

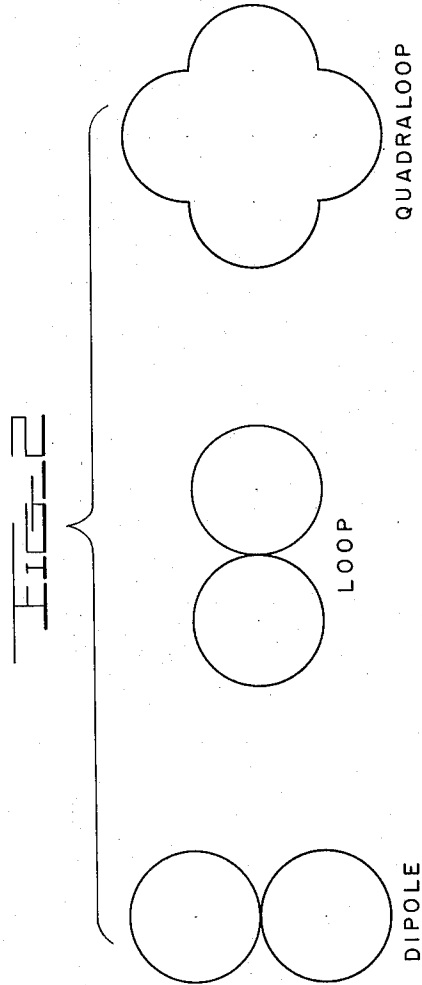
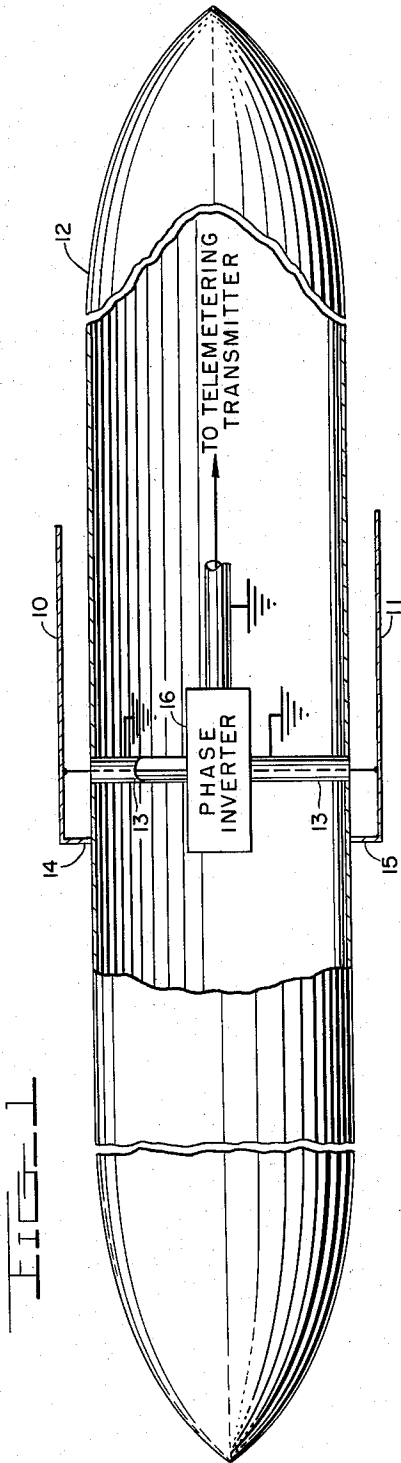
June 27, 1961

H. W. HAAS
QUADRALOOP ANTENNA

2,990,546

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2 Sheets-Sheet 1



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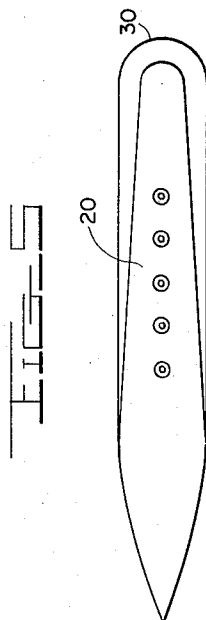
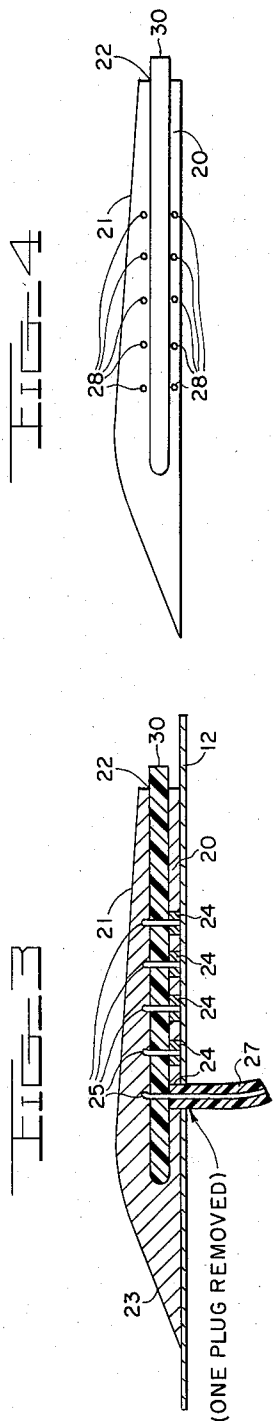
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QUADRALOOP ANTENNA

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This invention relates generally to antennas and more particularly to streamlined nondirectional antennas.

Antennas on fast moving objects should require a minimum of structure added to the object both for the preservation of the aerodynamic characteristics of the object and the mechanical integrity of the antenna. These are mechanical considerations which interfere seriously with the normal electrical design of antennas. One unobtrusive means of adding an antenna to a vehicle such as the self-propelled missile, is simply to cut resonant notches in the rear fins thereof. Such notches are sometimes filled with dielectric thus presenting a relatively smooth outer surface. However, fin notch antennas have a very restricted radiation pattern which is generally rearward of the supporting fins. Furthermore, some missile designs do not call for fins and other antenna devices are required. The fin notch principle can be duplicated in the side of such a missile by cutting an aperture or slot therein, however such an antenna also has a seriously restricted radiation pattern since it is almost entirely sideways from the missile surface.

It is therefore an object of this invention to provide a streamlined antenna structure which has a strong radiation pattern both rearwards and sideways from its mounting surface.

It is another object of this invention to provide a nondirectional streamlined antenna for mounting on a finless missile.

It is another object of this invention to provide a streamlined nondirectional antenna having selectable feed points.

Other objects and advantages of this invention will become apparent from a detailed consideration of the following description and accompanying drawings, wherein:

FIG. 1 is a cross-sectional diagram of a finless missile having a pair of antenna elements according to this invention connected in phase opposition,

FIG. 2 is a chart of illustrative antenna radiation patterns,

FIG. 3 is a preferred embodiment of this invention shown in longitudinal cross-section,

FIG. 4 is a side elevational view of the antenna of FIG. 3, and

FIG. 5 is a bottom elevational view of the antenna of FIGS. 3 and 4.

The antenna of this invention may be designated a "quadraloop" antenna because its general physical structure resembles one-quarter of a square loop. The antenna element is essentially an elongated conducting strip placed parallel and close to a large conducting surface such as a missile skin. At one end the elongated strip is electrically connected to and mounted on the large surface. The elongated strip is fed near its mounting end by the ungrounded side of an unbalanced line.

Referring now to FIG. 1 in detail, two antenna elements 10 and 11 respectively are shown mounted on opposite sides of the conducting metal surface of a finless missile body 12. A pair of coaxial lines 13 feed elements 10 and 11 near their mounting ends 14 and 15 respectively. By connecting coaxial lines 13 to the terminals of a phase inverter 16, antenna elements 10 and 11 may be fed in phase opposition from any source such as a telemeter transmitter. Antenna elements 10 and 11 are shown without streamlining in FIG. 1 to illustrate the

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electrical requirements of their configuration. Each element is an elongated conducting strip disposed closely adjacent to and parallel to the surface of missile body 12 and electrically connected to and mounted on said body at one end by members 14 and 15 respectively.

The antenna assembly of FIG. 1, although made up of loop type elements 10 and 11, has a dipole radiation mode in addition to its loop mode. The dipole mode has the effect of appearing in the minimum of the loop mode. By way of illustration, representative radiation patterns are shown in FIG. 2 for the dipole, loop, and for the quadraloop antenna of this invention. The dipole and loop patterns shown in FIG. 2 are for dipole and loop antennas oriented in the same plane.

FIGS. 3, 4 and 5 show the antenna elements of FIG. 1 modified mechanically to improve their suitability for use on the surface of high speed objects. The selectable feed point on the antenna elements is also shown in these figures. In FIG. 3 the antenna element is shown in longitudinal cross-section. In this embodiment the antenna element is machined from a single block of metal to comprise a flat strip 20 for mounting on the missile skin and an outer strip 21 parallel to strip 20 and separated therefrom by a slot 22 machined therein. Strips 20 and 21 are integrally connected together at the leading edge 23 of the antenna elements. A series of five holes 24 longitudinally disposed, have been drilled through strip 20. A series of five smaller holes 25 coaxial with holes 24 are drilled in strip 21. A series of four conducting plugs 26 are placed in four of holes 24. The outer conductor of a coaxial cable 27 is inserted in the remaining one of holes 24. The inner conductor of cable 27 enters the hole 25 corresponding to the hole 24 having the coaxial cable.

Each of holes 24 and 25 are in communication with set screws 28 which may be seen in FIG. 4. Set screws 28 provide electrical and mechanical connection of the outer and inner conductors of coaxial cable 27 into any selected pair of holes 24 and 25 in strips 20 and 21 respectively. The slot 22 as shown in FIGS. 3 through 5 may be fitted with a dielectric slab which completely fills slot 22 and has a constant width equal to that of strips 20 and 21 at their widest part. It will be noted in FIG. 5 that strip 20 narrows slightly toward its trailing edge. Strip 21 is similarly shaped in width, thus the dielectric slab 30 overflows slot 22 at the trailing edge thereof and also extends slightly to the rear of slot 22. While the dielectric slab 30 is not essential to the principle of operation of the antenna element, it serves a function much the same as the dielectric filling in notch antennas to provide a high degree of insulation across the slot to avoid voltage breakdown and also, depending upon the dielectric constant of the material chosen, may serve to increase the electrical length of the antenna elements.

In operation, the antenna element of this invention is usually constructed to appear as an electrical quarter wavelength at the operating frequency. The particular hole 24 selected for connection to the feed line is selected to achieve the most desirable impedance match. The antenna element of this invention is generally preferred and assembled in an oppositely oriented phase opposed pair as shown in FIG. 1. However, it may be used in other arrangements and other phase relations. For example, it may be used singly, two may be fed in-phase, three may be spaced 120° apart with numbers 2 and 3 phased 240° and 120° respectively to number 1. A single element does not have a strong radiation pattern on the side of the missile opposite its position. The use of more than two elements does not provide significant advantage in smoothing out the radiation pattern over that accomplished with two elements. The quadraloop antenna pattern shown in FIG. 2 is an ideal pattern for a pair of oppositely disposed elements fed in phase opposi-

tion as in FIG. 1 and is taken in a plane perpendicular to the missile's longitudinal axis. Actual measurements produced a pattern of the same nature but not as smoothly curved. Measurements taken in all planes from that of the missile's longitudinal axis to its transverse axis produced similar patterns characterized by good omnidirectional qualities. It may be observed in FIGS. 3 and 4 that the outer surface of strip 21 is not parallel to strip 20 but, like nose 23, has been shaped to provide an overall streamlined effect. This does not interfere with the electrical characteristics of the antenna.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A nondirectional antenna for mounting on a relatively large conductive surface comprising, an elongated conducting member having an elongated slot therein to form a U-shaped conducting path, said elongated conducting member having said slot formed with its open end across the narrow dimension of said member, means for mounting said member on said surface to orient said slot parallel to said surface, and means to feed energy to said slot intermediate the open and closed ends thereof.

2. A nondirectional antenna for mounting on a relatively large conductive surface comprising, an elongated conducting member having one flat elongated exterior

surface and an opposed exterior surface of streamlined contour, an elongated slot formed in said member parallel to its flat exterior surface to form a U-shaped conducting member, said slot being formed with its open end across the narrow dimension of said member, means for mounting said flat exterior surface on said large conducting surface, and means for feeding energy to said slot intermediate the open and closed ends thereof.

3. A nondirectional antenna system for a cylindrical conducting body comprising, a pair of conducting members mounted diametrically opposite on the outer surface of said body, each of said members being elongated along the longitudinal axis of said body and each having an elongated slot therein to form a U-shaped conducting path, said members having their respective slots formed with the open end across the narrow dimension thereof, said members being mounted so their respective slots are parallel to each other and to the longitudinal axis of said body, and means to feed energy in selected phase relation to each of said slots intermediate the open and closed ends thereof.

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