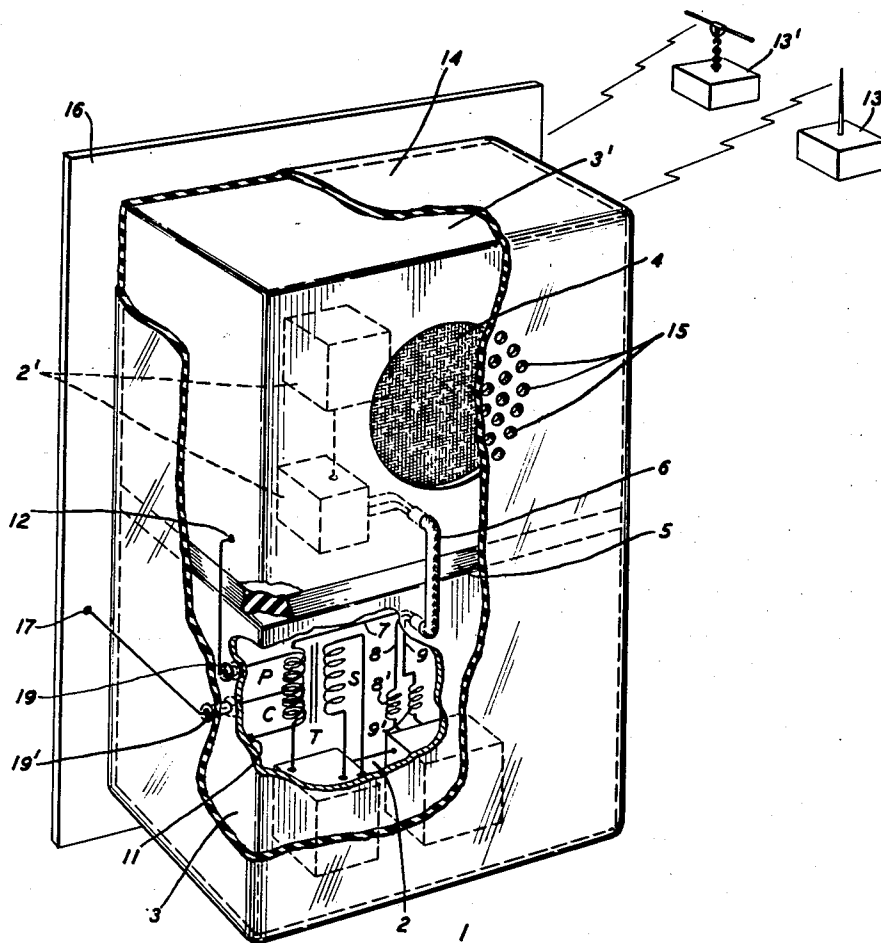


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SELF-CONTAINED ANTENNA-RADIO SYSTEM IN WHICH
A SPLIT CONDUCTIVE CONTAINER
FORMS A DIPOLE ANTENNA
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SELF-CONTAINED ANTENNA-RADIO SYSTEM IN WHICH A SPLIT CONDUCTIVE CONTAINER FORMS A DIPOLE ANTENNA

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This invention relates to antenna systems and more particularly to an antenna system for portable radio communication devices of minimum size.

A severe impediment to complete portability of radio communication apparatus has existed in the past. This impediment has arisen from an inability to provide an effective antenna of a size commensurate with the miniature radio receivers and transmitters made possible by progress in other radio system components.

Radio equipments have in the past been provided with loop antennas which in some instances partly surround the equipment's active elements. A loop antenna is, however, responsive to magnetic fields. Radio waves employed for communication are characterized, for most efficient propagation near the earth's surface, in having a great preponderance of their magnetic field strength residing in horizontally polarized waves. Hence, for most effective radio communications, any such loop antenna must be oriented in an essentially vertical plane. Without undue wiring complications a loop antenna so oriented has a response pattern that is nonuniform in a horizontal plane. This pattern imposes upon the operator of a radio equipment provided with a simple loop antenna the requirement that he take care to orient the equipment properly with respect to a particular transmitting or receiving station with which it is desired to maintain communications.

Other radio systems have taken advantage of the fact that the vertical electrical fields of radio waves propagated near the earth's surface tend to be of greater strength than electrical fields of other polarizations and, accordingly, have provided vertical antennas as a means to couple one radio apparatus with another through free space. A vertical electric antenna has a uniform response pattern in a horizontal plane, i. e., the plane of the earth's surface. Thus it does not require any particular orientation with respect to another station on the earth's surface. Vertical antennas as they have been embodied in prior radio systems, however, have proven cumbersome or fragile through being disproportionally large, in one dimension at least, with respect to the radio apparatus with which they operate.

As a net result the portability of miniature radio apparatus has been hampered severely in the past, on the one hand by the necessity of properly orienting the antenna and, on the other, by the physical unwieldiness of a disproportionally large electric field responsive antenna.

It is an object of this invention to minimize the size of portable radio communication apparatus and to eliminate from such apparatus any requirement for a particular azimuthal orientation with respect to a companion communication station. This object is achieved, in accordance with a feature of the invention, by providing an electrical field-responsive antenna adapted for enclosing its associated radio apparatus.

This and other objects of the invention will become more clear from a consideration of the following detailed description and sectioned perspective drawing of an illustrative embodiment of the invention.

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This drawing shows in approximate full scale a radio receiver 1 which has its components arranged in two groups 2 and 2' within two enclosed, conductive containers 3 and 3'. In this illustrative embodiment the first group of such components 2 constitutes the radio frequency detecting and amplifying stages of the radio receiver and the second group of components 2' make up the power supply and low frequency output stages of the receiver, including a loudspeaker 4. The conductive containers thus function to prevent unwanted electromagnetic radiation from interfering with the operation of the radio receiver as well as to preclude mutual interference between the two groups of radio components.

The first container is placed below the second and separated from it a convenient distance, say one-eighth inch, by a sheet of dielectric material 5 which thus serves to lend physical strength to the structure. Other considerations may indicate in other embodiments an air separation of the two containers.

A radio frequency transformer T, having a primary winding P and a secondary winding S, is enclosed within the lower container. The primary winding P has one terminal 12 connected to the upper container's conductive surface and its second terminal 11 connected to the lower container's surface. Thus the two conductive containers are interconnected through the inductive impedance element which constitutes the primary of the transformer T. The secondary of this transformer is connected to other receiver elements 2, not shown in detail, in a fashion well known in the art for connecting antenna coupling transformers.

A radio transmitter 13 radiates high frequency electromagnetic energy having an electric field component parallel to the axis on which the two conductive containers are arranged one above the other. This field component is coupled from the two containers through the transformer to the amplifying sections 2 and 2' of the radio receiver. Thus the containers constitute a dipole antenna and the transformer constitutes a familiar input stage to the receiver.

An insulated cable 6, having three illustrative conductors 7, 8 and 9, provides requisite low frequency electric paths between the two groups of components. Toward minimizing the size of the assembled equipment, the invention provides no radio frequency insulation between the components and their respective containers. Accordingly the conductors might serve as radio frequency paths of flow impedance to bypass voltages impressed upon the transformer primary P. This possibility is eliminated in two ways. The conductor 7 is wound turn for turn with the transformer primary P, that is to say, the primary coil has a bifilar winding. Thus the conductor 7 serves as an additional inductive impedance path for the primary with respect to radio frequency fields. At the same time it offers little impedance to low frequency currents. For a like purpose the conductors 8 and 9 are provided with radio frequency choke coils 8' and 9' suitably wound to present very high impedances to electric currents in the frequency range of the transmitter 13. These coils, however, present very low impedances to low frequency currents which pass through conductors 8 and 9. Hence, radio frequency potential differences are maintained between the two containers but low frequency currents pass freely between the receiver component groups.

In order to give physical rigidity to this structure the containers are embedded in a plastic coating 14 having appropriate openings 15 to couple acoustic radiations from the loudspeaker to the atmosphere.

A conductive shield 16 of substantial dimensions is provided adjacent both the conductive containers but is separated therefrom by the plastic coating 14. As is well

known in the radio art, the intercontainer capacitance, effectively connected in shunt with the transformer's primary winding P, is variable in the presence of movable objects, e. g., a human body. A capacitance so connected affects the resonant frequency of the receiver input transformer. The conductive shield 16, by its large area and fixed separation from the containers, protects the receiver from the capacitance varying effects of movable objects to one side. Thus in this illustrative equipment adapted to be carried in a man's shirt pocket, the shield is interposed between the wearer and the receiver.

A connecting lead 17 is passed through an insulating bushing 19' to interconnect the shield 16 with the center tap C of the transformer primary winding. This center tap connection tends to stabilize the electrical potential reference level of the radio receiver and its containers. Thus the overall stability of the receiving system is improved.

While the above-described illustrative embodiment of the invention sets forth an antenna for a radio receiving apparatus, it is well known that the principle of reciprocity is applicable to antennas generally. Hence, the invention encompasses not only a radio receiver, but a transmitter or transmitter-receiver, as well. In such embodiments the loudspeaker 4 becomes a microphone or a microphone-speaker; the low frequency output stages included in the upper component group 2' may comprise modulating circuitry; and the radio frequency stages of the lower component group 2 may perform reverse order amplification to couple energy to the antenna instead of from it.

Further, the invention comprehends employment of the antenna-receiver in orientations other than vertical. Near the earth's surface where vertical electric fields must be employed for effective communication, the small size of radio equipment in accordance with the invention permits an operator a simple control of output volume merely by twisting the equipment to a new orientation with respect to vertically polarized waves.

Similarly the invention may be employed in an environment removed from the earth's surface where electric waves of any polarization are freely propagated. Thus referring to the figure showing stations 13 and 13' which respectively radiate vertically and horizontally polarized electric waves, the operator may select between the two stations by a mere hand rotation of a receiver constructed in accordance with the invention to the orientation indicated to select the desired station.

What is claimed is:

1. In apparatus for communication by radio waves, the combination which comprises a first conductive container having a substantially closed surface, a second conductive container having a substantially closed surface, said second container being disposed in spaced relation with said first container, an impedance element interconnected between said first container surface and said second container surface, whereby said containers act as elements of a dipole antenna electromagnetically to couple said impedance element to free space, a radio frequency translating system having a terminal stage and comprising a plurality of components, said components being disposed within said containers, whereby said containers shield said system from stray electromagnetic radiation, means for coupling said terminal stage to said impedance element, whereby said translating system is coupled to free space, and in combination therewith a conductive sheet fixedly mounted in proximity to said containers thereby to establish a substantially fixed reactive coupling between said containers.

2. Radio communication apparatus which comprises a source for radiating electromagnetic energy into space, said energy having a fixed axis of polarization, a pair of substantially closed conductive containers fixedly mounted in spaced relation along an axis rotatable with respect to said fixed axis, impedance means for interconnecting said

containers, a radio receiving system consisting in a plurality of components disposed within both of said containers, said system comprising a terminal stage, means for coupling said impedance element to said terminal stage, whereby said system is coupled to said source in dependence upon the alinement of said rotatable axis with said fixed axis.

3. Radio communication apparatus comprising a first substantially closed conductive container, a second substantially closed conductive container mounted in spaced relation with said first container, a radio frequency impedance element interconnecting said containers, a radio frequency translating system having a plurality of components disposed in at least two groups, a first one of said groups being enclosed within said first container and the second one of said groups being enclosed within said second container, a terminal element connected to said translating system, and means for coupling said impedance element to said terminal element, whereby said translating system is coupled to free space.

4. Radio communication apparatus comprising a first substantially closed conductive container, a second substantially closed conductive container mounted in spaced relation with said first container, a radio frequency impedance element interconnecting said containers, a radio frequency translating system having a plurality of components disposed in at least two groups, the first one of said groups being enclosed within said first container and having at least one component connected for radio frequencies to said first container, and a second one of said groups being enclosed within said second container and having at least one component connected for radio frequencies to said second container, a terminal element connected to said translating system, means for coupling said impedance element to said terminal element, whereby said translating system is coupled to free space, and in combination therewith a radio frequency choke interconnecting said container-connected components, thereby to provide a low impedance path for low frequency currents between said last-named components.

5. Radio communication apparatus comprising a first substantially closed conductive container, a second substantially closed conductive container mounted in spaced relation with said first container, a radio frequency impedance element interconnecting said containers, a radio frequency translating system having a plurality of components disposed in at least two groups, the first one of said groups being enclosed within said first container and having at least one component connected for radio frequencies to said first container, and a second one of said groups being enclosed within said second container and having at least one component connected for radio frequencies to said second container, a terminal element connected to said translating system, and means for coupling said impedance element to said terminal element wherein said radio frequency element comprises a bifilar coil having one conductor interconnecting said last-named components thereby to provide a low frequency path between said last-named components and to couple said translating system to free space at radio frequencies through said last-named components.

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