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NONRESONANT DIRECTIVE ANTENNA

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Fig. 1.

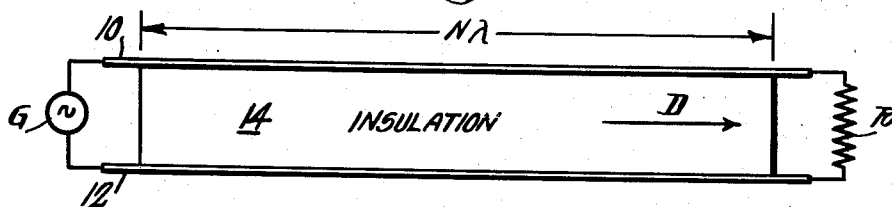


Fig. 2.

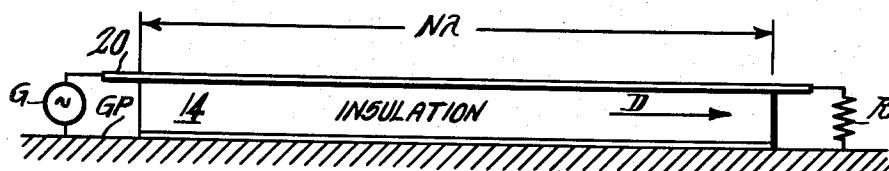
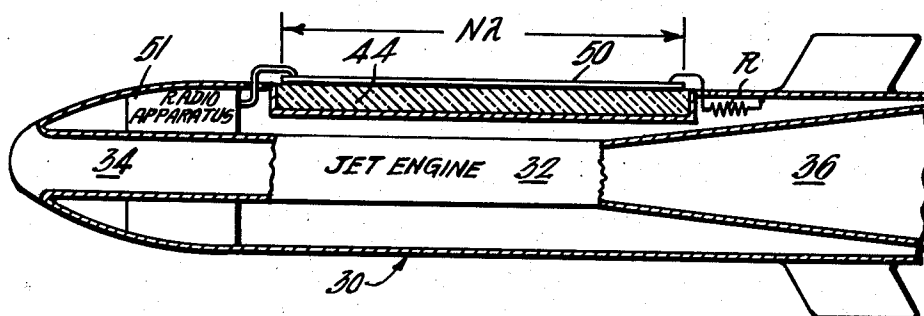


Fig. 3.



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NONRESONANT DIRECTIVE ANTENNA

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The present invention relates to ultra short wave antennas and more particularly to directive non-resonant antennas.

An object of the present invention is the provision of a non-resonant directive short wave antenna.

Another object of the present invention is the provision of an antenna which may be installed on high speed aircraft without introducing excessive drag or wind resistance.

Another object of the present invention is the provision of an antenna for use on high speed aircraft which is highly directional and which is compact.

A further object of the present invention is the provision of an antenna system which is usable on supersonic jet propelled missiles.

The foregoing objects and others which may appear from the following detailed description are attained by providing an antenna in the form of a linear conductor having a length comparable with a number of operating wavelengths. The conductor is disposed adjacent the boundary between two dielectrics of differing dielectric constant whereby a wave tilt is produced thereby coupling the energy carried by the wire to the surrounding space.

The present invention will be more fully understood by reference to the following detailed description which is accompanied by a drawing in which:

Figure 1 illustrates diagrammatically an application of the present invention to a balanced push-pull transmission line, while

Figure 2 illustrates a modification of the invention, and

Figure 3 illustrates the application of the antenna of the present invention to a supersonic jet propelled missile.

Referring now to Figure 1 there is shown a section of balanced, push-pull, two-wire transmission line consisting of conductors 10 and 12. The conductors are connected to a source of high frequency energy as indicated by the generator G. The other ends of the conductors 10 and 12 are connected together by the resistor R having a value of resistance equal to the characteristic impedance of the section of the transmission line. Thus the conductors carry a pure travelling wave in the direction from G to R.

Now, as so far described, the transmission line will have very little, if any, radiation in any direction and none in the direction of its axis if end effects are neglected. Now however, I have found that if a dielectric material such as that

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indicated by reference character 14 is placed in the neutral plane between the conductors, a radiation component in the direction of the transmission line axis will be obtained as shown by the arrow D. The radiation which results may be attributed to the so-called wave tilt. Normally the electrostatic field would be perpendicular to the line axis; that is, to the direction of the arrow D. The wave tilt is a result of the difference in velocity of the waves in the space surrounding the two-wire line and in the dielectric 14. Thus, the electric field enters the dielectric at some angle other than 90°. The field also becomes subject to reflection at the boundary between the dielectric and the surrounding space. Further, as the field tilts due to the presence of the dielectric, the magnetic field tilts with it. That is, when considering the transmission line as being in free space, the rings of the magnetic field are in a plane perpendicular to the line axis D. The presence of the dielectric 14 between wires causes the magnetic field around each wire to tilt toward the line axis. Since the fields about the two wires correspond to currents in opposite directions, their projections on a plane parallel to the line axis D are additive while the projections on a plane perpendicular to the line axis D are subtractive. The net result of these electrostatic and electromagnetic field tilts is a component of radiation along the line D.

A single conductor transmission line over conductive ground plane may also be caused to act as an antenna as shown in Figure 2. Here the single wire conductor 20 is disposed over a conductive ground plane GP. The wire 20 is terminated at one end by terminating resistor R and at the other end by generator G as described with reference to Figure 1. Also, as in the case of Figure 1, a block of insulating material such as wood or Bakelite is indicated by reference numeral 14. The manner in which radiation in the direction of arrow D takes place in the form of construction shown in Figure 2 may be compared with the system in Figure 1 on an image basis; that is, the conductive ground plane GP may be considered as producing a mirror effect as though a second conductor, carrying current in opposite direction to the current in wire 20, were placed below ground plane GP a distance equal to the distance of wire 20 above the ground plane GP. There will of course be some differences between the two, especially if the dielectric 14 is thick. However, forward radiation in the direction D will still take place.

It will be noted that at ultra high frequencies

the overall height of the antenna system shown in Figure 2 is very small. Its overall length is also small since a matter of several wavelengths of centimeter waves still does not result in a large bulky structure. The antenna of Figure 2 is thus well suited for use on high speed airplanes since its projection above the surface of the airplane is extremely small. In most cases the antenna would not project beyond the region of disturbed area surrounding the airplane and would therefore cause no increase in drag.

Another use of the present invention is illustrated diagrammatically in Figure 3. Here I have shown a supersonic speed jet-propelled missile as indicated generally by reference numeral 30. This missile may be propelled by the jet engine 32 within the body of the missile operating on air received through the nose of the missile in duct 34. The products of combustion which produce the thrust are discharged through the tail of the missile from duct 26.

Now, it may be desired to control the operation of the missile or to guide it by radio waves transmitted from the source of origin of the missile so some radio transmitting and/or receiving apparatus and an associated antenna system must be carried by the missile. The antenna system preferably should have a lobe of maximum response pointing to the rear of the missile. In normal operation the rear end of the missile may become extremely hot. Thus, any antenna arranged near the rear end of the missile will be subject to extreme temperature rises while the missile is in operation. Normally, insulators which are good at ultra high frequencies will not stand such high temperatures unless they are made of ceramic material. However, the ceramic materials are brittle and easily broken. Furthermore, due to the speed at which such missiles travel, normal antenna structures would introduce an excessive air drag. It will be apparent that it is not practicable to place rearwardly directed horn antennas around the body of the missile. Even a simple end fire array, if it is to have any effective height, will produce an excessive drag. To further complicate the problem it may be necessary to provide several independently operating antennas.

In accordance with my invention an antenna having characteristics suitable for use on jet-propelled missile may be attained by providing an elongated depression along the length of the missile at one or more locations around its periphery. Within the depression is located a block of insulating material 44 which, if required, may be made of high temperature ceramic. Along the outer surface of the insulator 44 is provided an elongated conductor 50 terminated at the rear end by terminating resistor R and connected at its forward end to the radio apparatus 51 carried within the nose of the missile 30. It will be noted that the antenna thus provided has very little drag effect on the missile, being substantially flush with the surface of the missile. The antenna is entirely constructed of materials resistant to high operating temperatures. The maximum lobe of the radiation pattern is in the direction toward the tail of the missile as required. Also, quadrantly arranged antennas may be provided, the several antennas being substantially independent in their operation.

While I have generally described my invention above as though applied to transmitting antennas, it is equally as well applicable to receiving

antennas if appropriate receiving apparatus is substituted for the generator G.

What is claimed is:

1. A directive antenna for use on a conductive surface structure and providing maximum effectiveness in a given direction and at an angle substantially less than a right angle with respect to said conductive surface structure, said conductive surface structure having a recess therein, a body of dielectric material arranged in said recess, a conductor arranged on said dielectric body substantially flush with said conductive surface structure, said conductor and said body being at least as long as several wavelengths at the operating frequency in said surface along said given direction, a resistive element connected between said conductive surface structure and one end of said conductor, said element having a resistance value substantially equal to the characteristic impedance of the transmission line formed by said conductor and said conductive surface, and means to couple utilization apparatus between said conductive surface structure and the other end of said conductor.

2. A directive antenna for use at centimeter wavelengths on a vehicle having a conductive outer surface without producing appreciable aerodynamic drag and providing maximum effectiveness at a small angle with respect to said surface, including a block of dielectric material arranged on said conductive surface, a conductor arranged on said dielectric body, said conductor and said block being at least as long as several wavelengths at the operating frequency in the desired direction of operation of said antenna, a resistive element connected between said conductive surface and one end of said conductor, and means to couple utilization apparatus between said conductive surface and the other end of said conductor.

3. A directive antenna for use at centimeter wavelengths on a vehicle having a conductive outer surface without producing appreciable aerodynamic drag and providing maximum effectiveness at a small angle with respect to said surface, said conductive outer surface having an elongated recess therein, a block of dielectric material arranged on said conductive surface, a conductor arranged on said dielectric body to locate said conductor substantially flush with said conductive surface of said vehicle, said conductor and said block being at least as long as several wavelengths at the operating frequency in the desired direction of operation of said antenna, a resistive element connected between said conductive surface and one end of said conductor, and means to couple utilization apparatus between said conductive surface and the other end of said conductor.

4. A directive antenna for use at centimeter wavelengths on a vehicle having a conductive outer surface without producing appreciable aerodynamic drag and providing maximum effectiveness at a small angle with respect to said surface, including a block of dielectric material arranged on said conductive surface, a conductor arranged on said dielectric body, said conductor and said block being at least as long as several wavelengths at the operating frequency in the desired direction of operation of said antenna, a resistive element connected between said conductive surface and one end of said conductor, and means to couple utilization apparatus between said conductive surface and the other end of said conductor, said resistive element having a

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resistance value substantially equal to the characteristic impedance of the arrangement of said conductor over said conductive outer surface.

5. A directive antenna for use at centimeter wavelengths on a vehicle having a conductive outer surface without producing appreciable aerodynamic drag and providing maximum effectiveness at a small angle with respect to said surface, including a block of dielectric material arranged on said conductive surface, a conductor arranged on said dielectric block, said conductor and said block being at least as long as several wavelengths at the operating frequency in the desired direction of operation of said antenna, a resistive element connected between said conductive surface and one end of said conductor, and means to couple utilization apparatus between said conductive surface and the other end of said conductor, said resistive element having a resistance value substantially equal to the characteristic impedance of the arrangement of said conductor over said conductive outer surface, said conductive outer surface being formed to provide an elongated recess for said dielectric block to locate said conductor substantially flush with said conductive surface of said vehicle.

6. An ultra short wave non-resonant directive antenna for use at centimeter wavelengths on a metallic aircraft structure without producing appreciable aerodynamic drag and providing maximum effectiveness in a direction substantially directly astern of the aircraft structure, including a block of dielectric material arranged on said metallic aircraft structure, a conductor arranged on said dielectric body, said conductor and said block being at least as long as several wavelengths at the operating frequency in the direction of the longitudinal axis of said aircraft structure, a resistive element connected between said metallic structure and the end of said conductor adjacent the stern of said aircraft structure, said element having a resistance value substantially equal to the characteristic impedance of the transmission line constituted by said conductor and said metallic structure, and means to couple radio frequency utilization apparatus between said metallic structure and the other end of said conductor.

7. An ultra short wave non-resonant directive antenna for use at centimeter wavelengths on a metallic aircraft structure without producing appreciable aerodynamic drag and providing maximum effectiveness in a direction substantially directly astern of the aircraft structure, the metallic aircraft structure having an elongated recess provided therein, a block of dielectric material arranged in said recess, a conductor arranged on said dielectric block substantially flush with the surface of said metallic aircraft structure, said conductor and said block being at least as long as several wavelengths at the operating frequency in the direction of the longitudinal axis of said aircraft structure, a resistive element connected between said metallic structure and the end of said conductor adjacent the stern of said aircraft structure, said element having a resistance value substantially equal to the characteristic impedance of the transmission line constituted by said conductor and said metallic structure, and means to couple radio frequency utilization apparatus between said metallic structure and the other end of said conductor.

8. A travelling wave antenna including a conductive surface element disposed in a medium through which radiation is effected, a body of

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dielectric material having a dielectric constant different from that of said medium and arranged on said conductive surface element, a conductor arranged on said body of dielectric material along a line of desired maximum effectiveness, said conductor having a length at least as long as several wavelengths at the operating frequency and lying for the greater part of the length thereof along a region of abrupt change of dielectric constant, a terminating resistor having a value of resistance equal to characteristic impedance of said antenna connected between one end of said conductor and said conductive surface element, and means to couple transducer equipment between the other end of said conductor and said conductive surface element.

9. An antenna including a conductive ground plane element, an elongated body of dielectric material having a dielectric constant differing from that of surrounding space, an elongated conductor having a length at least as long as several wavelengths at the operating frequency disposed on said body of dielectric material along a direction of desired maximum response and effectively for substantially the entire length thereof along a region of substantial change of dielectric constant, means to couple transducer apparatus between one end of said conductor and said ground plane element, and a resistance device connected between the other end of said conductor and said conductive ground plane element to terminate the antenna in the characteristic impedance thereof.

10. An antenna including a highly conductive ground plane element, a body of dielectric material having a dielectric constant differing from that of surrounding space arranged on said conductive ground plane element, an elongated conductor having a length at least as long as several wavelengths at the operating frequency disposed on said body of dielectric material substantially parallel to said ground plane element along a direction of desired maximum response whereby said conductor lies for the effective part of the length thereof in a region of substantially abrupt change of dielectric constant, means to couple transducer apparatus between one end of said conductor and said ground plane element, and a terminating resistor having a value of resistance equal to the characteristic impedance of said antenna connected between the other end of said conductor and said ground plane element.

11. A directive traveling wave antenna system for radio apparatus installed in close proximity to a semi-infinite conductive surface element, including an elongated block of dielectric material having a dielectric constant different from that of the medium in which the antenna is effective arranged on said conductive surface element, an elongated conductor arranged on said block of dielectric material to lie for the greater part of the length thereof along a boundary of an abrupt change of dielectric constant, said block of dielectric material and said elongated conductor having lengths at least several wavelengths at the operating frequency, a resistor having a resistance value substantially equal to the characteristic impedance of the transmission line effected by said elongated conductor and said conductive surface element connected between one end of said conductor and said conductive surface element, and means to connect said radio apparatus between the other end of said elongated conductor and said conductive surface element, thereby to provide maximum effectiveness of

said antenna system in the direction toward said one end of said elongated conductor and at substantially less than a right angle with respect to said conductive surface element.

12. A directive traveling wave antenna system for radio apparatus installed in a vehicle having an external portion thereof constituting a conductive surface element, said conductive surface element having an elongated depression externally of said vehicle, including an elongated block of dielectric material having a dielectric constant different from that of air arranged in the depression of said conductive surface element, an elongated conductor arranged on said block of dielectric material above said depression to lie for the greater part of the length thereof along a boundary of an abrupt change of dielectric constant, said block of dielectric material and said elongated conductor having lengths at least several wavelengths at the operating frequency, a resistor having a resistance value substantially equal to the characteristic impedance of the transmission line effected by said elongated conductor and said conductive surface element connected between one end of said conductor and said conductive surface element, and means to connect said radio apparatus between the other end of said elongated conductor and said conductive surface element, thereby to provide maximum effectiveness of said antenna system in the direction toward said one end of said elongated conductor and at substantially less than a right angle with respect to said conductive surface element.

13. A directive traveling wave antenna system for radio apparatus installed in close proximity to a semi-infinite highly conductive surface element, including an elongated block of substantially solid dielectric material having a dielectric constant different from that of the medium in

which the antenna is effectively arranged on said conductive surface element an elongated conductor arranged on said block of dielectric material whereby said elongated conductor lies for substantially the entire length thereof along a boundary of an abrupt change of dielectric constant, said block of dielectric material and said elongated conductor having lengths of at least several wavelengths at the operating frequency, a resistor having a resistance value substantially equal to the characteristic impedance of the transmission line formed by said elongated conductor and said conductive surface element connected between one end of said conductor and said conductive surface element, and means to connect said radio apparatus between the other end of said elongated conductor and said conductive surface element, thereby to provide maximum effectiveness of said antenna system in the direction toward the one end of said elongated conductor and at substantially less than a right angle with respect to said conductive surface element.

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