May 2, 1950 J. T. BOLLJAHN 2,505,751

BROAD BAND ANTENNA

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FIG. 1

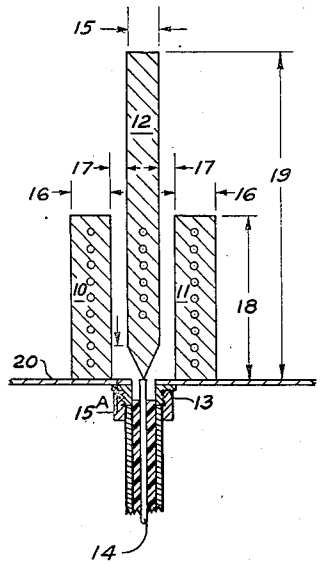


FIG. 2

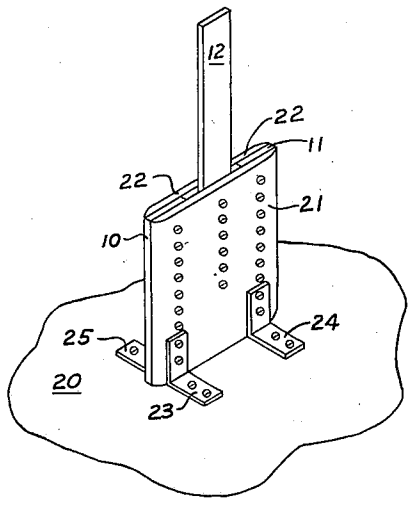


FIG. 4

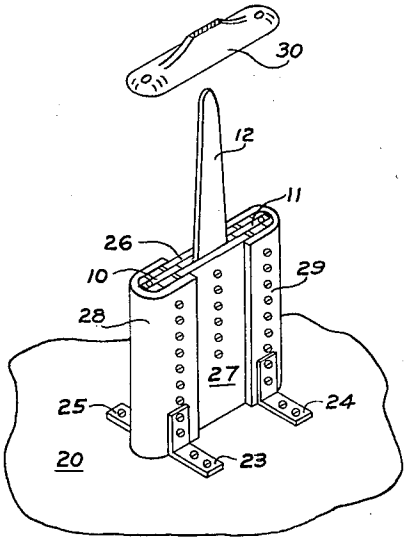
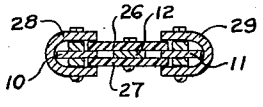


FIG. 3



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FIG. 5

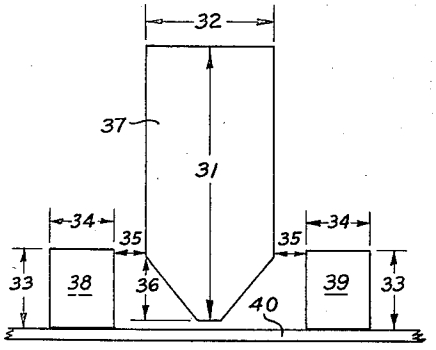


FIG. 6

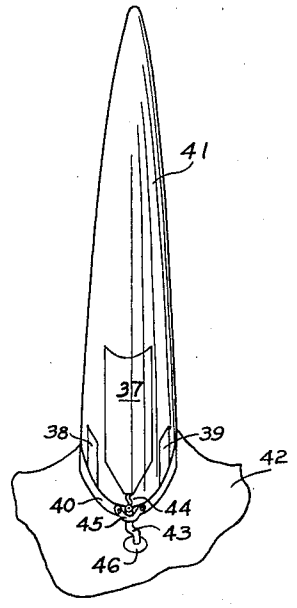
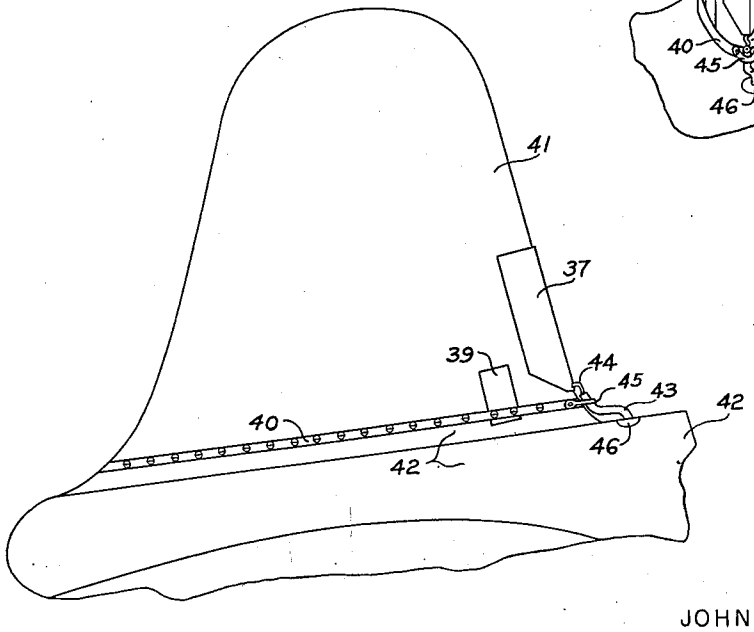


FIG. 7



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BROAD BAND ANTENNA

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Application September 27, 1946, Serial No. 699,649

9 Claims. (Cl. 250—33)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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This invention relates to antennas, and more particularly to a single non-directional broad band antenna which may be used where several antennas would otherwise be necessary and is especially well adapted for installation on aircraft.

Communication requirements in many different fields frequently necessitate transmitting and receiving with several sets of equipment over several different frequencies. Generally at least one antenna is provided for each equipment. This multiplicity of antennas is particularly undesirable in mobile and aircraft installations since all cannot be given the most advantageous location. A popular form of antenna for this purpose is a rod-like quarter-wave dipole mounted vertically. In aircraft installations such antennas frequently fail from the effect of slipstream. They are easily broken and, because some aircraft fairly bristle with such appendages, are frequently broken off by careless plane handlers as well as causing injury to careless people.

One solution might be the use of a single sleeve type antenna which employs about a quarter wave radiating element set in a grounded, coaxial section which extends from the ground plane a length of the order of an eighth wave length. The addition of the coaxial section serves to detune the antenna at its critical frequency and enables it to operate over a broad band of frequencies. However, in order to establish the proper impedance between the coaxial section and the radiating element, and have the latter large enough to handle transmitter power, the coaxial section must be unfortunately large. This bulkiness is undesirable when made in aircraft installations because of its wind resistance. However, if two pieces are cut, each from an opposite side of the coaxial section, a streamlined shape is obtained without losing the desired operating characteristics. This might be called an "open sleeve" type antenna. The use of such antenna greatly reduces the number of antennas required thus providing in addition to its other advantages an economy in weight, and material.

It is therefore an object of this invention to provide a non-directional antenna with a broad frequency range which may be used where several antennas would otherwise be used.

It is a further object of this invention to provide a nondirectional, broad band antenna that is streamlined.

It is another object of this invention to provide a driven element partially enclosed by a pair of shorter parasitic elements to be used as a streamlined, nondirectional, broad band antenna.

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It is still another object of this invention to provide a streamlined nondirectional broad band aircraft antenna attached flush with the surface of the vertical fin and requiring only, a non-metallic vertical fin and one driven and two parasitic elements of metal foil arranged around the leading edge thereof.

Other objects and advantages of the invention will be apparent from the following description and accompanying drawings, in which similar characters of reference indicate similar parts throughout the several views.

Fig. 1 is a sectional view of one embodiment of this invention taken along its longitudinal axis.

Fig. 2 is a perspective view of the embodiment appearing in Fig. 1.

Fig. 3 is a cross sectional view of the variant embodiment of this invention taken in a horizontal plane.

Fig. 4 is a perspective view of the same embodiment appearing in Fig. 3.

Fig. 5 is a diagrammatic view of a variant embodiment of the invention showing the dimensions of the antenna elements therein.

Fig. 6 is a perspective view of the antenna shown in Fig. 5 as installed on the leading edge of an aircraft's vertical fin.

Fig. 7 is a perspective side view of the installation shown in Fig. 6.

Briefly, this invention utilizes a sleeve type antenna to provide nondirectional operation over a broad band of frequencies. A novel type of open sleeve is employed to provide the advantages of a closed sleeve without its bulk. The open sleeve construction affords versatility in design variation thereby providing a simple antenna easily adapted to a multitude of uses and easily accommodated by the installation facilities.

Referring now to Fig. 1 in detail, the antenna is shown in cross-section consisting, for instance, of three thin, flat metal strips 10, 11, and 12. The center strip 12 is the driven element and has an approximate length 19 of a quarter-wave length as measured at the lower end of the frequency band to be covered. Its width 15, as are the other dimensions, is chosen in such a manner as to minimize its Q. For example, its width may be one tenth its length and it is tapered at its lower end for a distance 15A equal to its width. The two metal strips 10 and 11 have a length 18 about half that of the driven element 12 and may be spaced equi-distant therefrom at a distance 17 equal to about half the width 15 of said driven element. The width 16 as again are their other

dimensions, is chosen to minimize the Q of the parasitic elements 10 and 11. For example, the width 16 may be slightly greater than the width 15 of the driven element 12. The length of all three strips are measured from the ground plane 20 and the shorter elements 10 and 11 are electrically connected thereto and may be coincident or parasitic elements to the driven element. By being located equidistant from the driven element 12, the parasitic elements lie coplanar with the driven element 12 and on opposite sides thereof. This arrangement, therefore, constitutes an open sleeve design. The driven element alone would tune sharply at the frequency for which it is a quarter wave length. The addition of the parasitic elements 10 and 11 has the effect of a grounded sleeve to detune the antenna and with this arrangement the antenna will operate successfully for any frequency between that for which the driven element is a quarter wave length and that for which it is a half wavelength. The antenna is equipped with a coaxial connector 13 for feeding a coaxial line. The outer conductor is connected to the parasitic elements via the ground plane 20 and the center conductor 14 feeds the driven element 12. The taper at the lower end of said driven element facilitates its connection to said center conductor and may also serve to improve the impedance matching of the line and the antenna. The vertical rows of holes in all three metal strips provide a means of mounting same to the ground plane as will be further described below in reference to Fig. 2.

In Fig. 2 the embodiment of Fig. 1 is shown in perspective to demonstrate a means of assembling the various parts. Two thin pieces 21 and 22 cut from nonconducting material are fastened to each side of the three elements 10, 11, and 12. Said pieces of insulating material are held together and the elements held in place between them by means of bolts each passing through both nonconducting sections and the appropriate intervening element. For this purpose the elements are equipped with holes as shown in Fig. 1. The antenna structure so obtained may be affixed to the ground plane 20 by four angle pieces 23, 24, 25 (one opposite 24 not shown) bolted to the ground plane and the antenna structure. The lower bolts supporting the parasitic elements 10 and 11 in the nonconducting sections 21 and 22 may also be used for attachment to these angle pieces. It will be noted that the resultant structure is both streamlined and compact.

Figures 3 and 4 illustrate a variant embodiment of the invention wherein the streamlining is accomplished by the shape of the parasitic elements themselves. Fig. 3 is a cross section of this antenna in a vertical plane. The same driven element 12 and parasitic elements 10 and 11 as in Figs. 1 and 2 are used here but in addition the parasitic elements 10 and 11 receive electrical support from a pair of curved metal sections 28 and 29 respectively. These curved metal sections join the outer edges of strips 10 and 11 at their respective centers from which line of intersection each curves toward the driven element 12. One section 28 may be given the smooth curve of a leading edge and the other 29 the more pointed shape of a trailing edge to improve the streamlining of the antenna. In this construction the two nonconducting sections 26 and 27 supporting the driven element are clamped between the curved portions of each parasitic element and its corresponding flat strip. For a lighter construction the flat strips 10 and 11 may be removed and the curved sections 28 and 29 alone used as the parasitic elements.

The perspective view in Fig. 4 demonstrates a method of mounting the antenna structure to the ground plane 20. Angle brackets are used as described in reference to Fig. 2. It will be noted that the upper portion of the driven element 12 has been tapered in this embodiment to lessen the effect of slipstream upon the antenna. For the same purpose a cap 30 of insulating material may be mounted on the tops of the parasitic elements, its periphery fitting flush therewith and sloping upward to the driven element 12. Said cap 30 is also useful as a moisture seal.

The structure shown in Figs. 5, 6, and 7 to which reference is now made, includes in part a driven element and two parasitic elements cut from metal foil. The relative dimension of these elements may be understood from the diagrammatic view in Fig. 5 in which the driven element 37 has a maximum length 31 corresponding to a quarter wave length as determined by the lower end of the frequency band to be covered. Said element 37 has a width 32 at its widest point slightly less than its greatest length 31. Its lower end tapers an amount 36 as measured along its length equivalent to half its width 32. By adding a parasitic element on each side of the driven element the operable frequency band of the antenna is extended to the point where the driven element's length 31 approaches half a wave length. There parasitic elements 38 and 39 are much smaller than the driven element and located equidistant therefrom about its base. The separation 35 of said elements measures about one fourth the width 32 of said large element 37. Said smaller elements are of equal size, having a width 34 approximately half that of the large element and a height 33 approximately one-fourth again its width 34. The lengths of the smaller elements 38 and 39 are measured from a ground plane 40 to which they are connected. The larger driven element 37 is separated slightly from said ground plane 40 to avoid electrical continuity therewith.

Figs. 6 and 7 show a method of employing the antenna system of Fig. 5. In these figures the pieces of metal foil have been wrapped about the leading edge of an aircraft's vertical fin 41. For this purpose it is essential that said vertical fin be constructed of some nonconducting material to avoid a universal shorting of the antenna elements and serious interference with the radiation pattern. The metal strip 40, described in Fig. 5 as a ground plane, may be used as shown in Figs. 6 and 7 to facilitate the junction of the nonconducting vertical fin 41 to the metal aircraft fuselage 42 as well as to provide a mounting means for the antenna. The bulk of the fuselage 42 provides a ground plane for the system. The antenna system may be fed by means of a coaxial cable 43 penetrating the fuselage 42 through fitting 46 having its center conductor 44 joined to the tapered end of the large driven element 37, and its outer conductor connected to the ground plane 42. The free end of the cable 43 may be secured in proximity to the driven element 37 by means of a bracket 45 clamping it to the metal strip 40 at the base of the antenna. Adding this antenna system to an aircraft will effect no change in the airstream about the aircraft and the system is versatile enough to replace most of the antennas otherwise required therefore removing the disturbance of the airstream brought about by the normal assortment of antennas.

Although only limited and specific embodiments of the present invention have been shown and described, it may be modified without departing from the principles thereof and any such modifications are, therefore, deemed to be within the scope of the invention as defined by the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. An antenna, comprising a driven element, a pair of parasitic elements disposed equal-distant from said driven element, a ground plane supporting said parasitic elements, nonconducting means extending from said driven element to each of said parasitic elements to form a substantially smooth surface therebetween and operative to support said driven element and streamline the antenna to the flow of air, and a connecting terminal for feeding said driven element whereby radiant energy may be transmitted and received nondirectionally over a broad band of frequencies.

2. An antenna, comprising a driven element having a taper at one end thereof, a pair of parasitic elements of a length less than said driven element and located equi-distant therefrom, a ground plane electrically connected to said parasitic elements, nonconducting means extending from said driven element to each of said parasitic elements to form a substantially smooth surface therebetween and operative to support said driven element and streamline the antenna to the flow of air, and a coaxial line feeding means having an inner and outer conductor, said feeding means arranged so that said outer conductor electrically connects to said ground plane and said inner conductor connects to said tapered end of said driven member.

3. An antenna, comprising a driven element cut from a flat strip of metal and having a length several times its width, said element being tapered at one end thereof, a pair of parasitic elements also cut from flat strips of metal and having a length less than said driven element and spaced equi-distant therefrom, nonconducting means extending from said driven element to each of said parasitic elements to form a substantially smooth surface therebetween and operative to support said driven element and streamline the antenna to the flow of air, a connecting means including a coaxial conductor having inner and outer conductors, said connecting means being arranged to feed the tapered end of said driven element from said inner conductor and said pair of parasitic elements from said outer conductor of said coaxial line, a ground plane supporting the combination and electrically connected to said pair of parasitic elements and said outer conductor, whereby radiant energy may be transmitted and received nondirectionally over a broad band of frequencies.

4. An antenna, comprising a driven element cut from a flat strip of metal and having a length several times its width said element being tapered at one end thereof, a pair of parasitic elements also cut from flat strips of metal and having a length less than said driven element, said parasitic elements being located co-planar with said driven element and on opposite sides thereof, a pair of thin nonconducting sections extending between the parasitic elements and enclosing same, said sections being operative to support the driven element and streamline the antenna to the flow of air, a connecting means including a coaxial conductor having inner and outer conductors, said means being arranged to feed the tapered end of said driven element from said inner conductor and said pair of parasitic elements from said outer conductor of said coaxial line, a ground plane electrically connected to said pair of parasitic elements and said outer conductor, whereby radiant energy may be transmitted and received nondirectionally over a broad band of frequencies.

5. An antenna, comprising a driven element cut from a flat strip of metal, and having a taper at one end thereof, a pair of parasitic elements also cut from strips of metal so as to have a length shorter than said driven element, said parasitic elements being located adjacent said driven element and bent along their width so as to resemble respectively the leading and trailing edges of a tear drop in cross-section placed about the driven element so that its longitudinal axis lies in the plane of said driven element, a connecting means including a coaxial line having inner and outer conductors, said means being adapted to feed said tapered end of the driven element from the inner conductor of said coaxial line and said pair of parasitic elements from the outer conductor, a ground plane supporting the combination and electrically connected to said pair of parasitic elements and said outer conductor, whereby radiant energy may be transmitted and received nondirectionally over a broad band of frequencies.

6. An antenna, comprising a driven element cut from a flat strip of metal and having a length several times its width, said element being tapered sharply at one end and gradually at the other end, a pair of parasitic elements also cut from flat strips of metal so as to have a length shorter than said driven element, said parasitic elements being located equi-distant from said driven element and bent along their width so as to resemble respectively the leading and trailing edges of a tear drop in cross-section placed about the driven element so that its longitudinal axis lies in the plane of said driven element, a connecting means including a coaxial line having inner and outer conductors, said means being adapted to feed said sharply tapered end of the driven element from the inner conductor of said coaxial line and said pair of parasitics from the outer conductor, a ground plane supporting the combination and electrically connected to said pair of parasitic elements and said outer conductor, whereby radiant energy may be transmitted and received nondirectionally over a broad band of frequencies.

7. An antenna, comprising a driven element cut from a flat strip of metal and having a taper at one end thereof, a pair of parasitic elements also cut from strips of metal so as to have a length shorter than said driven element, said parasitic elements being located equi-distant from said driven element and bent along their width so as to resemble respectively the leading and trailing edges of a tear drop in cross-section placed about the driven element so that its longitudinal axis lies in the plane of said driven element, a pair of thin nonconducting sections extending between the two parasitic elements operative to form an enclosure therewith and streamline the antenna to the flow of air, a connecting means including a coaxial line having inner and outer conductors, said means being adapted to feed said tapered end of the driven element from the inner conductor of said coaxial line and said pair of parasitic ele-

ments from the outer conductor, a ground plane supporting the combination and electrically connected to said pair of parasitic elements and said outer conductor, whereby radiant energy may be transmitted and received nondirectionally over a broad band of frequencies.

8. In an aircraft having a vertical fin made of nonconducting material, an antenna comprising, a driven element cut from metal foil so that its shape is rectangular except that one narrow end is tapered, said driven element being mounted flush with the leading edge of said vertical fin with said tapered end pointing down and located near the base thereof, a pair of parasitic elements also cut from metal foil and having a rectangular shape much smaller than said driven element, said parasitic elements being mounted flush with said vertical fin at its base on either side of and a suitable equal distance from said driven element, said parasitic elements being operative to greatly extend the frequency range of said driven element, a connecting means suitable to feed the tapered end of the driven element from the center conductor of a coaxial cable and the parasitic elements from the outer conductor said latter elements also making electrical contact with the skin of the aircraft which serves as a ground plane, whereby radiant energy may be transmitted and received by an aircraft nondirectionally over a broad band of frequencies.

9. An antenna, comprising a driven element having a taper at one end thereof, a parasitic element of a length less than said driven element and located ajacent thereto, a ground plane electrically connected to said parasitic element, nonconducting means extending from said driven element to said parasitic element to form a substantially smooth surface therebetween and operative to support said driven element and streamline the antenna to the flow of air, and a coaxial line feeding means having an inner and outer conductor, said means arranged so that said outer conductor electrically connects to said ground plane and said inner conductor connects to said tapered end of said driven element.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,158,124	Fessenden	Oct. 26, 1915
2,061,508	Dallenbach	Nov. 17, 1936
2,171,256	Moullin	Aug. 29, 1939
2,286,179	Lindenblad	June 9, 1942
2,368,298	Harris	Jan. 30, 1945
2,368,663	Kandoian	Feb. 6, 1945
2,412,249	Brown et al.	Dec. 10, 1946