United States Patent [19]

Ancona et al.

[11] **3,781,894**

[45] **Dec. 25, 1973**

[54] **BALLOON CARRIED DIRECTIONAL ANTENNA**

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[22] Filed: **Sept. 9, 1971**

[21] Appl. No.: **178,910**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 793,082, Jan. 22, 1969, abandoned.

[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **343/706,** 343/792, 343/846, 343/872

[51] **Int. Cl.** **H01q 1/28**

[58] **Field of Search** 343/706, 790, 791, 343/792, 846, 872

[56] **References Cited**

UNITED STATES PATENTS

3,438,042	4/1969	Kuecken	343/792
3,588,903	6/1971	Hampton	343/792
3,315,264	4/1967	Brueckmann	343/791
2,704,811	3/1955	Walters	343/791

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[57] **ABSTRACT**

Directional antenna comprising a cylindrical skirt and a base perpendicular to the skirt axis, and a unipole extending from the base along the axis and out of the skirt. Electrically insulated fixing means extending through an aperture in the base fix the unipole to the base. A coaxial feeder line extends through the skirt and has its inner conductor extending through the insulated fixing means and connected to the unipole through the aperture and its outer conductor connected to the skirt. The unipole has a length of $\leqslant 0.25\ \lambda$, the skirt has a length of $0.35\ \lambda$–$0.65\ \lambda$ and a diameter of 0.05–$0.2\ \lambda$, whereby the antenna has a radiation pattern which lies substantially entirely on the side of the plane of the skirt base opposed to the unipole.

17 Claims, 12 Drawing Figures

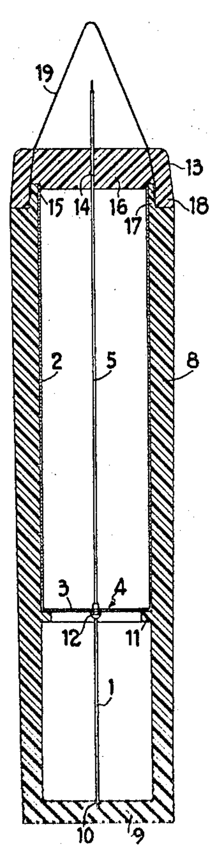


Fig.1

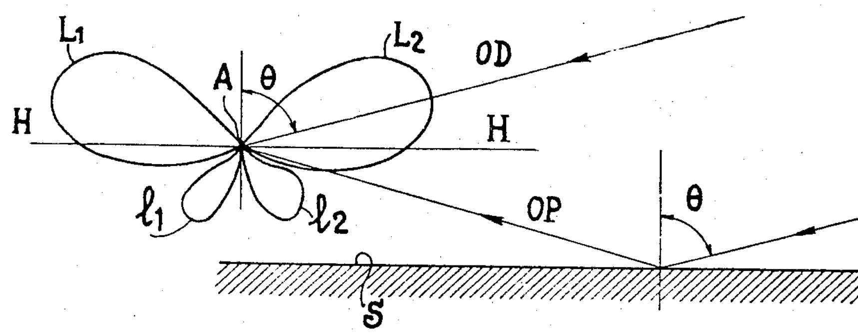
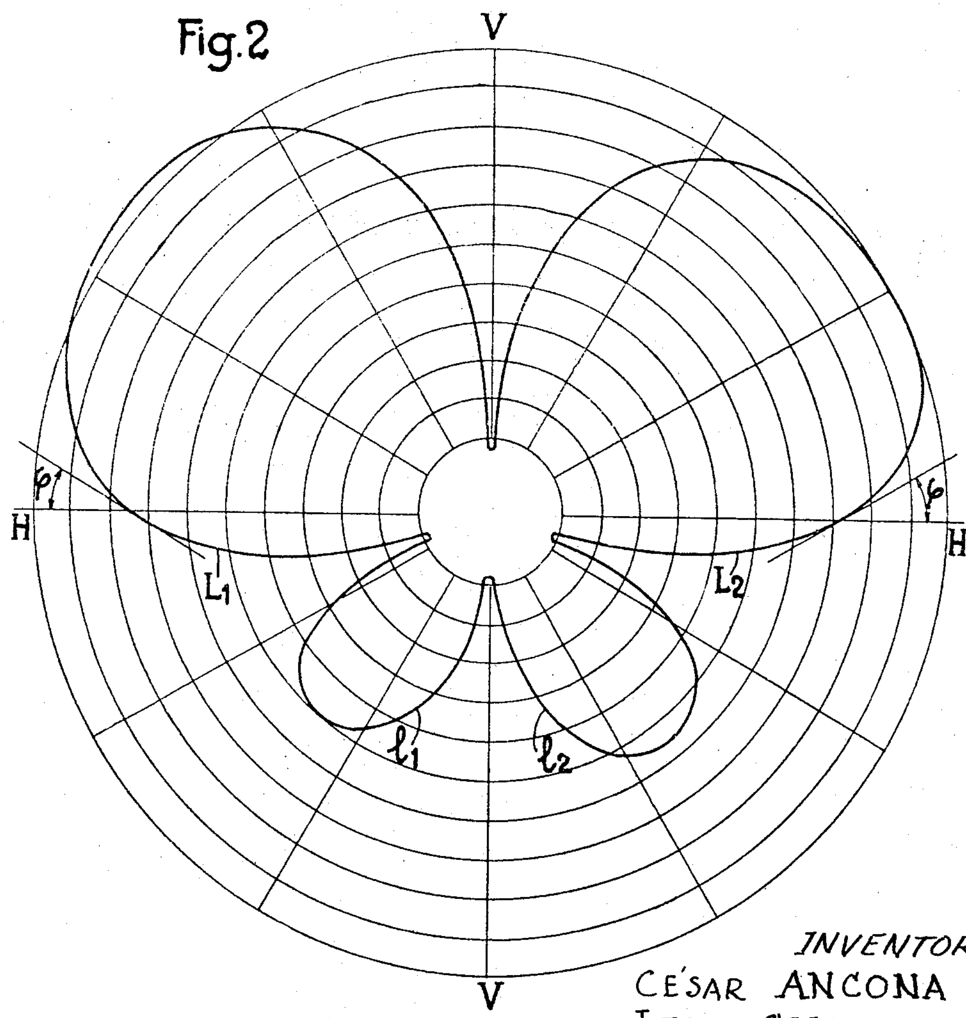


Fig.2



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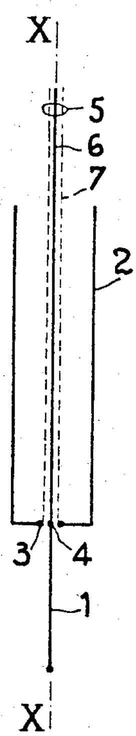
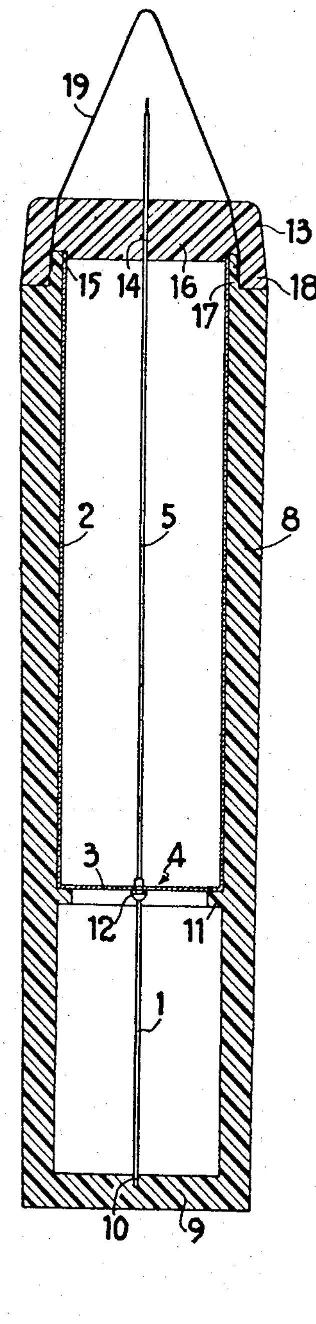


Fig. 3

Fig. 4



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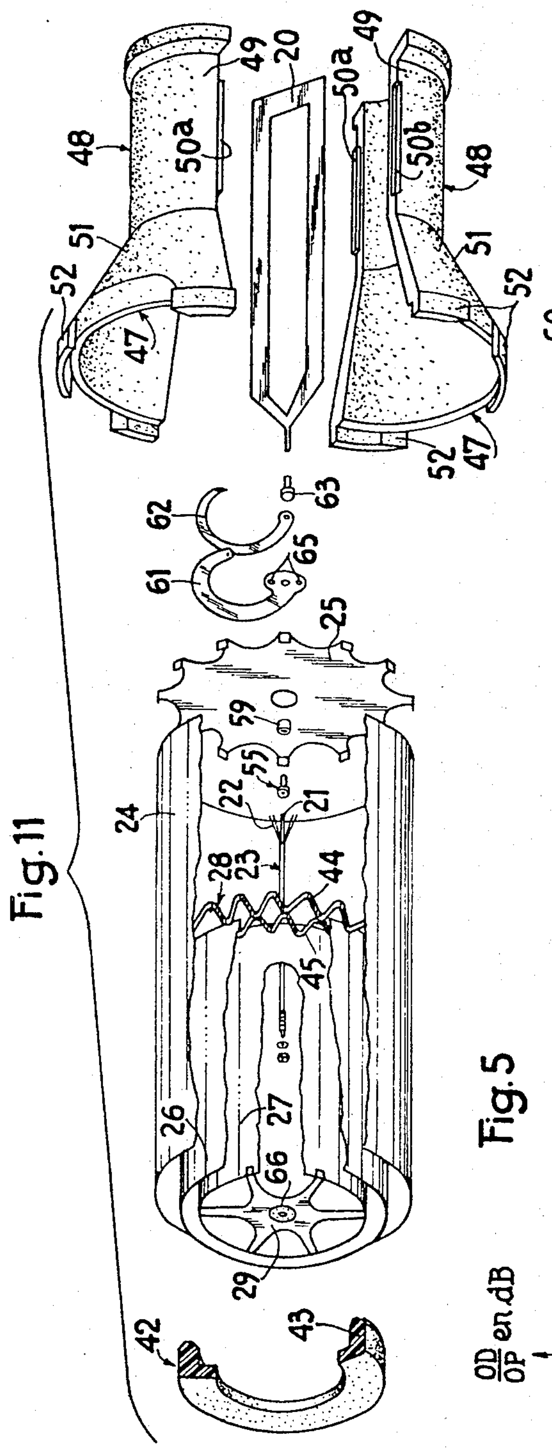

Fig.11

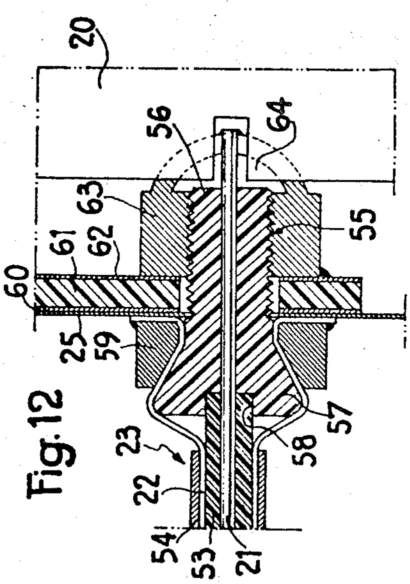

Fig.12

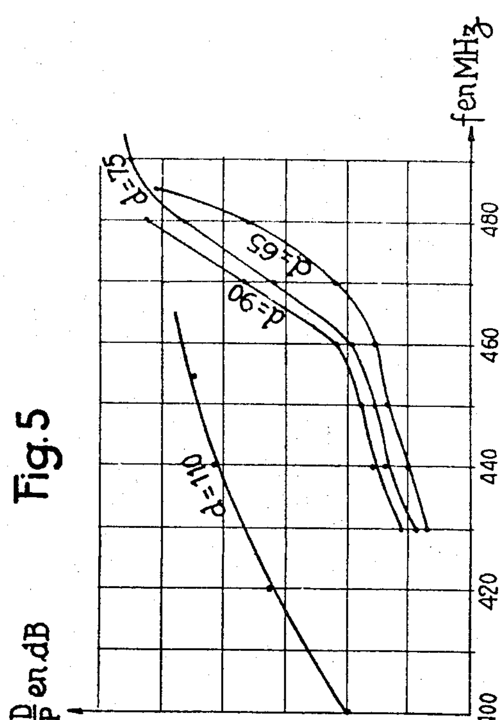

Fig.5

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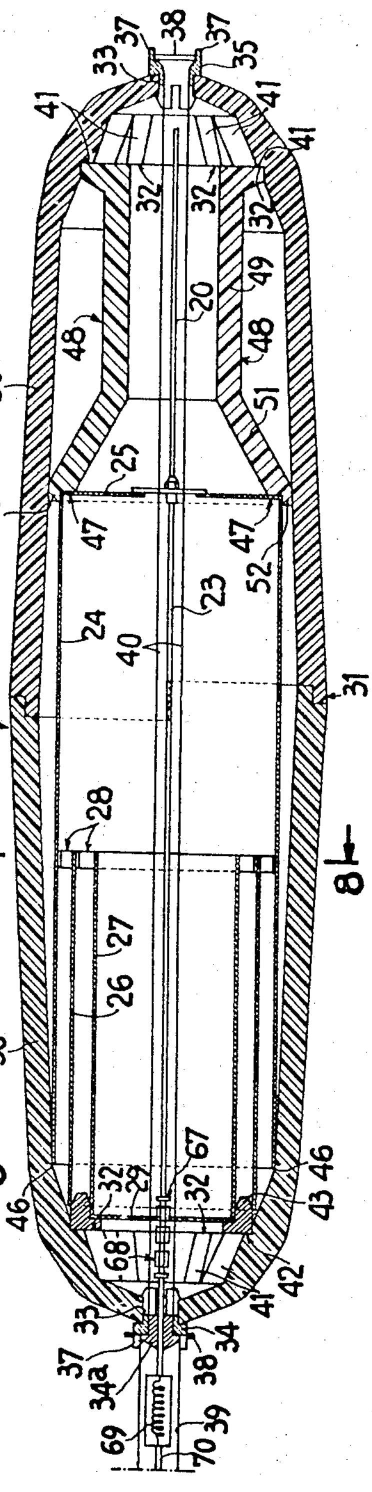

Fig.7

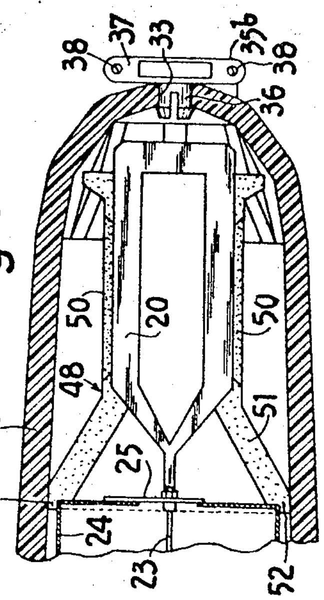

Fig.10

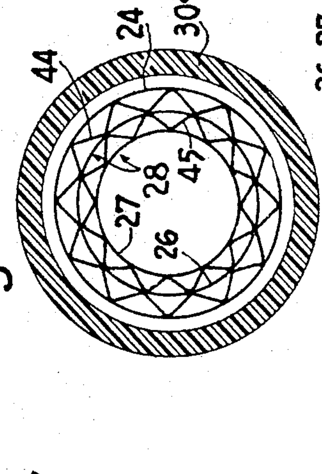

Fig.8

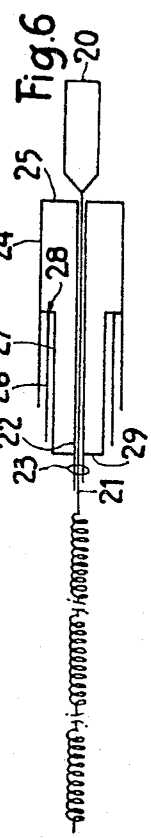

Fig.6

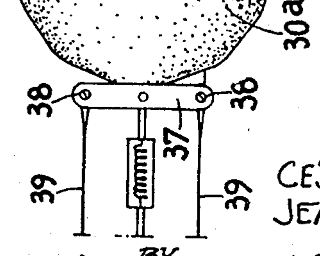

Fig.9

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BALLOON CARRIED DIRECTIONAL ANTENNA

This application is a continuation-in-part of our application Ser. No. 793,082, filed Jan. 22, 1969, now abandoned.

The present invention relates in a general way to very high frequency antennas and more particularly to an antenna adapted to establish communications for example between a meterological balloon and a satellite within a frequency range of for example 100 MHz–1 GHz. The antenna according to the present invention, although not limited to the aforementioned particular application, is particularly designed to ensure a ballon-satellite communication and for this purpose it can be suspended from a balloon and accompanied by a very high frequency transmitter-receiver.

In the construction of antennas of this type, several manufacturing problems are encountered owing to the fact that it must be possible to meet air security requirements at any moment. The security conditions require in particular that the antenna must be destructible by a flying aircraft without however damaging the latter. The antenna must therefore be as light as possible and its mass per unit length M/L must be less than 5 g/cm.

Among the other problems created by telecommunication between a balloon and a satellite is that of the echoes reflected by the surface of the earth and in particular of the sea, which requires that the antenna be designed in a very special manner and have a radiation pattern which eliminates as far as possible the effect of these reflections.

It has been found that these reflections are, in respect of incidences skimming the sea, substantially specular, so that only the slope of the radiation pattern of the antenna in the vicinity of the horizontal plane can be relied upon for improving the discrimination of the direct wave from the reflected wave.

FIG. 1 of the accompanying drawings clearly illustrates this important condition.

With the antenna suspended at point A from, for example, a balloon and receiving electromagnetic energy directly in the direction OD (direct wave) from a transmitter, such as that of a satellite, there is formed, owing to reflections off the surface S of the sea, a direct radiation OP (parasite wave) which may seriously disturb the reception of the information contained in the direct wave OD. Indeed, at skimming incidences (θ=80° for example), the reflection is practically specular so that the reflected energy received in the region of the antenna is not negligible. Further, for higher incidences ($0<\theta<60°$), the waves reflected by the sea have a diffused character and consequently add noise to the useful direct signal if they are picked up by the antenna. The latter must therefore have a radiation which is as small as possible in the direction of the earth.

Consequently, the radiation pattern of the antenna must have a shape such as that shown in FIG. 2, in which:

1. The pattern has two large lobes L_1, L_2 above the horizontal plane (H—H) and much smaller lobes l_1, l_2 below this plane.
2. The slope that the pattern of the upper lobes L_1, L_2 makes with the horizontal plane (H—H) is very small (angle ϕ very small). In other words, what is desired is the maximum possible damping, expressed in dB, of the wave OP relative to the wave OD.

Much research has shown that an antenna having these characteristics can be constructed which has a unipole disposed in the extension of the axis of a conductive cylindrical skirt of adequate diameter, this skirt extending vertically upward in use of the antenna. One end of the unipole is located roughly in one of the base planes of the cylindrical skirt. The antenna is excited by supplying power to the end of a unipole and the cylindrical skirt in phase opposition.

Antennas having this general shape are known. For example, U.S. Pat. No. 2,267,951 discloses an antenna in respect of which it is easy to show that the radiation pattern is substantially symmetrical relative to the base plane of the skirt, since the lengths of the skirt and of the unipole are identical (¼ λ). This antenna therefore has a radiation pattern equivalent to that of an ordinary dipole and thus cannot be employed for the aforementioned particular application or, in a general way, cannot have the radiation pattern shown in FIG. 2.

Further, antennas are known which furnish an asymmetric radiation pattern. For example, U.S. Pat. No. 3,009,154 discloses a discone antenna comprising a unipole having a capacity disc which is associated with a conical conductive body on the axis of the disc. The assembly is mounted at the focus of a parabolic reflector by a tubular support on the axis of the reflector.

However, the antenna of this patent has two major drawbacks which render it unsuitable for the aforementioned particular applications. Indeed, owing to its conical shape and as concerns frequency ranges of interest, this antenna has a relatively large size. Moreover, owing to its robust construction (massive cone for example) and its large mass per unit length it does not meet the aforementioned air security requirements. Further, this patent does not describe means for avoiding the electric coupling phenomena which exist between the discone antenna and the tubular support disposed on the axis of this primary source. These couplings considerably affect the performance of the discone antenna whose radiation pattern has numerous corrugations incompatible with a good separation of the upper and lower radiations.

An object of the invention is to provide an antenna which is derived from that of U.S. Pat. No. 3,267,951 but which is able to avoid all this drawbacks. Consequently, according to a first feature of the invention, the antenna is essentially asymmetric so that with λ equal to the operating wave length of the antenna, the unipole has a length of $\leq 0.25\ \lambda$ and the cylindrical skirt has a length between 0.35 λ and 0.65 λ and a diameter between 0.05 and 0.2 λ.

However, in these conditions and owing to the fact that the skirt and the unipole must be supplied through a coaxial line, it is advantageous to provide matching means to prevent the outer sheath of the coaxial line from participating itself, with the skirt and the unipole, in the radiation which would unfavorably affect the radiation pattern. Further, in order to obtain an adequate unipole dimension for the required radiation, it has been found preferable to provide a matching between the unipole and the skirt.

Another object of the present invention is therefore to provide a directional antenna in which this matching is achieved.

Consequently, according to a second feature of the invention, the directional antenna, of the type comprising a unipole defining an axis, a conductive disc located in a plane perpendicular to said axis at one of the ends of the unipole, a first skirt coaxial with said unipole and extending from said plane in the opposite direction to the unipole to which it is electrically connected, comprises at least one second cylindrical skirt which is coaxial with the first skirt and electrically connected at its end adjacent the unipole to the first skirt and has an extent from said end different from the extent of the first skirt, spacer means for positioning the free edges of said skirts and a coaxial supply line whose outer sheath is connected to said skirts and whose inner conductor is connected to said unipole.

Owing to this feature, it is possible, by suitably choosing the respective lengths of the cylindrical skirts, to form a ¼λ choke at the operating frequency of the antenna, which fixes the electrical length of the skirt at 0.49λ producing the required asymmetric radiation while affording a first reduction in the parasite currents which may circulate in the sheath of the coaxial line.

In some cases it may be desirable to have a plurality of operating frequencies. However, as has been seen, the dimensions of the antenna are intimately related to the wavelength so that if a ¼λ choke of given dimension is chosen, the matching at another operating frequency is less effective.

Consequently, according to another feature of the invention, the antenna comprises a third cylindrical skirt which is coaxial with the two other skirts and electrically connected to the latter at one of its ends adjacent the unipole and has an extent from said end different from the extents of the first and second skirts, the free edge of said third skirt being in contact with said spacer means.

The length of the third skirt is preferably chosen as a function of a second operating frequency of the antenna.

It has been found, moveover, that, with these features, the radiation pattern becomes relatively selective and there is a noticeable dispersion for frequencies in the form of the diagram, in the ratio of about f^1/f_2 = about 1.15. This is why there is preferably chosen, in accordance with another feature of the invention, a length for the cylindrical skirt which is equal to 1.49λ. Note that, in these conditions, the physical lengths of the skirts are different.

Although the matching skirts arranged in this way already enable the radiation of the antenna to be improved, it is advantageous, in accordance with another feature of the invention, to provide at least one choke formed by the coaxial supply line of the antenna.

This choke is preferably constituted by a helical winding of several turns of the supply cable itself a full stop.

The helical chokes constructed in this way are devices having a high-pass band which attenuate, both by their high series impedance distributed over a plurality of centimeters and by their over voltage, the induced currents propagated in the outer sheath of the coaxial line of the antenna, source of disturbance of the radiation proper of the antenna.

This decoupling arrangement is much more effective than that employing tuned λ/4 sleeves coaxial with said sheath, which is a well-known technique in the antenna art. Tests have shown that the latter devices, which are selective, are insufficient if not employed in a great number along the supply line.

It has been found that three coils each having ten turns and located at appropriate distances apart enable the desired effect to be achieved irrespective of the width of the nacelle of elongated shape disposed on the axis of and above the antenna and containing the transmitter-receiver circuitry.

According to another feature of the invention there is provided a matching line for matching said unipole to the impedance of the coaxial line, this matching line being connected in parallel to the point of connection between the inner conductor of the coaxial line and the unipole.

This matching line is preferably constituted by a conductive band which is connected to, but insulated from, the conductive disc.

Another object of the invention is to provide an improved case for an antenna of the type defined hereinbefore.

Further features and advantages of the invention will be apparent from the ensuing description with reference to the accompanying drawings.

In the drawings:

FIG. 1 is a diagram showing the conditions of operation of an antenna according to the invention;

FIG. 2 shows the radiation pattern of this antenna;

FIG. 3 shows diagramatically an antenna according to a first embodiment of the invention;

FIG. 4 is an axial sectional view of the embodiment according to the schematic shown in FIG. 3;

FIG. 5 is a diagram showing the gain in dB of the direct wave relative to the reflected wave as a function of the frequency for several diameters of the antenna shown in FIG. 4;

FIG. 6 is the schematic of the principle of operation of another embodiment of the antenna according to the present invention;

FIG. 7 is a longitudinal axial sectional view of the embodiment the principle of which is shown in FIG. 6;

FIG. 8 is a radial sectional view taken along line 8—8 of FIG. 7;

FIG. 9 is a partial outside view of the upper end of the antenna shown in FIG. 7 turned through 90°;

FIG. 10 is a partial sectional view of the lower end of the antenna shown in FIG. 7 turned through 90°;

FIG. 11 is an exploded view of this antenna without its protective case, and

FIG. 12 is a detail axial sectional view on an enlarged scale of the connection between the coaxial line and the unipole.

In the schematic shown in FIG. 3 the antenna comprises a radiating element or unipole 1 constituted by a metal rod and having a length equal to or less than ¼λ, λ being the operating wavelength of the antenna. There is associated with the unipole 1 a cylindrical skirt 2 of uniform diameter which is closed at the end adjacent the unipole 1 by a conductive disc 3 through which passes the inner conductor 6 of a coaxial line 5, which conductor is connected to the unipole 1 at the point of connection 4 which is substantially in the plane of the conductive disc 3. The outer conductor 7 of the coaxial line 5 is connected to the disc 3.

An antenna whose schematic is that described hereinbefore has the radiation pattern shown in FIG. 1 when the dimensions are carefully chosen as a function of the wavelength.

Thus, the length of the unipole is equal to or less than 0.25λ, the length of the cylindrical skirt being chosen between 0.35λ and 0.65λ whereas the diameter of the skirt is preferably chosen within the range of 0.05λ to 0.2λ.

The material of the cylindrical skirt can be very thin copper foil or rustless steil having a thickness of for example 0.05 mm.

Note that the illustrated antenna is freely suspended in such manner that the unipole is pointing downwardly; in these conditions the radiation pattern is oriented in the way shown in FIG. 1.

FIG. 4 shows the embodiment of the invention in which the antenna shown in FIG. 3 is disposed in a protective case.

The cylindrical skirt 2 extends within a case body 8 having a slightly part-conical or tapered shape and downwardly convergent. This shape has no effect on the electrical operation of the antenna.

The base 9 of the body 8 has a blind aperture 10 receiving the free end of the unipole 1.

The cylindrical skirt 2 provided with the conductive disc 3 bears against a shoulder 11 which is integral with the case body 8.

The connection point 4 is constituted by a connector 12 to which the unipole 1 and the coaxial line 5 are fixed in such manner that the inner conductor 6 of this line is directly connected to the unipole 1 whereas the outer conductor is connected to the conductive disc 3.

A detailed description of such a connector 12 will be given hereinafter with reference to FIG. 12.

The body 8 is closed by a cover 13 provided with an aperture 14 in its center for the passage of the coaxial line 5. The diameter of this aperture is so chosen as to slightly grip the line and thus hold the latter taut inside the case.

FIG. 4 shows that the cover 13 has in its center a circular projecting portion 16 whose diameter exactly corresponds to the inside diameter of the cylindrical skirt 2.

The body 8 is provided with an extension portion 17 which, in co-operation with the projecting portion 16 of the cover 13, maintains the free edge portion of the cylindrical skirt 2 in position.

The cover 13 has a flange 18 which engages around the extension portion 17 and closes the case body 8.

A suspension strap 19 is secured to the cover for suspending the antenna from a balloon (not shown).

The material of the case is preferably expanded polystyrene or polystyrene foam, such as the material known under the trade name "STYROPOR" so that the assembly has the required lightness.

An antenna arranged in this way and having the following dimensions has given full satisfaction :

length of the unipole 1—180 mm

length of the skirt 2—350 mm

diameter of the skirt 2—110 mm

for an operating frequency of about 400 MHz (λ=0.75 m).

FIG. 5 shows the effect of the diameter of the cylindrical skirt on the sensitivity of the antenna receiving the direct wave OD (FIG. 1) relative to that of a reflected wave (OP), the ratio being expressed in dB and θ being equal to 80°.

It can be seen that this ratio is most favorable for large diameters of the cylindrical skirt (d=110 mm), when a satisfactory performance is desired at given frequencies, for example 400 and 460 MHz.

However, this excessively large diameter cannot be chosen, since otherwise the size of the antenna would be excessive to satisfy the security requirements for the antenna.

The antenna shown in FIGS. 6–12 constitutes the preferred embodiment of the invention.

As can be seen in FIG. 6, this antenna comprises a unipole 20 constructed from a metal sheet cut into the shape of a U.

This unipole is connected to the inner conductor 21 of the coaxial line 23. The outer conductor 22 of the latter is connected to a first cylindrical skirt 24 coaxial with the unipole 20.

The skirt 24 is connected to a conductive disc 25 which is perpendicular to its axis. The skirt 24 and the unipole 20 extend from the disc 25 in opposite directions.

The antenna further comprises two auxiliary skirts 26 and 27 which are coaxial with the first-mentioned skirt and extend in a part of and project axially from the latter, their lengths being adapted to two respective operating frequencies of the antenna and preferably chosen to be 0.49λ.

The inner ends of the cylindrical skirt 26, 27 are introduced and connected to the outer skirt 24 by two shorting elements 28 which will be described in detail hereinafter (FIG. 8).

The free end of the longest and innermost skirt 27 is closed by a star-shaped shorting disc 29 through which the coaxial line 23 extends.

The assembly just described is housed in a case 30 composed of two identical parts 30*a* and 30*b* which fits one inside the other at 31 (FIG. 7).

The fact of employing two identical halves markedly reduces the manufacturing and assembly costs.

The case is preferably composed of polystyrene foam such as that known under the trade mark "STYROPOR".

Each case half 30*a* or 30*b* has a slightly part-conical or tapered shape and a roughly spherical end wall.

Shoulders 32 are provided inside the halves for locating the various component parts of the antenna.

The end of each half 30*a* or 30*b* is provided with an aperture 33 receiving a plug which is of for example a material known under the trade name "PLEXIGLASS" and has an axial aperture. One of the plugs 34 is provided for the passage of a coaxial line 33 and the other 35 for discharging water which might accumulate in the case 13 owing to, for example, condensations.

The plug 34 is closed by an insulating sleeve 34*a* (FIG. 7) and a seal is achieved by inserting the product known under the trade name "SILASTENE RTV 730" between the sleeve and the line 23 and between the sleeve and the plug 34.

As can be seen in particular in FIGS. 9 and 10, the plugs 34 and 35 comprise a cylindrical portion 36 engaged in the corresponding aperture 33 and two strip portions 37 apertured at their ends and extending in a direction parallel to each other and perpendicular to the axis of the antenna. Metal pins 38 are engaged in the apertures 33 and they may be connected to suspension straps 39 constituted, for example, by bands of plastics material.

The two halves 30*a* and 30*b* of the base 30 are held fitted together by a cord 40 which is folded back onto itself and extends through the case twice from one end to the other by starting at the plug **34** and passing through the plug **35** and returning to the plug **34**, the cord being held taut and clamped at both ends in the plug **34** so as to suitably close the case **30**.

The end portion of each half **30***a* or **30***b* has several inner radial ribs **41** the ends of which form shoulders **32**. A maintaining washer **42** acts as a spacer member for the end edges of the auxiliary skirts **26** and **27** and bears against the shoulders **32** of the half **30***a*.

The washer **42** has a flange **43** which engages between the ends of the skirts **26** and **27** so as to maintain them in position in the radial direction.

In the axial direction it is the star-shaped shorting disc **29** which bears against the washer **42**.

The opposite ends of the skirts **26** and **27** are mechanically maintained in position relative to the main skirt **24** by means of two shorting elements **28**. The latter are constituted by metal bands **44** and **45** which are folded in a zig-zag fashion and fixed by their apices to the respective skirts **24**, **26** and **27** and enable this arrangement to deform radially, which is necessary for the aforementioned air security. The fixing of the bands **44** and **45** is preferably achieved by spot welding (FIG. **8**). The free end edge portion **46** of the skirt **24** is maintained against the inner tapered wall of the half **30***a* of the case **30**.

The opposite end of the skirt **24** is maintained in position by a shoulder **47** provided on the end edges of two identical half-shells **48**. The latter extend between the conductive disc **25** and the shoulders **32** of the half **30***b* of the case **30**.

Each of the half-shells **48** comprises a cylindrical portion **49** which is provided on the respective edge portions with a positioning rib **50***a* and a corresponding notch **50***b*, the rib and the notch of the same half-shell being spaced apart the width of the unipole **20** (FIG. **7**). It will be clear that, upon assembly of the half-shells, the ribs **50***a* of one is engaged in the notch **50***b* of the other.

Each half-shell **48** further comprises a tapered portion **51** which is divergent in the direction of the wall of the case on which it bears through feet **52**. The latter maintain the half-shell in position in the radial direction.

It can be seen that this arrangement supplies an adequate support for the unipole **20** which is, as already mentioned, constituted by a sheet of very thin metal and therefore requires to be maintained firmly.

Note that the unipole **20** is free to move in the axial direction between the two half-shells **48** so that the axial tolerances of the assembly can be compensated easily.

The coaxial line **23** is of any appropriate type. It comprises in the known manner an inner conductor or core **21** which is connected to the unipole **20**, as clearly seen in FIG. **12**.

It also has an inner insulating sheath **53** and a conductive sheath or outer conductor **22**, the assembly being completed by a protective insulating sheath **54**.

In the region of the conductive disc **25** (FIG. **12**), the conductor **21** extends through a small insulating sleeve **55**. The latter has a screwthreaded cylindrical portion **56** engaged in a center aperture in the conductive disc **25** and a part-conical portion **57** having a cylindrical axial cavity **58**. The latter receives the end member of the insulator **53** of the coaxial line **23**.

The outer conductor **22** of the coaxial line has its end portion spread out and placed around the partconical portion **57** and clamped thereagainst by a ring **59** whose bore is complementary to the portion **57**.

The spread portion of this outer conductor is bent in the direction parallel to the disc **25** and soldered to the ring **59** at its periphery.

Placed flat against the disc **25** is a band **60** for example of silver which may have the shape of a spiral in the plane perpendicular to the axis of the antenna.

A band **61** of insulating material, such as that known under the trade name "TEFLON" is adehered to the silver band **60** and another metal layer **62** covers the band **60**.

This layer is in contact with a blind conductive nut **63** which is screwed on the cylindrical portion **56** of the insulating sleeve **55** and has a dome-shaped end portion **64**. The latter is split so as to receive the end of the unipole **20** which is carefully soldered thereto at the same time as the conductive inner end member **21** of the coaxial line.

The nut **63** clamps the disc **25**, the bands **60** and **61**, the layer **62** and the spread portion of the outer conductor **22** against the ring **59**. The nut **63** is prevented from rotating by soldering or welding between the nut and the layer **62** of the matching line.

In this way, a completely satisfactory passage having the appropriate electrical and mechanical properties is obtained.

A parallel line is furnished by the stack or assembly of bands **60**, **61** and layer **62**, which line is adapted for the matching of the unipole **20** by the suitable choice of its shape and length.

FIG. **11** shows that the base of the matching line is provided with two apertures **65** which coincide with corresponding apertures in the disc **25** for the passage of the cord **40** in both directions. The disc **29** has apertures **66** at its center provided for the same purpose.

In FIG. **7**, it can be seen that the coaxial line **23** extends through the antenna up to its upper end by passing through a passage nut **67** which is fixed to the disc **29** in the center of the latter. This nut permits putting the cable **23** under suitable tension in the space between the discs **25** and **29**.

A coaxial plug **68** is engaged in the passage nut **67** to connect an exterior coaxial line **70**. In order to ensure the attenuation of induced currents propagated in the outer sheath of the coaxial line, the line **70** comprises at least three chokes **69** each of which is constituted by, for example, ten turns of the coaxial line **70** wound on itself. These turns can be suitably maintained in position by a small case of plastics material shown diagrammatically in FIGS. **7** and **9**. The coils are spaced a suitable distance apart, this distance being determined by experience.

All the metal parts of the antenna are preferably assembled by spot welding. They are of 0.05 mm thick rustless steel, copper foil or of some other suitable material, the thinness of these materials contributing to increase the air security.

The following characteristics have been employed by the Applicants for an antenna designed for the aforementioned application:

length of the unipole **20**—175 mm
length of the main skirt **24**—318 mm
height of the shorting elements **28**—8 mm
length of the first auxiliary skirt **26**—184 mm

length of the second auxiliary skirt 27—190 mm
diameter of the skirt 24—110 mm
diameter of the skirt 26 (460 MHz trap)—90 mm
diameter of the skirt 27 (400 MHz trap)—70 mm
operating frequencies—400 and 460 MHz
length of the case 30—610 mm
maximum diameter of the case 30—150 mm
total weight—320 g.

Having now described our invention what we claim and desire to secure by Letters Patent is:

1. A directional antenna comprising a hollow conducting cylindrical skirt of constant diameter having an axis and at one end a base extending in a plane perpendicular to said axis, a hole provided in said base, a unipole extending from said base along the axis of said skirt and outside of the latter, electrically isolated fixing means extending through said hole for mechanically fixing said unipole to said base, a coaxial feeder cable extending through said skirt and having an inner conductor and an outer conductor, said inner conductor extending through said isolated fixing means so as to be connected to said unipole through said hole, said outer conductor being connected to said skirt and λ being the operating wavelength of the antenna, the unipole having a length of ≤0.25 λ, the cylindrical skirt having a length between 0.35 λ and 0.65 λ and a diameter between 0.05 and 0.2 λ, whereby the antenna is substantially asymmetric and has a radiation pattern which lies substantially entirely at the side of the plane of said base opposite to said unipole, an elongated casing of light material enclosing said unipole and said skirt, said casing comprising mounting means for positioning said unipole and said skirt therein and calibrated passage means for said coaxial cable so as to hold the cable straight in said casing, said antenna further comprising a suspension strap provided on said casing at the end of the latter opposite to that of said unipole.

2. A directional antenna comprising a unipole defining an axis, a conductive disc located in a plane perpendicular to said axis at one of the ends of the unipole, a first skirt coaxial with the unipole and extending from said plane in the opposite direction to the unipole to which it is electrically connected, said antenna further comprising a second cylindrical skirt which is coaxial with the first skirt and electrically connected at its end adjacent the unipole to the first skirt and has an extent from said end different from the extent of the first skirt, spacer means for positioning the free edges of said skirts, and a coaxial supply line whose outer sheath is connected to said skirts and whose inner conductor is connected to said unipole, the electrical connection between the first and second skirts being by means of a shorting element constituted by a conductive band folded in a zig-zag pattern and connected by its apices to the skirts, so that the band maintains the skirts together.

3. A directional antenna comprising a unipole defining an axis, a conductive disc located in a plane perpendicular to said axis at one of the ends of the unipole, a first skirt coaxial with the unipole and extending from said plane in the opposite direction to the unipole to which it is electrically connected, a second cylindrical skirt which is coaxial with the first skirt and electrically connected at its end adjacent the unipole to the first skirt and has an extent from said end different from the extent of said first skirt, a third cylindrical skirt coaxial with said first and second skirts and electrically connected thereto at one of its ends adjacent the unipole and extending from said last-mentioned end a distance different from the first and second skirts, spacer means for positioning the free edges of said skirts, a coaxial supply line whose outer sheath is connected to said skirts and whose inner conductor is connected to said unipole, said first, second and third skirts being electrically connected to each other through shorting elements, each being constituted by a band folded in a zig-zag pattern and connected by its apices to adjacent skirts so as to maintain the skirts assembled.

4. A directional antenna comprising a unipole defining an axis, a conductive disc located in a plane perpendicular to said axis at one of the ends of the unipole, a first skirt coaxial with the unipole and extending from said plane in the opposite direction to the unipole to which it is electrically connected, a second cylindrical skirt which is coaxial with the first skirt and electrically connected at its end adjacent the unipole to the first skirt and has an extent from said end different from the extent of said first skirt, a third cylindrical skirt coaxial with said first and second skirts and electrically connected thereto at one of its ends adjacent the unipole and extending from said last-mentioned end a distance different from the first and second skirts, spacer means for positioning the free edges of said skirts, a coaxial supply line whose outer sheath is connected to said skirts and whose inner conductor is connected to said unipole, the third skirt being closed at its free end by a shorting disc having a center aperture for the passage of the coaxial line.

5. An antenna as claimed in claim 2, wherein said spacer means comprises a washer having a circular flange which maintains said free edges of said first and second skirts spaced apart.

6. An antenna as claimed in claim 3, wherein the unipole is a metal rod.

7. An antenna as claimed in claim 3, wherein the unipole has a U-shape and is cut from a sheet of foil.

8. A directional antenna comprising a unipole defining an axis, a conductive disc located in a plane perpendicular to said axis at one of the ends of the unipole, a first skirt coaxial with the unipole and extending from said plane in the opposite direction to the unipole to which it is electrically connected, said antenna further comprising a second cylindrical skirt which is coaxial with the first skirt and electrically connected at its end adjacent the unipole to the first skirt and has an extent from said end different from the extent of the first skirt, spacer means for positioning the free edges of said skirts, and a coaxial supply line whose outer sheath is connected to said skirts and whose inner conductor is connected to said unipole, said unipole having an U-shape and being cut from a sheet of foil, said antenna further comprising two half-shells which have a generally semicylindrical shape and are adjoining in an axial plane, the unipole being clamped between respective adjoining edges of said half-shells.

9. An antenna as claimed in claim 3, comprising a case having two identical halves which are in adjoining relation in a radial plane, and means for fixing in position component parts of the antenna inside the case.

10. An antenna as claimed in claim 9, wherein the case is of expanded polystyrene.

11. A directional antenna comprising a unipole defining an axis, a conductive disc located in a plane perpendicular to said axis at one of the ends of the unipole, a

first skirt coaxial with the unipole and extending from said plane in the opposite direction to the unipole to which it is electrically connected, said antenna further comprising a second cylindrical skirt which is coaxial with the first skirt and electrically connected at its end adjacent the unipole to the first skirt and has an extent from said end different from the extent of the first skirt, spacer means for positioning the free edges of said skirts and a coaxial supply line whose outer sheath is connected to said skirts and whose inner conductor is connected to said unipole, a third cylindrical skirt coaxial with the other two skirts and electrically connected to the other two skirts at one of its ends adjacent the unipole and extending from the last-mentioned end a distance different from the first and second skirts, the free edge portion of the third skirt being in contact with said spacer means, said unipole being made of metal foil having U-shape, and a casing comprising two identical halves which are in adjoining relation in a radial plane, the case being provided with means for fixing in position the component parts of the antenna.

12. A directional antenna as claimed in claim **11,** wherein at least one choke is mounted in the coaxial line.

13. A directional antenna as claimed in claim **11,** comprising a matching line for matching said unipole to the impedance of the coaxial line, said matching line being connected in parallel to a point of connection between the inner conductor of the coaxial line and the unipole,

14. An antenna as claimed in claim **3,** wherein said spacer means comprises a washer having a circular flange which maintains said free edges of said first and second skirts spaced apart.

15. An antenna as claimed in claim **3,** wherein at least one choke is mounted in said coaxial line.

16. An antenna as claimed in claim **15,** wherein said choke comprises a number of turns constituted by a winding of the coaxial line itself.

17. An antenna as claimed in claim **15,** wherein said choke is housed in a case of plastics material.

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