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(54) RECEIVING ANTENNA FOR MINIATURE RADIO RECEIVER

(71) We, MOTOROLA, INC., a corporation of the State of Illinois, United States of America of 9401 West Grand Avenue, Franklin Park, Illinois, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This application relates generally to antennas for miniature radio receivers, and more particularly to an antenna formed by part of the radio receiver housing.

Miniature radio receivers are used in many applications such as for personal paging or for receiving broadcast transmissions for entertainment purposes. There is a problem in providing an antenna for such a receiver which does not increase the size of the receiver, and which provides effective signal pick-up frequencies extending from the order of one megahertz up to frequencies of 500 megahertz or more. Ferrite rod antennas have been used, but these antennas take up substantial space and have the disadvantage that they are highly directional. This is objectionable for an antenna that is to be used with a receiver worn on the body, as the effectiveness of the antenna depends upon the position of the person wearing the same.

The provision of an antenna which is external to the receiver is also objectionable, particularly when the antenna is to be worn on the body of the user. Such an antenna increases the effective size of the receiver, and detracts from the appearance thereof. It has been proposed to use a part of the housing of the receiver for the antenna, but a satisfactory arrangement has not previously been provided, especially for use at frequencies under 200 megahertz.

It is an object of this invention to provide

an improved receiving antenna for a miniature radio receiver.

Another object of the invention is to provide an antenna for a radio receiver to be worn on the body of the user which provides effective signal pick-up and which has no projecting parts extending outside the receiver housing.

A further object of the invention is to provide an antenna for a miniature receiver which does not contribute substantially to the size of the receiver.

A still further object of the invention is to provide a receiving antenna for a miniature receiver wherein a part of the housing forms the wave receiving antenna member.

According to the present invention there is provided an antenna for a miniature radio receiver adapted to be carried on a person and having a housing with parallel sides extending vertically in the normal position of the receiver, and with one side therein in proximity to the person, comprising a flat conducting member formed in a U-shaped configuration having first and second elongated substantially parallel arms forming parts of the parallel housing sides and a portion connecting said arms, and a reactance network connected to the ends of said arms opposite to said connecting portion for deriving signals therefrom.

The antenna of the invention is formed by a flat metal cover formed into a U-shape and which also serves as two opposite sides and one end, or parts thereof, of the housing for a miniature receiver. In the normal position of the receiver, when worn on the body of the user, the two elongated arms extend vertically, with the connecting portion at the top. Connected to the open (bottom) ends of the arms is a reactance network which applies a capacitive reactance across the open ends of the cover so that the con-

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ducting cover forms an antenna which detects the H-field of the electromagnetic wave to be received. Electrically, the antenna forms an inductive loop and the H-field is intercepted by the metal arms which form the loop. The reactance network is tunable to adjust the antenna for reception at a particular frequency, and has been used effectively in the frequency range between 148 and 174 megahertz. The signal pick-up of the antenna in free space is somewhat better at the front and at the back, than at the sides. When worn on the body, the pick-up becomes less directional. The cover may be removable to provide access to batteries within the housing, and also to permit removal of the receiver chassis therein for maintenance.

The invention will now be described by way of example only with particular reference to the accompanying drawing wherein:

Figure 1 illustrates a receiver having an antenna of the invention carried in the pocket of the shirt of the user;

Figure 2 illustrates the receiver housing cover member which forms an antenna, and the connections thereto;

Figure 3 is a schematic diagram showing the electrical circuit of the antenna, and

Figure 4 is a schematic diagram of the antenna with a different reactance network coupled thereto.

In Figure 1 there is shown a person carrying a paging receiver 10 with an antenna of the invention, with the receiver carried in the shirt pocket of the user. The receiver has a clip 12 on the front side for holding the receiver so it will not fall out of the pocket if the person stoops over or moves suddenly. The receiver has a housing including a part 14 which is moulded of plastics material and forms the main support for the components for the receiver, and also a part of the walls of the housing. A cover 16 slides over the moulded plastic member 14 and forms a large portion of the front, back and top walls of the housing. This cover is formed of a flat sheet of conductive metal which has been formed in the shape of a "U" having elongated arms 18 and 19 and a top connecting portion 20.

The cover 16 may be slid with respect to the plastic part 14 to provide access to batteries within the receiver housing. The cover may be completely removed from the plastic part to give access to the chassis of the receiver and/or to permit disassembly of the receiver, as to remove the chassis. The structure of the moulded part 14 and the cooperation therewith of the cover 16 is described in co-pending Patent Application No. 36040/71 (Serial No. 1,350,445).

The cover portion 16 is shown disassembled from the receiver in Figure 2. The conducting arms 18 and 19 which form

the transmission line may have a length of about 4.3 inches and a width of about one inch. The connecting portion 20 is continuous with the arms and thus has a width of about one inch, and has a dimension between the two arms 18 and 19 of about 0.6 inch.

As shown in Figure 2, the moulded plastic member 14 has spring biased gold plated contacts 22 and 23 which engage the inside surfaces of the arms 18 and 19, at the ends thereof remote from the connecting portion 20. These spring biased contacts make good electrical contact with the arms of the conducting cover 16.

Figure 3 illustrates the connections of the cover 16 to the receiver circuit. As previously stated, connection is made to the arm 18 of the cover by contact 22. This contact is connected to the reference ground of the receiver chassis. The other arm 19 is connected by contact 23 to a reactance circuit which includes inductor 25 and capacitors 26 and 27. The contact 23 is connected to an intermediate tap on the inductor 25. The inductor 25 may have a movable core to control the inductance thereof. The circuit including coil 25 and capacitors 26 and 27 is adjusted to be capacitive at the frequency of operation, so that the connections to the cover 16 in effect connects a capacitor across the open end thereof. The signal picked up by the antenna is derived from the reactance network at the common connection between capacitors 26 and 27, and may be coupled to the base electrode or transistor 30 which functions as a radio frequency amplifier. This is merely representative of various circuits for utilizing the received signal.

As shown in Figure 3, the arm 18 of the conducting cover 16 at the back side of the receiver is connected to ground. When the receiver is carried in the pocket of the person using the same (Figure 1), this grounded arm is adjacent the body of the person. The H-field of the electro-magnetic wave to which the antenna is subjected induces current in the inductive loop formed by the U-shaped conducting member 16. Although the structure shown has the connecting portion 20 between the arms 18 and 19 at the top, the antenna will operate just as effectively with the conducting portion which shorts the transmission line at the bottom.

Figure 4 shows another embodiment of the reactance circuit which may be used with the antenna. The lower end of conducting arm 18 of the U-shaped conducting member 16 is connected to ground by spring contact 22. The end of conducting arm 19 is connected by contact 23 to a reactance circuit having a plurality of parallel branches connected to ground. The first branch includes variable inductor 32 connected in series with capacitor 33. The inductor 32 can be adjusted for operation of the antenna at the

desired frequency. Capacitor 33 is provided so that the inductor can be of a value to provide the required tuning range. The second branch includes capacitor 35 which is selected for the particular band of frequencies involved. A capacitor of the value can be used for the frequency range from 148 to 154 megahertz, a second value for the range from 154 to 160 megahertz, and so forth. The third branch includes a diode 36 which is conducting on extremely strong signals to protect the receiver circuit. The fourth branch includes capacitors 38 and 39 connected in series.

The signal across the parallel reactance circuit is coupled by capacitor 40 to radio frequency amplifier 42, which may include transistors or other semiconductor devices. The diode 36 prevents application of strong signals thereto which might damage the devices. The junction between capacitors 38 and 39 is connected through choke 44 to battery 45. The battery is connected through switch 48 to terminal 50 to energize the receiver circuit. Terminal 43 can be used to apply charging current to the battery, and also forms a 50 ohm input to the radio receiver, which can be used for testing purposes.

The antenna as described has been shown to operate satisfactorily over the frequency range from 148 to 174 megahertz, being tunable to the specific frequencies involved by adjustment of the inductor 25. The antenna has also been found to operate effectively at other frequencies above and below the range specified. The antenna of the invention has been found to have a response in free space which is somewhat greater for signals from the front and from the back. This directional action is less pronounced when the pager is worn on the body, and in such case the antenna has an effective response in all directions. This is desired in a paging receiver in order to receive signals when the person is facing in any direction.

WHAT WE CLAIM IS:—

1. An antenna for a miniature radio receiver adapted to be carried on a person and having a housing with parallel sides extending vertically in the normal position of the receiver, and with one side therein in proximity to the person, comprising a flat conducting member formed in a U-shaped configuration having first and second elongated substantially parallel arms forming parts of the parallel housing sides and a portion connecting said arms, and a react-

arms opposite to said connecting portion for a reactance network connected to the ends of said deriving signals therefrom.

2. An antenna as claimed in claim 1 wherein said U-shaped conducting member forms an inductive loop antenna.

3. An antenna as claimed in claim 2 wherein said reactance network presents a capacitance reactance across said conducting member, and is adjustable to select the value of said capacitive reactance to tune said conductive member for reception of the H-field of an electromagnetic wave.

4. An antenna as claimed in claim 1 wherein said reactance network includes an inductor and a pair of series connected capacitors connected in parallel with said inductor, said inductor having end terminals and an intermediate terminal, with one end terminal and said intermediate terminal being connected respectively to said arms of said conducting member, and an output conductor connected to the junction of said capacitors.

5. An antenna as claimed in claim 1 wherein said reactance network includes a plurality of parallel branches connected between said ends of said arms, with one of said branches including a capacitor, and another branch including an inductor.

6. An antenna as claimed in claim 5 wherein said reactance network includes a parallel branch having a diode therein which is rendered conductive in response to a received wave which exceeds a predetermined strength.

7. An antenna as claimed in any one of claims 4 to 6 wherein said inductor is variable for tuning said reactance network.

8. An antenna as claimed in any one of claims 1 to 7 including spring biased contacts engaging said arms for making electrical connections between said arms and said reactance network.

9. An antenna as claimed in claim 8 wherein said contact engaging said arm forming part of said one side of the housing is connected to ground potential.

10. An antenna substantially as hereinbefore described and as shown in the accompanying drawing.

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arms opposite to said connecting portion for a reactance network connected to the ends of said arms for deriving signals therefrom.

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8. An antenna as claimed in any one of claims 1 to 7 including spring biased contacts engaging said arms for making electrical connections between said arms and said reactance network.

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