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MULTI-TURN LOOP ANTENNA WITH HELICAL TWIST TO INCREASE THE SIGNAL-TO-NOISE RATIO

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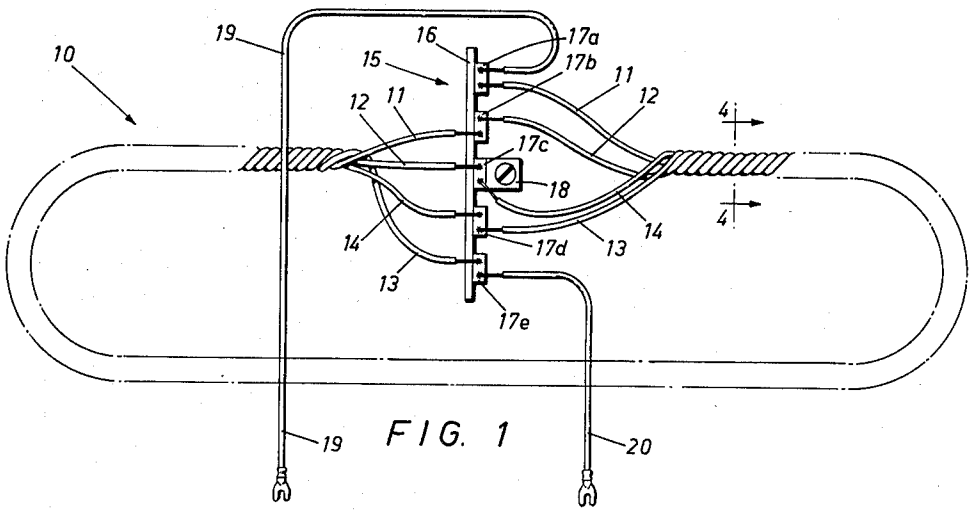


FIG. 1

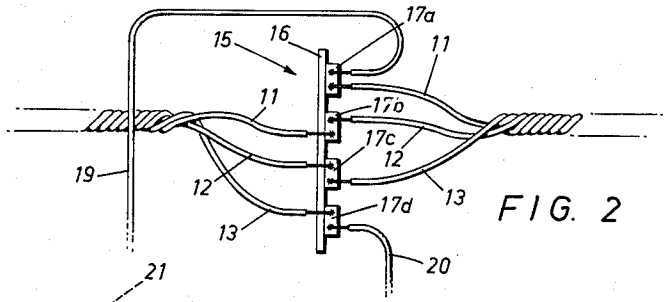


FIG. 2

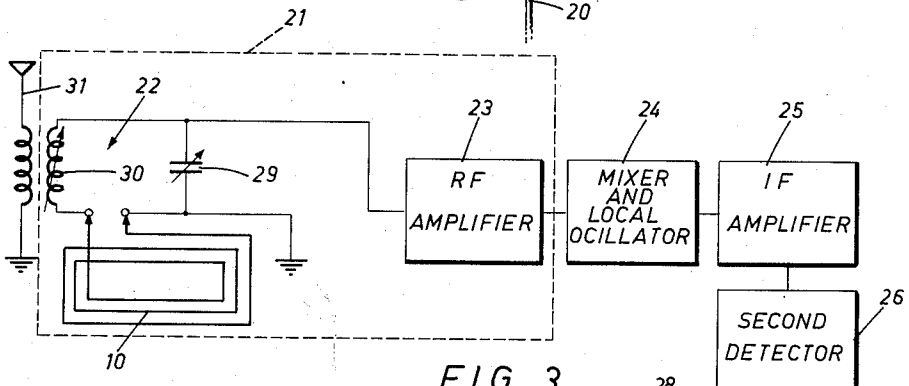


FIG. 3

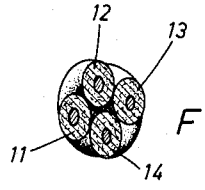


FIG. 4

INVENTOR.

HORST OSCAR HEISRATH

BY

Attorney

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Horst O. Heisrath, Kitchener, Ontario, Canada, assignor to Dominion Electrohome Industries Limited, Kitchener, Ontario, Canada

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This invention relates to antennae for AM receivers. More particularly, this invention relates to high gain, low impedance, AM, loop antennae designed to provide a high signal-to-noise ratio and to minimize distributed capacity and the effects of electrostatic fields in the vicinity of the antennae.

As is well known, radio reception in the standard AM broadcast band is seriously and detrimentally affected by spurious radiation from such equipment as television receivers and by other types of man-made interference. Since the greatest part of this interference is electrostatic radiation, an antenna which is virtually insensitive to electrostatic fields is required. While prior art types of antennae consisting of a single-turn, low impedance loop, and which usually constitute part of the first tuning circuit of an AM receiver, are generally fairly insensitive to electrostatic fields, because such antennae have only a single turn, they have a low sensitivity, and hence the improvement in signal-to-noise ratio under adverse conditions is not fully realized. This suggests the need for an antenna of higher sensitivity to electromagnetic fields, but with the same degree of immunity to electrostatic fields as is achieved with a single turn, low impedance, loop antenna.

It is well known that the sensitivity of an antenna is proportional to the product of the number of turns making up the antenna and the area of the antenna. Since the area of an antenna for use with a radio receiver is fixed by the physical size of the cabinet of the receiver, it is apparent, from a practical point of view, that the sensitivity of such an antenna can be increased only by increasing the number of turns making up the loop antenna. It has been found, however, that the solution to the problem is not as simple as this. With a multi-conductor antenna constructed with each conductor arranged in a loop, the loops being positioned side-by-side in physical parallelism with each other, and the conductors being connected in series with each other, it has been found that together with a proportional increase in desired sensitivity, the undesired noise pickup increases by about the same amount, and hence the signal-to-noise ratio remains virtually the same. While the noise pickup of such an antenna can be greatly reduced by placing the antenna in a grounded metallic sheath of the type which shields against electrostatic, but not electromagnetic, radiation, and while an antenna so constructed has high sensitivity and a high signal-to-noise ratio, such an antenna suffers the disadvantages of being relatively expensive (because of the need for a shield) and also of requiring a tuning capacitor of abnormally high capacity.

Accordingly, an object of my invention is to provide an unshielded, high gain, low impedance, AM loop antenna constructed so as to have a low distributed capacity and a high signal-to-noise ratio, and yet also to be of such a nature that it can be employed with tuning capacitors of a practical size.

In brief, a high gain, low impedance, loop antenna embodying my invention comprises at least two electrically insulated electrical conductors connected together in series. Each of the conductors is formed in a loop. The first of the conductors has a free end adapted to be connected to ground, and the last of the conductors also has a free end. The conductors are closely twisted together with one another and form a loop.

It should be noted that where herein I indicate that conductors are connected in series, I mean that the finish of the first conductor is connected to the start of the second, and the finish of the second to the start of the third, and so on.

The construction of antennae embodying my invention will become apparent from the following detailed description, taken in conjunction with the drawings, in which:

FIGURE 1 illustrates an antenna embodying my invention composed of four conductors,

FIGURE 2 depicts a three conductor antenna embodying my invention,

FIGURE 3 illustrates schematically a standard AM receiver employing an antenna embodying my invention in its first tuned circuit, and

FIGURE 4 is a cross-section taken along line 4—4 in FIGURE 1.

Referring now to the drawings, and in particular to FIGURE 1, for one example of my invention I have shown a high gain, low impedance, AM, loop antenna **10** which consists of four electrically insulated electrical conductors **11**, **12**, **13** and **14**. Each of the conductors is formed in a loop. A terminal board **15** which consists of a plate **16** made of electrical insulating material and having five conductive contacts **17***a*, **17***b*, **17***c*, **17***d* and **17***e* secured thereto is provided. Also secured to plate **16** is a mounting tab **18** which may be employed in mounting antenna **10** in an AM receiver.

Conductors **11**, **12**, **13** and **14** are connected together in series, conductor **11** being connected to conductor **12** at contact **17***b*, conductor **12** being connected to conductor **14** at contact **17***c*, and conductor **14** being connected to conductor **13** at contact **17***d*. Conductor **11** has a free end which is connected to contact **17***a* and is adapted to be connected through an electrically insulated electrical conductor **19**, also connected to contact **17***a*, to ground. Conductor **13** has a free end connected to contact **17***e*. Also connected to contact **17***e* is an electrically insulated electrical conductor **20**.

In accordance with my invention, conductors **11**, **12**, **13** and **14** are closely twisted together with one another and form a loop, and in order to minimize distributed capacity the conductor adapted to be grounded, in this case conductor **11**, is positioned as far away as possible from conductor **13**, i.e., diagonally across from conductor **13** in a cross-sectional view, as shown in FIGURE 4.

The embodiment of my invention shown in FIGURE 2 is similar to that shown in FIGURE 1 but employs three conductors instead of four.

In constructing antennae of the type shown in the drawings I prefer to employ No. 20 solid wire for conductors **11**, **21**, **13** and **14**, but other types of wire also may be used.

While antennae embodying my invention may be constructed using two or more conductors, it is preferred that not more than four conductors be used for cabinets of normal size, as this provides the most practical combination of high sensitivity and low distributed capacity. For smaller cabinets it may be possible to increase the number of turns moderately.

I have found that antennae embodying my invention and constructed of two or more conductors connected in series, the conductors being closely twisted together and the conductor adapted to be grounded being positioned as far away as possible from the conductor having the other free end have the following characteristics: a high sensitivity to electromagnetic fields with self-shielding against electrostatic fields, resulting in a high signal-to-

noise ratio. Actual field tests showed that the antenna illustrated in FIGURE 1 had the same sensitivity and degree of noise immunity as the four turn, untwisted, shielded antenna referred to hereinbefore. As compared to a single turn loop antenna of the same dimensions, the antenna of FIGURE 1 had an improvement in sensitivity and signal-to-noise ratio that was found to be directly proportional to the number of turns, i.e., four times or 12 db.

Antennae embodying my invention are especially suitable for present day "hi-fi" equipment where advantage can be taken of the relatively large cabinet size.

In constructing antennae embodying my invention one must take care to ensure that distributed capacity is kept as low as possible to permit use of the antennae with tuning capacitors of a practical size. Distributed capacity can be kept low by the use of thick insulation on the conductors.

Referring now to FIGURE 3, I have shown a conventional AM receiver consisting of an RF section 21 (a tuned circuit 22 and an RF amplifier 23), a mixer and local oscillator 24, an IF amplifier 25, a second detector 26, an AF amplifier 27 and a loudspeaker 28. Tuned circuit 22 consists of an antennae 10 embodying my invention, a tuning capacitor 29 and a variable inductance coil 30 which is transformer coupled to an external antenna 31. External antenna 31 may be omitted if the use of an external antenna is not desired. Coil 30 constitutes the largest part of the total inductance of tuned circuit 22 and can be adjusted for alignment purposes.

Those skilled in the art will realize that while I have disclosed certain preferred embodiments of my invention, changes and modifications may be made therein without departing from the spirit and scope of my invention.

What I claim as my invention is:

1. A high gain, low impedance, loop antenna comprising at least two electrically insulated electrical conductors, means electrically connecting said insulated conductors together in series, each of said insulated conductors being formed in a loop, each of said insulated conductors within its respective loop being coiled in a multi-turn configuration of substantially helical form, the first of said conductors having a free end adapted to be connected to ground, the last of said conductors having another free end, said insulated conductors being closely and tightly twisted together with each of said insulated conductors being in physical contact with adjacent ones of said insulated conductors substantially throughout said loops.

2. A high gain, low impedance, loop antenna according to claim 1 wherein there are three of said conductors.

3. A high gain, low impedance, loop antenna according to claim 1 wherein there are four of said conductors.

4. A high gain, low impedance, loop antenna according to claim 3 wherein said first conductor is positioned diagonally opposite said last conductor in the cross-sectional plane of said antenna and throughout said loop.

5. In an AM type receiver, a tuning circuit, said tuning circuit comprising a high gain, low impedance, loop antenna comprising at least two electrically insulated electrical conductors, means electrically connecting said insulated conductors, together in series, each of said insulated conductors being formed in a loop, each of said insulated conductors within its respective loop being coiled in a multi-turn configuration of substantially helical form, the first of said conductors having a free end connected to ground, said conductors being closely and tightly twisted together with each of said insulated conductors being in physical contact with adjacent ones of said insulated conductors substantially throughout said loops, and a tuning capacitor electrically connected in parallel with said antenna.

6. The invention according to claim 5 wherein said capacitor is connected in parallel with said antenna and a variable inductance connected in series with said antenna.

7. The invention according to claim 5 wherein there are three of said conductors.

8. The invention according to claim 5 wherein there are four of said conductors.

9. The invention according to claim 8 wherein said first conductor is positioned diagonally opposite the last conductor in the cross-sectional plane of said antenna and throughout said loop.

10. A high gain, low impedance, loop antenna comprising an electrically insulated electrical conductor having two free ends, said insulated conductor being formed into a plurality of loops, the portions of said insulated conductor making up different ones of said loops each being coiled within their respective loops in a multi-turn configuration of substantially helical form, said portions of said insulated conductor being closely and tightly twisted together with each of said portions being in physical contact with adjacent ones of said portions substantially throughout the lengths of said portions, said loops thereby being integrated together into a loop antenna.

11. A high gain, low impedance, loop antenna according to claim 10 wherein there are three of said loops.

12. A high gain, low impedance, loop antenna according to claim 10 wherein there are four of said loops.

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