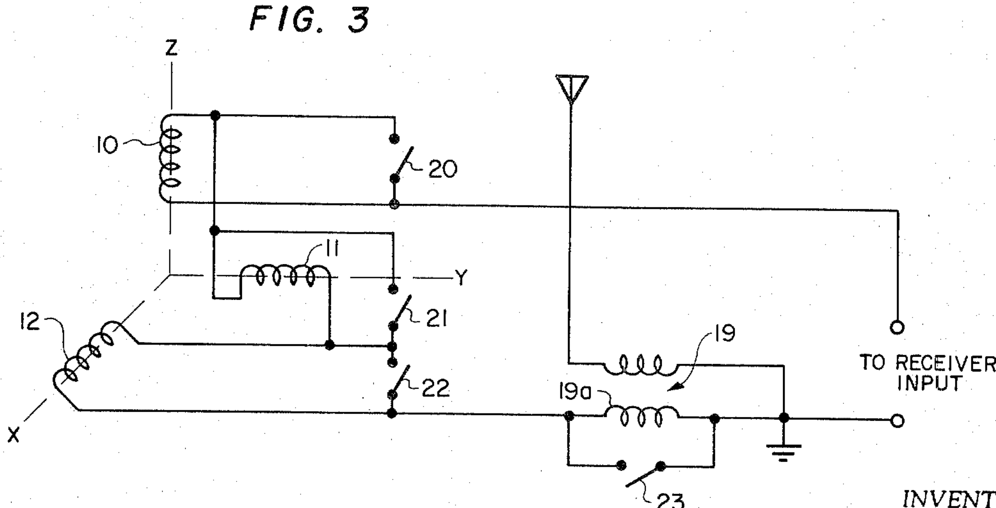

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FIG. 5

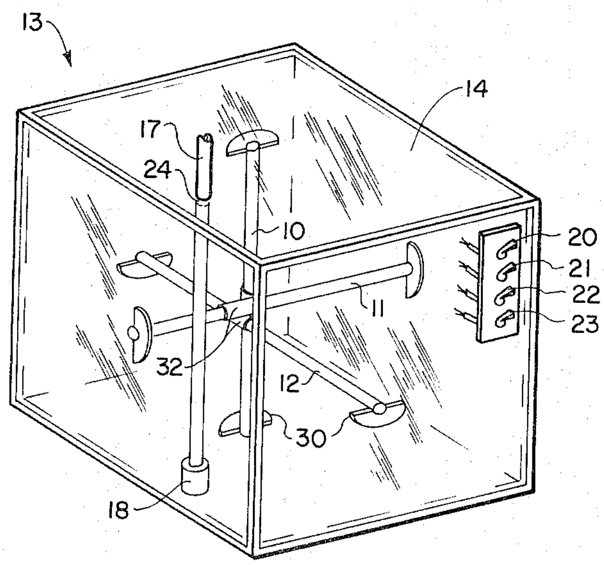
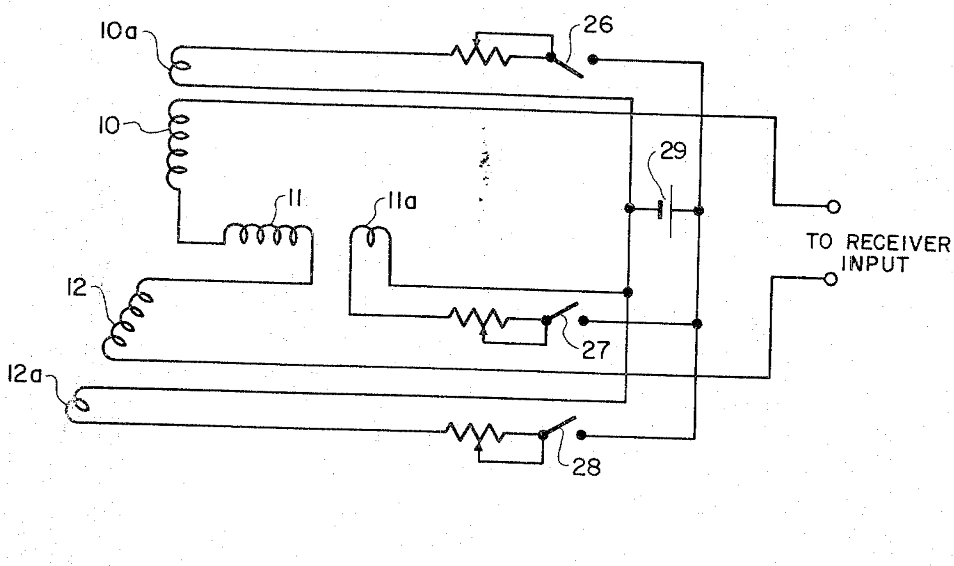


FIG. 4



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COMBINED MULTI-POLARIZATION LOOPSTICK AND WHIP ANTENNA

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ABSTRACT OF THE DISCLOSURE

A receiving antenna assembly for mitigating signal fading and cancellation caused by the degrading effects of multipaths and scatter in jungle, mountain or urban environments which antenna has three mutually-perpendicular, multi-polarization ferrite loopsticks for sensing H field signal energy and a whip antenna for sensing E field signal energy, and selection means for choosing among the signal energies sensed by the ferrite loopsticks and the whip antenna.

BACKGROUND OF THE INVENTION

Radio reception is best in free space. Where reception quality approaches that of free space, an E field antenna, e.g. a whip antenna is superior to and preferred over an H field antenna because of its higher sensitivity; however, antenna size limitations or directionality requirements may dictate an H field antenna rather than an E field antenna. If the receiver is equipped with an E field antenna or an H field antenna, there will be locations where signal fading and nulls are so bad that the radio communication link is effectively broken. For an E field antenna particularly, deep jungle paths, low places in mountainous regions, urban canyons, proximity to massive metal structures such as bridges, and highly conductive water soaked soil are examples of problem areas for radio reception. Because mobile or portable communications receivers are used in many different kinds of terrain and even change terrain during message reception, it is expected that there will be reception difficulty in some locations of the receiver. In problem receiving areas, the receiver operator often is unaware of incoming calls. If he detects a call that is not clearly audible, he orients the antenna, or the equipment if the antenna is not adjustable and he may succeed in increasing the signal level. Experiments demonstrated that sometimes reorientation of a whip antenna may enable a signal to be received when its presence is not detectable or just barely detectable, with the whip oriented vertically. If a call goes completely undetected, there can be no reorientation efforts.

Generally, signal degradation results from multipaths and scatter. An effect of multipaths and scatter on radio transmission is that the signals undergo continuous phase, amplitude and polarization changes during propagation. This may cause fading or cancellations in many planes of polarization. However, it is highly improbable that at a particular location there will be signal cancellation in all planes of polarization simultaneously.

SUMMARY OF THE INVENTION

An object of this invention is to mitigate the signal fading, deep nulls and signal cancellation manifested by mobile and portable radio receivers operated in jungle areas, urban areas, on areas of water-soaked conductive soil, and in proximity to massive conductive structures.

A further object is to provide improvements in radio receiver equipments to enable the receiver operator to be apprized of incoming calls that he might otherwise miss.

A further object is to improve operation of a radio receiver that is moved through different kinds of environments along which signal degradation might occur.

The foregoing as well as other objects are accomplished in accordance with the present invention by assembling three mutually-perpendicular ferrite loopstick elements for sensing H field energy and a whip element for sensing E field energy and selector switches. In one arrangement selector switches are used to complete by-pass shunts across individual antenna elements. In another arrangement, an auxiliary coil is provided on each loopstick core and selector switches are used to connect the auxiliary coil to a direct current supply to magnetically saturate the respective loopstick core. In all embodiments, all antenna elements may be active until a call is heard at which time an antenna arrangement can be selected for good reception and for proper impedance for the receiver input.

BRIEF DESCRIPTION OF THE DRAWINGS

The above recited objects and others along with many of the attendant advantages of the present invention will become more readily apparent as the detailed description is considered in connection with the accompanying drawings in which:

FIG. 1 is a perspective view of an antenna assembly including three ferrite loopsticks, a whip element and switches in accordance with the teachings of this invention but not including electrical connections;

FIG. 2 is a circuit diagram of the loopstick coils of FIG. 1;

FIG. 3 is a circuit diagram that includes the loopstick coils, the whip antenna and the switches shown in FIG. 1;

FIG. 4 is a circuit diagram that shows the loopsticks and switches of FIG. 1 plus auxiliary saturation coils and a direct current power source not shown in FIG. 1; and

FIG. 5 is a modification of the embodiment shown in FIG. 1.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now in detail to the drawings wherein like reference characters represent like parts throughout the several views there are shown in FIGS. 1 and 2 three ferrite loopsticks **10, 11** and **12** supported in essentially mutually-perpendicular relationship by a nonconducting housing **13.** Impregnated fiberglass or resin are suitable materials for housing **13.** A rigid nonconductive open framework not shown may be used in place of housing **13.** Initially, at assembly, upper side **14** of the housing is not in place. The loopstick coils either are connected in series as shown in FIG. 2 or in the alternative, not shown in the drawing, they are connected in parallel, prior to being fixed in place in the housing. All three loopsticks are fixed in place in the housing along three mutually-perpendicular corners radiating from common point **15** and contiguous to each other adjacent point **15**. Any convenient nonmagnetic, nonconductive hold-down means such as a suitably molded resinous element **16** cemented to the housing secures the ferrite loopsticks relative to each other and relative to the housing. In FIG. 2, the series connection of the loopstick coils and the orientation of the three loopsticks relative to point **15** is such that the windings of the three coils advance in the same direction relative to point **15** and are electrically connected so that the coils are in corresponding relationship whereby any signal sensed by the three H field elements are additive irrespective of orientation of the antenna assembly. Impedance matching to the receiver influences the choice between connecting the coils in series or in parallel in the assembly.

In addition to three loopsticks, the embodiment shown in FIG. 1 includes a whip antenna **17** nested and cemented in a support member **18** that is either anchored to the bottom of the housing or integrally molded with the housing bottom. The secondary **18** of the whip antenna coupler **19** shown in FIG. 3 is connected in additive series with the series-connected coils of the loopsticks. Switches **20, 21, 22** and **23** are provided to complete shunts selectively across any one or a plurality of the coils of the loopsticks or of the secondary **18** of antenna coupler **19**. The housing **13** may be filled with potting material, not shown, to more firmly secure the antenna elements. The sixth side **15** of the housing is cemented in place and has a perforation **24** for registration with the whip **17**.

Tests on an arrangement of the type described in the presence of multipath signals at VHF frequencies showed that when the whip antenna was actively connected to the input, and the antenna was moved about the area, detected signal strength was dramatically influenced also by change in whip orientation and by proximity to metal sheets and pipes. When the whip antenna was encoupled from the receiver input and the series-connected loopstick assembly was coupled to the receiver input, detected signal strength did not vary appreciably as the assembly was moved about the test area under the same test conditions as was imposed with the whip coupled to the receiver. The three ferrite loopstick assembly was rotated and oriented in all directions; detected signal strength exhibited only minor variation. The sensitivity of the multiple polarization ferrite loopstick assembly was not significantly affected even when placed close to and behind metal sheets and pipes. The excellent performance of the ferrite loopstick assembly in proximity to conducting material ensures good reception in the vicinity of massive metal structures and in areas of conducting ground where the sensitivity of the whip antenna is low.

Some environments cause considerable changes in radio signal electromagnetic field, e.g. reversal of preferred polarization, or shifts in predominance between E and H components of the field. These effects may be encountered in urban environments or over mixed paths such as jungle to clearing. Also variations in electrical characteristics of lossy conductive and dielectric ground tend to cause mismatch of a single E or H field antenna element to the wave impedance of that environment, causing reduced signal power transfer to the antenna. By using a combination of E and H field antenna elements as in FIGS. 1 and 3, a better impedance match may be achieved in some environments. If the whip antenna element has the same impedance as the loopstick antenna elements, and two of four are selected, the impedance presented to the receiver input is the same for all combinations.

If the operator has the equipment turned on, all switches **20, 21, 22** and **23** may be left open whereby

all the antenna elements are connected in series to the input. The three H field elements are omnidirectional and will sense a radio signal when the H field is of minimal strength, and the E field element will sense E field energy polarized in the direction of the E field element. Once the operator is alerted to the incoming call, as when the detected signal overrides the squelch, he opens and closes the several switches and adjusts the orientation of the E field element to optimize reception. Three mutually-perpendicular E field elements may be used instead of the single one shown to obviate the need for adjusting the orientation of the E field antenna; however, three such antenna elements are impractical on mobile and portable communication equipment.

An alternative method for switching H field elements is shown in FIG. 4. It includes an auxiliary coil **10***a*, **11***a* and **12***a* on the ferrite core of the respective loopsticks. Switch and potentiometer units **26, 27** and **28** shown only in FIG. 4 are connected in series with coils **10***a*, **11***a* and **12***a* respectively and direct current source **29**. Closing any of the switches **26, 27** and **28** and setting the potentiometer at lowest resistance saturates the respective ferrite core so that the corresponding loopstick is rendered insensitive. If the potentiometer is adjusted after the respective switch is closed, $m\mu$ of the loopstick is adjusted for improving reception.

FIG. 5 shows another embodiment of the assembly of antenna elements wherein the three ferrite loopsticks **10, 11** and **12** are supported in housing **13** to cross one another near their centers and to butt against one another. There is a thin mylar insulation collar **32** on each loopstick intermediate the ends where the loopsticks cross. The loopsticks are seated in place in housing **13** against cushion-lined arcuate nesting elements **30** that are cemented to the inside faces of the sides of housing **13**. The orientation of the pairs of nesting elements **30** for the respective loopsticks is such that the loopsticks are braced by one another at assembly. As in the embodiment of FIG. 1, the sixth side **14** of the housing has a perforation **24** that registers with the whip at assembly. The housing **14** may be filled with lightweight non-conductive granular material to add support against vibration or it may be filled with plastic potting material for support and waterproofing. If filling is not essential, minimum weight would suggest no filler material. The side **14** is cemented in place.

While the invention has been described in connection with an illustrative embodiment, obvious modifications thereof are possible without departing from the spirit of the invention. Accordingly, the invention should be limited only by the scope of the appended claims.

What is claimed is:

1. A multipolarization antenna comprising three ferrite loopsticks, each having a ferrite core and a coil surrounding the core, the coils being connected in open series, means fixedly supporting the three loopsticks in a mutually-perpendicular contiguous assembly, essentially radially relative to a common center, and the coils on the three loopstick cores having the same direction of advance relative to this common center.

2. A multipolarization antenna as defined in claim **1** further including means for selectively rendering insensitive any of the three loopsticks.

3. A multipolarization antenna as defined in claim **2** wherein said means for selectively rendering insensitive any of the three loopsticks includes selectively operable shunt means for short circuiting any of said coils.

4. A multipolarization antenna as defined in claim **2** wherein said means for selectively rendering insensitive any of the three loopsticks includes an auxiliary coil on each core and a switch in series therewith for connecting the respective auxiliary coil to a direct current supply for saturating the respective core.

5. A multipolarization antenna comprising three ferrite loopsticks, each having a ferrite core and a coil surrounding the core, the three coils being connected in open series, means fixedly supporting the three loopsticks in a mutually perpendicular contiguous assembly, a whip antenna affixed to the three loopstick assembly, an antenna coupler including a primary in series with the whip antenna and a secondary in series with the three series-connected loopstick coils.

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