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AIRCRAFT ANTENNA SYSTEM

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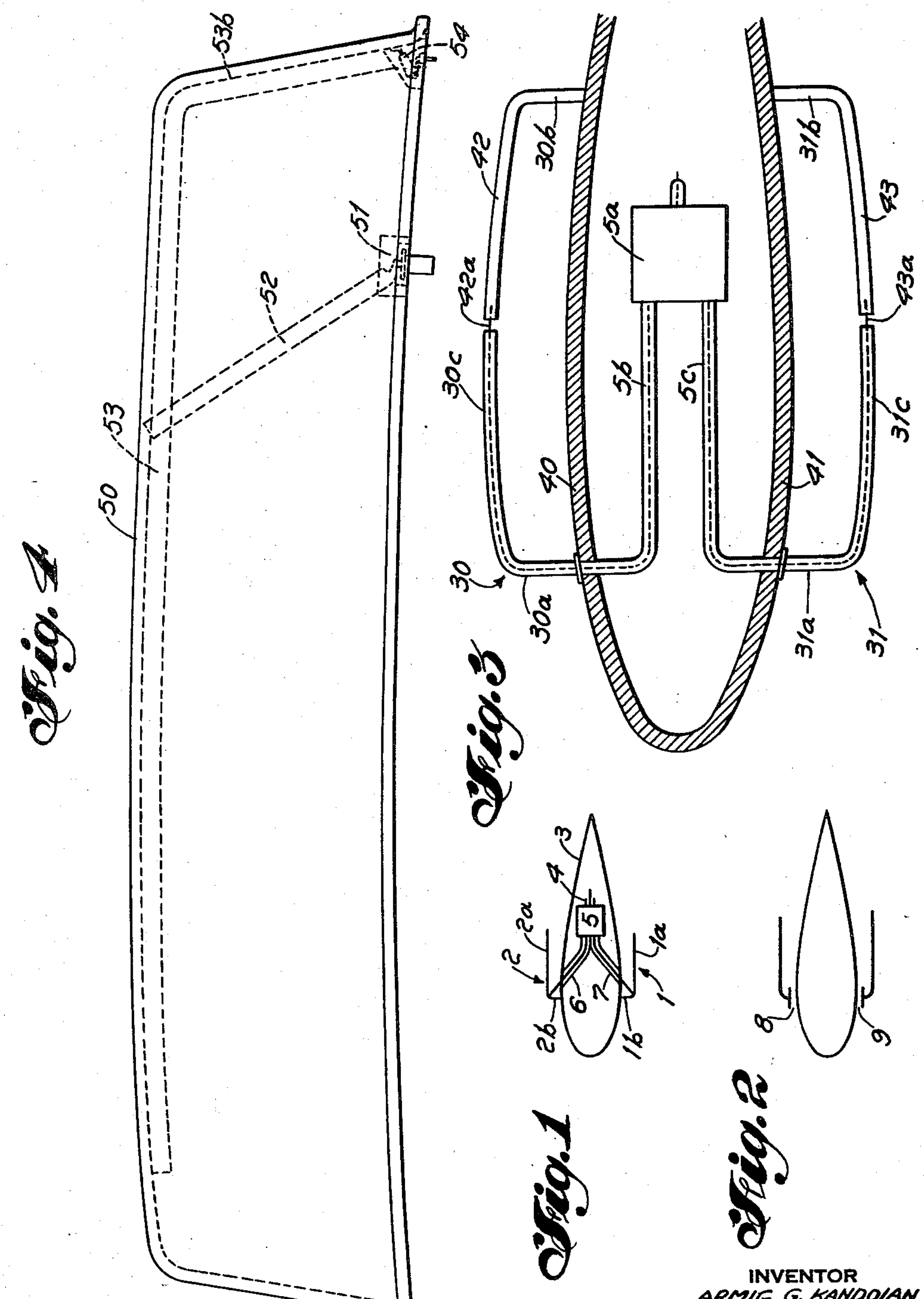

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AIRCRAFT ANTENNA SYSTEM

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This invention relates generally to antenna systems suitable for installation on aircraft and more particularly it relates to a horizontally polarized antenna system for aircraft installation having an omnidirectional radiation pattern.

In numerous aircraft installations it is desired to employ antenna systems having horizontal polarization characteristics and azimuth coverage in all directions. Aircraft antennas obviously must not interfere with the aerodynamic characteristics of the aircraft. In addition aircraft antenna installations cause difficulties because the radiating elements must of necessity be close to conductive surfaces of the plane which act as reflectors to produce marked asymmetry in the radiation pattern. This asymmetry is frequently unpredictable and causes undesirable directivity or blind spots instead of the desired omnidirectional pattern. Although many antennas have desirable characteristics such as small size, low input impedance, good structural strength and simple construction they usually have other disadvantages such as poor polarization or radiation patterns and characteristics. A dipole antenna is a simple example of an otherwise desirable horizontal radio antenna which having deep nulls in its horizontal pattern is undesirable as an omnidirectional antenna system.

Prior art has already modified the simple dipole so that the two radiating halves are made to meet at some angle other than 180°. Examples of such modified dipoles include the V antenna and the U antenna. These units have been installed in aircraft either in front, above, below or to one side of the fuselage. Installation on either side usually resulted in unpredictable asymmetry while installation above or below the fuselage interfered with the directivity of the signals.

To overcome the electrical disadvantages of such systems it has heretofore been proposed to modify a V type dipole antenna so that its two radiating elements are physically set apart on either side of the fuselage. Due to the straight line characteristics of the longitudinal axis of each half of the V antenna when divided and set on either side of the fuselage this aircraft system had extremely poor aerodynamic characteristics and although electrically it might have been satisfactory, due to its interference with the aerodynamics of the aircraft it has not proven completely satisfactory.

It is an object of this invention, therefore, to provide an aircraft antenna installation minimizing the above disadvantages mentioned above as being present in the prior art antenna systems.

It is a further object of this invention to provide an aircraft antenna system having horizontal polarization characteristics and an omnidirectional radiation pattern.

Still another object of this invention is to provide an aircraft antenna installation in which each of two radiating elements has a portion substantially parallel to the surface on which it is mounted to reduce its aerodynamic drag and provide a substantially semi-flush aircraft antenna.

One of the features of this invention is to provide an antenna system including an antenna unit having a plane of symmetry perpendicular to the major plane of said unit dividing said antenna into two radiating elements and having a conductive surface located therebetween on which said elements are supported, and in which each of said elements has at least a portion thereof substantially parallel to the plane of said conductive surface.

The above-mentioned and other features and objects of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawings, in which:

Figs. 1 and 2 are schematic diagrams of two embodiments of aircraft antennas in accordance with the principles of my invention; and

Fig. 3 is a plan view partly in cross-section of one embodiment of an antenna in accordance with the principles of this invention; and

Fig. 4 is an elevation view partly in cross-section of one embodiment of an antenna system in accordance with the principles of my invention.

Referring to Fig. 1 of the drawing one embodiment of an antenna system in accordance with the principles of my invention is seen to comprise two radiating elements **1** and **2** each of which has two sections *1a*, *1b*, *2a*, *2b* bent at an angle to each other. The total effective electrical length of each of the radiating elements **1** and **2** is substantially ¼ wave length at the midpoint of the operating frequency band although it must be recognized that this antenna system is broad band and thus elements **1** and **2** need not be exactly a ¼ wave length but are suitable for use over relatively wide frequency bands. A vertical stabilizer **3**, having a generally elliptical cylindrical cross-section, has the radiating elements **1** and **2** mounted thereon. The vertical stabilizer **3** has its outer portions composed of conductive material to cause a reflective surface to be associated with each of the radiating elements **1** and **2**. The elements **1** and **2** are supported on the vertical stabilizer in accordance with ordinary design principles. It is merely desirable that they have adequate strength to withstand air resistance during flight.

In order to conduct electrical energy to and from the antenna elements **1** and **2** it is desirable to utilize a coaxial type transmission line. In order that the coaxial transmission line leading from the translating equipment may be connected readily to the antenna elements **1** and **2** which form an electrically balanced structure it is necessary to convert the electrically unbalanced coaxial transmission line to a balanced line. In order to accomplish this transformation from balanced to unbalanced, a balun generally indicated at **5** is provided.

A transmission line **4** couples energy from a translating device (not shown) to the balun **5** which is a conventional unbalanced-to-balanced frequency transformer and may be designed to be broad band in accordance with conventional principles. Lead-in lines **6** and **7** are low impedance cables used to couple the output terminals of the balun **5** to the conductive portions of radiating elements **1** and **2**.

In operation balun **5** provides balanced RF energy for this antenna system even though an unbalanced transmission line is used to feed power from a translator (not shown). The balun **5** may be located at any convenient position. If elements **1** and **2** had their sections which are substantially perpendicular to the reflecting surfaces **3** coupled together with each end connected to one of the output receptacles of the balun **5** they would comprise a U antenna. The use of the lead-in lines **6** and **7** permits elements **1** and **2** to act in substantially their usual manner while at the same time permitting their separation to either side of the reflecting surfaces 3 to form a split V antenna.

Referring to Fig. 2 a U antenna array which is split and mounted on either side of a conductive surface in accordance with the principles of this invention is shown to be similar to the antenna of Fig. 1 except that the portions of the radiating elements which are perpendicular to the conductive surfaces instead of being grounded thereto are capacitively coupled thereto as indicated at **8** and **9**. The capacitive load at one end of each of the split U radiating elements shifts the current maximum point away from the surface of the elliptical cylinder to that region of the radiating elements in which the longitudinal axis of said elements is parallel to the major axis of the elliptical cylinder and provides a better omnidirectional radiation pattern.

Referring to Fig. 3 of the drawing, a split loop semi-flush antenna system in accordance with the principles of this invention is shown in which the generally elliptical cylindrical cross-section of the vertical stabilizer portion of an aircraft has mounted on each side thereof one half of a coaxial loop antenna. Each radiating element **30** and **31** of the loop antenna comprises a radiating section having an effective electrical length substantially equal to one half wave length at the center of the operating frequency band. A coaxial feed line couples energy from a translator (not shown) to a balun *5a* having its output connected to lead-in lines *5b* and *5c*. The lead-in lines *5b* and *5c* are coupled through the reflecting surfaces **40** and **41** and the central conductor thereof is coupled to the second half **42** and **43** of each radiating element past the usual coaxial loop antenna gaps **42***a* and **43***a*. It is to be noted that each radiating element is composed of at least 3 sections two of which **30***a*, **30***b*, **31***a*, **31***b* have their longitudinal axis substantially perpendicular to the conductive surface of the vertical stabilizer while the other section **30***c*, **31***c* has its longitudinal axis substantially parallel to the reflecting surface of the stabilizer. As will be readily appreciated by those skilled in the art as being common to all loop antennas, the antenna of Fig. 3 compared to the antennas of Fig. 1 or 2 has a better omnidirectional radiation pattern with better polarization characteristics and better gain in the horizontal direction whereas the split U antennas shown in Figs. 1 and 2 have less aerodynamic drag, broad band width and more gain in the forward direction.

Referring to Fig. 4 of the drawing it is seen that the antenna embodiments in accordance with the principles of my invention may be mounted inside a streamlined fiber glass housing as indicated at **50**. The lead-in line from the balun is coupled at point **51** to an antenna take-off conductor **52** which is connected to the antenna element **53** along that portion which is parallel to the conductive surface of the vertical stabilizer. The portion of radiating element **53** which is perpendicular to the conductive surface as indicated at **53***b* is coupled to the vertical stabilizer by a capacitor **54**.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

I claim:

1. An antenna system for an aircraft comprising a first radiating element, a second radiating element, said radiating elements being disposed in a given plane on opposite sides of a portion of said aircraft, an extensive conductive surface for each of said radiating elements including the outer surface of said portion of said aircraft, each of said radiating elements having a first radiating portion substantially parallel to the outer surface of said portion of said aircraft and a second radiating portion integral with said first portion disposed substantially perpendicular to said first portion and the outer surface of said portion of said aircraft extending outward from the outer surface of said portion of said aircraft a given distance to space said first portion of said radiating elements a distance related to the wavelength of the operating frequency of said antenna system, means physically supporting each of said second portions from the outer surface of said portion of said aircraft including means to electrically couple said second portion to the outer surface of said portion of said aircraft, and means in energy coupling relation at a given point along each of said radiating elements removed from the outer surface of said portion of said aircraft.

2. An antenna system for an aircraft comprising a first radiating element, a second radiating element, said radiating elements being disposed in a given plane on opposite sides of a portion of said aircraft, an extensive conductive surface for each of said radiating elements including the outer surface of said portion of said aircraft, each of said radiating elements having a first radiating portion substantially parallel to the outer surface of said portion of said aircraft and a second radiating portion integral with said first portion disposed substantially perpendicular to said first portion and the outer surface of said portion of said aircraft extending outward from the outer surface of said portion of said aircraft a given distance to space said first portion of said radiating elements a distance related to the wavelength of the operating frequency of said antenna system, means physically supporting each of said second portions from the outer surface of said portion of said aircraft including means to electrically couple said second portion to the outer surface of said portion of said aircraft, and means in energy coupling relation at a given point along said first portion of each of said radiating elements.

3. An antenna system for an aircraft comprising a first radiating element, a second radiating element, said radiating elements being disposed in a given plane on opposite sides of a portion of said aircraft, an extensive conductive surface for each of said radiating elements including the outer surface of said portion of said aircraft, each of said radiating elements having a first radiating portion substantially parallel to the outer surface of said portion of said aircraft and a second radiating portion integral with said first portion disposed substantially perpendicular to said first portion and the outer surface of said portion of said aircraft extending outward from the outer surface of said portion of said aircraft a given distance to space said first portion of said radiating elements a distance related to the wavelength of the operating frequency of said antenna system, means physically supporting each of said second portions from the outer surface of said portion of said aircraft including means to electrically couple said second portion to the outer surface of said portion of said aircraft, and means in energy coupling relation with the end of said first portion removed from said second portion of each of said radiating elements.

4. An antenna system for an aircraft comprising a first radiating element, a second radiating element, said radiating elements being disposed in a given plane on opposite sides of a portion of said aircraft, an extensive conductive surface for each of said radiating elements including the outer surface of said portion of said aircraft, each of said radiating elements having a first radiating portion substantially parallel to the outer surface of said portion of said aircraft and a second radiating portion integral with said first portion disposed substantially perpendicular to said first portion and the outer surface of said portion of said aircraft extending outward from the outer surface of said portion of said aircraft a given distance to space said first portion of said radiating elements a distance related to the wavelength of the operating frequency of said antenna system, means physically supporting each of said second portions from the

outer surface of said portion of said aircraft including capacitive means to electrically couple said second portion to the outer surface of said portion of said aircraft, and means in energy coupling relation at a given point along each of said radiating elements removed from the outer surface of said portion of said aircraft.

5. An antenna system for an aircraft comprising a first radiating element, a second radiating element, said radiating elements being disposed in a given plane on opposite sides of a portion of said aircraft, an extensive conductive surface for each of said radiating elements including the outer surface of said portion of said aircraft, each of said radiating elements having a first radiating portion substantially parallel to the outer surface of said portion of said aircraft and a second radiating portion integral with said first portion disposed substantially perpendicular to said first portion and the outer surface of said portion of said aircraft extending outward from the outer surface of said portion of said aircraft a given distance to space said first portion of said radiating elements a distance related to the wavelength of the operating frequency of said antenna system, means physically supporting each of said second portions from the outer surface of said portion of said aircraft including capacitive means to electrically couple said second portion to the outer surface of said portion of said aircraft, and means in energy coupling relation at a given point along said first portion of each of said radiating elements.

6. An antenna system for an aircraft comprising a first radiating element, a second radiating element, said radiating elements being disposed in a given plane on opposite sides of a portion of said aircraft, an extensive conductive surface for each of said radiating elements including the outer surface of said portion of said aircraft, each of said radiating elements having a first radiating portion substantially parallel to the outer surface of said portion of said aircraft and a second radiating portion integral with said first portion disposed substantially perpendicular to said first portion and the outer surface of said portion of said aircraft extending outward from the outer surface of said portion of said aircraft a given distance to space said first portion of said radiating element a distance related to the wavelength of the operating frequency of said antenna system, means physically supporting each of said second portions from the outer surface of said portion of said aircraft including capacitive means to electrically couple said second portion to the outer surface of said portion of said aircraft, means in energy coupling relation at a given point along said first portion of each of said radiating elements, and a housing of electromagnetic wave energy pervious material enclosing each of said radiation elements.

7. An antenna system comprising an antenna unit lying in a given plane, a plane of symmetry perpendicular to said given plane dividing said unit into two halves, each of said halves including a radiating element and an extended conductive surface, each of said surfaces lying substantially parallel to said plane of symmetry and disposed between said plane of symmetry and its associated one of said radiating elements, each of said radiating elements having a first radiating portion substantially parallel to its associated one of said surfaces and a second radiating portion integral with said first portion disposed substantially perpendicular to said first portion and said associated surface extending outward from said associated surface a given distance to space said first portion of said radiating elements a distance related to the wavelength of the operating frequency of said antenna system, means coupling each of said second portions to its associated one of said surfaces and means in energy coupling relation at a given point along each of said radiating elements removed from its associated one of said surfaces.

8. An antena system comprising an antenna unit lying in a given plane, a plane of symmetry perpendicular to said given plane dividing said units into two halves, each of said halves including a radiating element and an extended conductive surface, each of said surfaces lying substantially parallel to said plane of symmetry and disposed between said plane of symmetry and its associated one of said radiating elements, each of said radiating elements having a first radiating portion substantially parallel to its associated one of said surfaces and a second radiating portion integral with said first portion disposed substantially perpendiuclar to said first portion and said assoicated surface extending outward from said associated surface a given distance to space said first portion of said radiating elements a distance related to the wavelength of the operating frequency of said antenna system, and means in energy coupling relation at a given point along said first portion of each of said radiating elements.

9. An antenna system comprising an antenna unit lying in a given plane, a plane of symmetry perpendicular to said given plane dividing said units into two halves, each of said halves including a radiating element and an extended conductive surface, each of said surfaces lying substantially parallel to said plane of symmetry and disposed between said plane of symmetry and its associated one of said radiating elements, each of said radiating elements having a first radiating portion substantially parallel to its associated one of said surfaces and a second radiating portion integral with said first portion disposed substantially perpendicular said first portion and said associated surface extending outward from said associated surface a given distance to space said first portion of said radiating elements a distance related to the wavelength of the operating frequency of said antenna system, and means in energy coupling relation with the end of said first portion removed from said second portion of each of said radiating elements.

10. An antenna system comprising an antenna unit lying in a given plane, a plane of symmetry perpendicular to said given plane dividing said units into two halves, each of said halves including a radiating element and an extended conductive surface, each of said surfaces lying substantially parallel to said plane of symmetry and disposed between said plane of symmetry and its associated one of said radiating elements, each of said radiating elements having a first radiating portion substantially parallel to its associated one of said surfaces and a second radiating portion integral with said first portion disposed substantially perpendicular to said first portion and said associated surface extending outward from said associated surface a given distance to space said first portion of said radiating elements a distance related to the wavelength of the operating frequency of said antenna system, means capacitively coupling each of said second portions to its associated one of said surfaces and means in energy coupling relation at a given point along each of said radiating elements removed from its associated one of said surfaces.

11. An antenna system comprising an antenna unit lying in a given plane, a plane of symmetry perpendicular to said given plane dividing said units into two halves, each of said halves including a radiating element and an extended conductive surface, each of said surfaces lying substantially parallel to said plane of symmetry and disposed between said plane of symmetry and its associated one of said radiating elements, each of said radiating elements having a first radiating portion substantially parallel to its associated one of said surfaces and a second radiating portion integral with said first portion disposed substantially perpendicular to said first portion and said associated surface extending outward from said associated surface a given distance to space said first portion of said radiating elements a distance related to the wavelength of the operating frequency of said antenna system, means capacitively coupling each of said second portions to its associated one of said surfaces and means in energy cou-

pling relation at a given point along said first portion of each of said radiating elements.

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