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(54) **Antenna assembly**

Antennenanordnung

Agencement d'antenne

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Description

[0001] The invention relates to an antenna assembly for transmitting or receiving RF signals of a given wavelength, said assembly comprising a metal feed tube member having a feed line for connexion to an RF signal source at one end thereof, and two wire helices of pre-

[0002] In a communication system of the abovementioned kind, there exists a requirement for a mast style, high gain, circularly polarised omni-directional antenna for each mobile earth station to allow for operation at all azimuth angles. The need for high gain requires the antennas elevation pattern to be very directional. The satellite will appear at different angles above the horizon from mobile earth stations positioned at different geographical locations, and therefore for maximum antenna gain at an earth mobile station, the major radiation lobe of the station's antenna should be adjusted to precise elevation angle vis-a-vis the satellite. Typically, the elevation angle of a geostationary satellite for an Australian satellite communication system presently in use is 160° E longitude and therefore the correct angle of elevation for an associated earth station antenna for optimum gain in, for example Sydney, is 50°, whereas in Perth the correct angle of elevation of the antenna is 30°.

[0003] Antenna arrangements are known which use an array phasing method for electronically controlling the elevation angle of the antennas radiation lobe, but this method is complex and relatively expensive. Further, some known antenna arrangement for satellite communication, such as a quadrifilar helical antenna have undesirable wide beam low gain elevation lobe patterns.

[0004] The earlier, late published patent application WO 94/27338 describes a steerable beam helix antenna for transmitting and receiving RF signals. Two wire helices are arranged in bifilar manner within a dielectric sheet which is wound around the axis of the antenna. The outer side of the dielectric sheet is affixed to a radome while the inner side is affixed to a central tube. The wire helices are fed via feed lines which are positioned within the central tube.

[0005] It is an object of the present invention to provide a simple, relatively high gain antenna arrangement whose radiation lobe's angle of elevation can be simply adjusted.

[0006] According to the invention there is provided an antenna assembly for transmitting or receiving RF signals of a given wavelength, in which the feed tube member has a co-axial inner conductor as a part of the feed line, each helix being commonly coupled with one end to the inner conductor's end and the other end of each helix being separately fixed to a first annular-shaped support member slidably encircling said feed tube member, said assembly further including a calibrated adjust-

ment means comprising a tubular housing member of dielectric material that is transparent to RF energy, and a tubular base member into which one end of said tubular housing member slidably nests, said helices, said tubular housing member and said tubular base member having a common axis and said tubular housing member enclosing said helices, and said first annular-shaped support member being attached to said tubular housing member, said tubular base member including two parallel screw channels formed in the base member's inner surface which co-operate with two pin members extending outwardly from a portion of said tubular housing member resting within said tubular base member such that selective partial rotation of said tubular housing member causes a partial rotation and axial movement of said first annular-shaped support member, whereby the pitch of said helices is changed by a predetermined distance and the diameter of said helices is substantially maintained, thereby changing the elevation angle of electromagnetic waves radiating from or received by said antenna assembly at said given wavelength to a desired angle of elevation corresponding to a selected calibration.

[0007] In order that the invention may be readily carried into effect an embodiment thereof will now be described in relation to the accompanying drawings, in which:

[0008] Figure 1 shows a bifilar helical antenna element of the antenna assembly of the present invention.

[0009] Figure 2 shows the top section of the antenna element of Figure 1.

[0010] Figure 3 shows the bottom section of the antenna element of Figure 1.

[0011] Figure 4 shows the radome assembly within which the antenna element of Figure 1 is enclosed.

[0012] Figure 5 shows, in cross section, details of an adjusting element of the antenna assembly.

[0013] Figure 6 illustrates the relationship between the diameter and pitch of the antenna element of Figure 1.

[0014] Figure 6a graphically illustrates a typical radiation pattern of the antenna element of Figure 1.

[0015] Referring to the drawings, the antenna element comprises a copper feed tube 1 within which is a co-axial inner conductor 2 surrounded by dielectric material 3. Feed tube 1 is fixedly attached to a base member 4 through which an RF signal is fed to the inner conductor 2.

[0016] About feed tube 1 is formed two helices 5 and 6 of beryllium copper wire to form a bifilar helix. One end of each helix 5, 6 is fixedly attached to an annular shaped bottom support member 7 of dielectric material which slidably encircles feed tube 1. The other end of each helix is electrically terminated on respective contact zones 8 and 9 provided on an annular-shaped top support member 10 of dielectric material. The top support member 10 encircles feed tube 1 and is fixedly attached thereto. The distal end of inner conductor 2 is

terminated on contact zone 9. Contact zones 8 and 9 are coupled by a cable balun 11 of a predetermined length.

[0017] The radome assembly shown in Figures 4 and 5 comprises a tubular member 12 of dielectric material that is transparent to R.F. energy. The inside diameter of tubular member 12 is preferably equal to the diameter of the bifilar helix. Tubular member 12 nests co-axially, in a slidable manner, within a tubular base adjustment-guide member 13. The radome assembly further comprises a locking collar 14 which co-operates with a screw-thread (not shown) at the end of base adjustment guide member 13.

[0018] Tubular member 12 is provided on its exterior surface with predetermined calibrations 15 for setting the required radiation lobe elevation angle. On the inner surface 16 of tubular base adjustment-guide member 13 there are provided two parallel channels 17 of a predetermined pitch for respectively co-operating with two adjustment guide pins, one of which, 18, is shown, extending from the surface of bottom support member 7 and protruding through tubular member 12 to engage respective channels 17.

[0019] To assemble the antenna, the antenna element shown in Figure 1 is placed within the radome assembly. Base member 4 of the antenna assembly is co-axially fixed within the end portion of tubular base adjustment guide member 13. Adjustment guide pins 18 respectively co-operatively engage screw channels 17 so that on twisting tubular member 12 about its axis bottom support member 7 is caused to move axially and rotate thereby causing the pitch of the helices 5 and 6 to deform whilst maintaining the diameter of the helices substantially constant and equal to the inner diameter of tubular member 12 to prevent movement of the helices.

[0020] Referring to Figure 6 and 6a, the relationship between diameter and pitch of the bifilar helical antenna element is graphically illustrated. The following formula sets out this relationship:

$$D = \frac{1}{\pi} \sqrt{\lambda} (\lambda - 2 P \sin \phi) - P^2 \cos^2 \phi$$

Where

D = Diameter of helix in meters

P = Pitch between turns of the same helix in meters.

λ = Wavelength at radiation frequency in meters.

ϕ = Elevation angle in degrees.

[0021] As shown in the above formula the diameter and pitch of a given bifilar helix can be deformed to give complete and continuous adjustment of the elevation angle ϕ . A practical constraint is to maintain the diameter

of the helices substantially constant within the radome.

[0022] In use, the user of a mobile earth station equipped with an antenna arrangement of the present invention would adjust the elevation angle of the radiated lobe when necessary by twisting tubular member 12 to align a predetermined calibration 15. The calibrations may be geographical labels such as a city name. After the antenna's radiation lobe elevation angle is adjusted, tubular member 12 is locked by tightening locking collar 14.

Claims

1. An antenna assembly for transmitting or receiving RF signals of a given wavelength, said assembly comprising a metal feed tube member (1) having a feed line for connexion to an RF signal source at one end thereof, and two wire helices (5,6) of predetermined length, diameter and pitch arranged co-axially about said feed tube in a bifilar manner, one end of each helix (5,6) being coupled to the feed line, characterized in that the feed tube member (1) has a co-axial inner conductor (2) as a part of the feed line, each helix (5,6) being commonly coupled with one end to the inner conductor's (2) end and the other end of each helix (5,6) being separately fixed to a first annular-shaped support member (7) slidably encircling said feed tube member (1), said antenna assembly further includes a calibrated adjustment means comprising a tubular housing member (12) of dielectric material that is transparent to RF energy, and a tubular base member (13) into which one end of said tubular housing member (12) slidably nests, said helices (5,6), said tubular housing member (12) and said tubular base member (13) having a common axis and said tubular housing member (12) enclosing said helices (5,6), and said first annular-shaped support member (7) being attached to said tubular housing member (12), said tubular base member (13) including two parallel screw channels (17) formed in the base member's (13) inner surface which co-operate with two pin members (18) extending outwardly from a portion of said tubular housing member (12) resting within said tubular base member (13) such that selective partial rotation of said tubular housing member (12) causes a partial rotation and axial movement of said first annular-shaped support member (7), whereby the pitch of said helices (5,6) is changed by a predetermined distance and the diameter of said helices (5,6) is substantially maintained, thereby changing the elevation angle of electromagnetic waves radiating from or received by said antenna assembly at said given wavelength to a desired angle of elevation corresponding to a selected calibration.

2. An antenna assembly as claimed in claim 1, characterized in that a second annular-shaped support member (10) fixed to an end section of said metal feed tube (1) is included, said second annular-shaped support member (10) including contact means for coupling said one end of each helix (5,6) to said the inner conductor's (2) said other end. 5
3. An antenna assembly as claimed in claim 2, characterized in that said contact means comprises two contact zones (8,9) each of which is respectively connected to a said one end of a helix, one of said contact zones (9) being further connected to the inner conductor's (2) said other end, said contact zones (8,9) being coupled by a balun cable means (11) of a predetermined length. 10 15
4. An antenna assembly as claimed in any one of claims 1 to 3, characterized in that said tubular housing member (12) includes calibration means (15) thereon. 20
5. An antenna assembly as claimed in claim 4, characterized in that said calibration means (15) comprise markings indicating geographic locations. 25
6. An antenna assembly as claimed in any one of claims 1 to 5, characterized in that locking means (14) for releasably locking said tubular housing member (12) to said tubular base member (13) are included. 30
7. An antenna assembly as claimed in any one of the preceding claims, characterized in that said wire helices (5,6) are formed from beryllium copper wire. 35

Patentansprüche

1. Antennenbaugruppe zum Senden und Empfangen von HF-Signalen mit einer gegebenen Wellenlänge, wobei die Baugruppe ein Metallzuleitungsrohren-Element (1) mit einer Zuleitung zur Verbindung mit einer HF-Signalquelle an einem Ende davon und zwei Drahtspiralen (5, 6) mit vorher festgelegter Länge, Durchmesser und Steigung umfasst, die auf bifilare Weise koaxial um die Zuleitungsrohre angeordnet sind, wobei ein Ende jeder Spirale (5, 6) mit der Zuleitung verbunden ist, dadurch gekennzeichnet, dass das Zuleitungsrohrenelement (1) einen koaxialen inneren Leiter (2) als Teil der Zuleitung aufweist, wobei ein Ende jeder Spirale (5,6) mit dem Ende des inneren Leiters (2) und das andere Ende jeder Spirale (5, 6) gesondert an einem ersten ringförmigen Halteelement (7) befestigt ist, das das Zuleitungsrohrenelement (1) verschiebbar umgibt, wobei die Antennenbaugruppe außerdem ein kalibriertes Einstellmittel enthält, das ein röhrenförmiges Gehäuseelement (12) aus elektrisch isolierendem Material, das durchlässig für HF-Energie ist, und ein röhrenförmiges Basiselement (13) umfasst, in das ein Ende des röhrenförmigen Gehäuseelementes (12) verschiebbar hineingeschoben ist, wobei die Spiralen (5, 6), das röhrenförmige Gehäuseelement (12) und das röhrenförmige Basiselement (13) eine gemeinsame Achse aufweisen und das röhrenförmige Gehäuseelement (12) die Spiralen (5, 6) umschließt und das erste ringförmige Halteelement (7) an dem röhrenförmigen Gehäuseelement (12) befestigt ist, wobei das röhrenförmige Basiselement (13) zwei in der Innenfläche des Basiselementes (13) geformte parallele schraubenförmige Kanäle (17) enthält, die mit zwei Stiftelementen (18) im Wirkeingriff sind, die sich von einem Teil des röhrenförmigen Gehäuseelementes (12) nach außen erstrecken, das sich im röhrenförmigen Basiselement (13) befindet, so dass eine selektive Teilrotation des röhrenförmigen Gehäuseelementes (12) eine Teilrotation und eine axiale Bewegung des ersten ringförmigen Halteelementes (7) bewirkt, wobei die Steigung der Spiralen (5, 6) um einen festgelegten Betrag geändert und der Durchmesser der Spiralen (5, 6) im wesentlichen beibehalten wird, wodurch der Erhebungswinkel von elektromagnetischen Wellen, die bei der gegebenen Wellenlänge von der Antennenbaugruppe abgestrahlt werden oder von ihr empfangen werden, zu einem gewünschten Erhebungswinkel geändert werden, der einer ausgewählten Kalibrierung entspricht.

ges Gehäuseelement (12) aus elektrisch isolierendem Material, das durchlässig für HF-Energie ist, und ein röhrenförmiges Basiselement (13) umfasst, in das ein Ende des röhrenförmigen Gehäuseelementes (12) verschiebbar hineingeschoben ist, wobei die Spiralen (5, 6), das röhrenförmige Gehäuseelement (12) und das röhrenförmige Basiselement (13) eine gemeinsame Achse aufweisen und das röhrenförmige Gehäuseelement (12) die Spiralen (5, 6) umschließt und das erste ringförmige Halteelement (7) an dem röhrenförmigen Gehäuseelement (12) befestigt ist, wobei das röhrenförmige Basiselement (13) zwei in der Innenfläche des Basiselementes (13) geformte parallele schraubenförmige Kanäle (17) enthält, die mit zwei Stiftelementen (18) im Wirkeingriff sind, die sich von einem Teil des röhrenförmigen Gehäuseelementes (12) nach außen erstrecken, das sich im röhrenförmigen Basiselement (13) befindet, so dass eine selektive Teilrotation des röhrenförmigen Gehäuseelementes (12) eine Teilrotation und eine axiale Bewegung des ersten ringförmigen Halteelementes (7) bewirkt, wobei die Steigung der Spiralen (5, 6) um einen festgelegten Betrag geändert und der Durchmesser der Spiralen (5, 6) im wesentlichen beibehalten wird, wodurch der Erhebungswinkel von elektromagnetischen Wellen, die bei der gegebenen Wellenlänge von der Antennenbaugruppe abgestrahlt werden oder von ihr empfangen werden, zu einem gewünschten Erhebungswinkel geändert werden, der einer ausgewählten Kalibrierung entspricht.

2. Antennenbaugruppe nach Anspruch 1, dadurch gekennzeichnet, dass ein zweites ringförmiges Halteelement (10) enthalten ist, das an einem Endabschnitt der Metallzuleitungsrohre (1) befestigt ist, wobei das zweite ringförmige Halteelement (10) Kontaktmittel zum Verbinden des einen Endes jeder Spirale (5, 6) mit dem anderen Ende des inneren Leiters (2) enthält.
3. Antennenbaugruppe nach Anspruch 2, dadurch gekennzeichnet, dass das Kontaktmittel zwei Kontaktbereiche (8, 9) umfasst, wobei jeder mit dem einen Ende einer Spirale verbunden ist, wobei einer der Kontaktbereiche ausserdem mit dem anderen Ende des inneren Leiters (2) verbunden ist, wobei die Kontaktbereiche (8, 9) durch ein Kabelsymmetrieglied (11) mit einer festgelegten Länge verbunden sind.
4. Antennenbaugruppe nach irgendeinem der Ansprüche 1 bis 3, dadurch gekennzeichnet, dass das röhrenförmige Gehäuseelement (12) darauf Kalibriermittel (15) enthält.
5. Antennenbaugruppe nach Anspruch 4, dadurch gekennzeichnet, dass das Kalibriermittel (15) Markie-

rungen enthält, die geografische Standorte anzeigen.

6. Antennenbaugruppe nach irgendeinem der Ansprüche 1 bis 5, dadurch gekennzeichnet, dass ein Blockiermittel (14) zum lösbaren Verriegeln des röhrenförmigen Gehäuseelementes (12) auf dem röhrenförmigen Basiselement (13) enthalten ist.
7. Antennenbaugruppe nach irgendeinem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die Drahtspiralen (5, 6) aus Beryllium-Kupfer-Draht gebildet werden.

Revendications

1. Un mécanisme d'antenne destiné à la transmission et à la réception d'ondes radio d'une longueur d'onde déterminée, ce mécanisme comprend un tube métallique d'antenne (1) comportant une ligne d'alimentation permettant de le raccorder à une source de signal d'ondes radio à une extrémité, il comprend également deux fils en hélices (5,6) possédant une longueur, un diamètre et un pas d'hélice prédéterminés disposés suivant le même axe autour de ce tube d'antenne de façon bifilaire, un extrémité des hélices (5,6) est reliée à la ligne d'alimentation, l'invention est caractérisée par le fait que le tube d'antenne (1) possède un conducteur interne coaxial (2) appartenant à la ligne d'alimentation, une extrémité des deux hélices étant reliée en commun à une des extrémités du conducteur interne (2), et les autres extrémités des deux hélices (5,6) étant reliées séparément à une pièce support annulaire primaire (7) qui peut coulisser sur l'élément tubulaire (1), ce mécanisme d'antenne comprend aussi un dispositif d'ajustement étalonné composé d'un boîtier tubulaire (12) en matériau diélectrique transparent au rayonnement des ondes radio, et une embase tubulaire (13) dans laquelle une des extrémités du boîtier tubulaire (12) est guidée en translation, ces hélices (5,6), ce boîtier tubulaire (12) et cette embase tubulaire (13) possèdent un axe commun, le boîtier tubulaire (12) enferme les hélices (5,6), la pièce support annulaire primaire (7) est fixée sur le boîtier tubulaire (12), l'embase tubulaire (13) comporte deux rainures de guidage (17) usinées dans sa face interne et destinées au guidage de deux pions de guidage (18) montés sur le diamètre externe du boîtier tubulaire (12) qui lui-même est maintenu dans l'embase tubulaire (13) qui autorise une rotation axiale partielle limitée du boîtier tubulaire (12) qui provoque un mouvement de rotation et de translation partiel de la pièce support annulaire primaire (7), lors de ce déplacement le pas des hélices (5,6) est modifié d'une longueur déterminée et le diamètre des hélices (5,6) est maintenu de fa-

çon substantielle, cette opération permettant de modifier, l'angle d'élévation du rayonnement d'ondes électromagnétiques reçu ou transmis par le mécanisme d'antenne suivant une longueur d'onde prédéterminée, sur une valeur d'angle d'élévation correspondante à la calibration sélectionnée.

2. Un mécanisme d'antenne suivant la revendication d'invention 1 et caractérisé par la présence d'un support annulaire secondaire (10) fixé sur une section d'extrémité du tube d'antenne (1), ce support annulaire secondaire (10) comporte un dispositif de contact servant à relier une des extrémités de chaque hélice (5,6) à l'autre extrémité du conducteur interne (2).
3. Un mécanisme d'antenne suivant la revendication d'invention 2 et caractérisé par le fait que ce dispositif de contact comprend deux zones de contact (8,9) dont chacune d'entre elles est reliée respectivement à l'extrémité d'une des hélices, une des zones de contact (9) étant reliée également à l'autre extrémité du conducteur interne (2), ces zones de contact (8,9) sont reliées par un câble (Balun) transformateur d'entrée (11) pour une longueur d'onde prédéterminée.
4. Un mécanisme d'antenne suivant une des revendications d'invention 1 à 3 et caractérisé par le fait que le boîtier tubulaire (12) comprend un dispositif de calibration étalonné (15).
5. Un mécanisme d'antenne suivant la revendication d'invention 4 et caractérisé par le fait que ce dispositif de calibration étalonné (15) comporte l'indication de lieux géographiques.
6. Un mécanisme d'antenne suivant une des revendications d'invention 1 à 5 et caractérisé par la présence d'un dispositif de verrouillage commutable (14) du boîtier tubulaire (12) sur l'embase tubulaire (13).
7. Un mécanisme d'antenne suivant une des revendications d'invention précédentes et caractérisé par le fait que les brins d'hélices (5,6) sont fabriqués en fil de cuivre au béryllium.

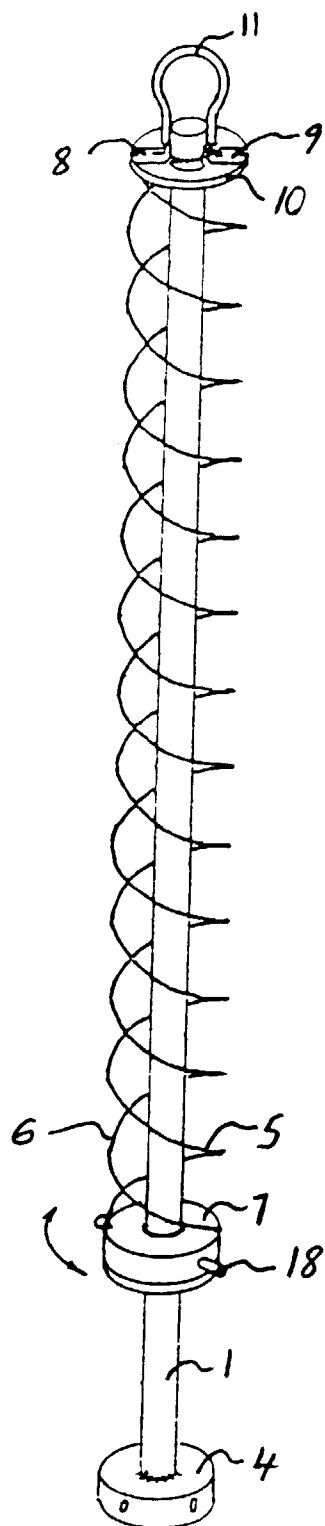
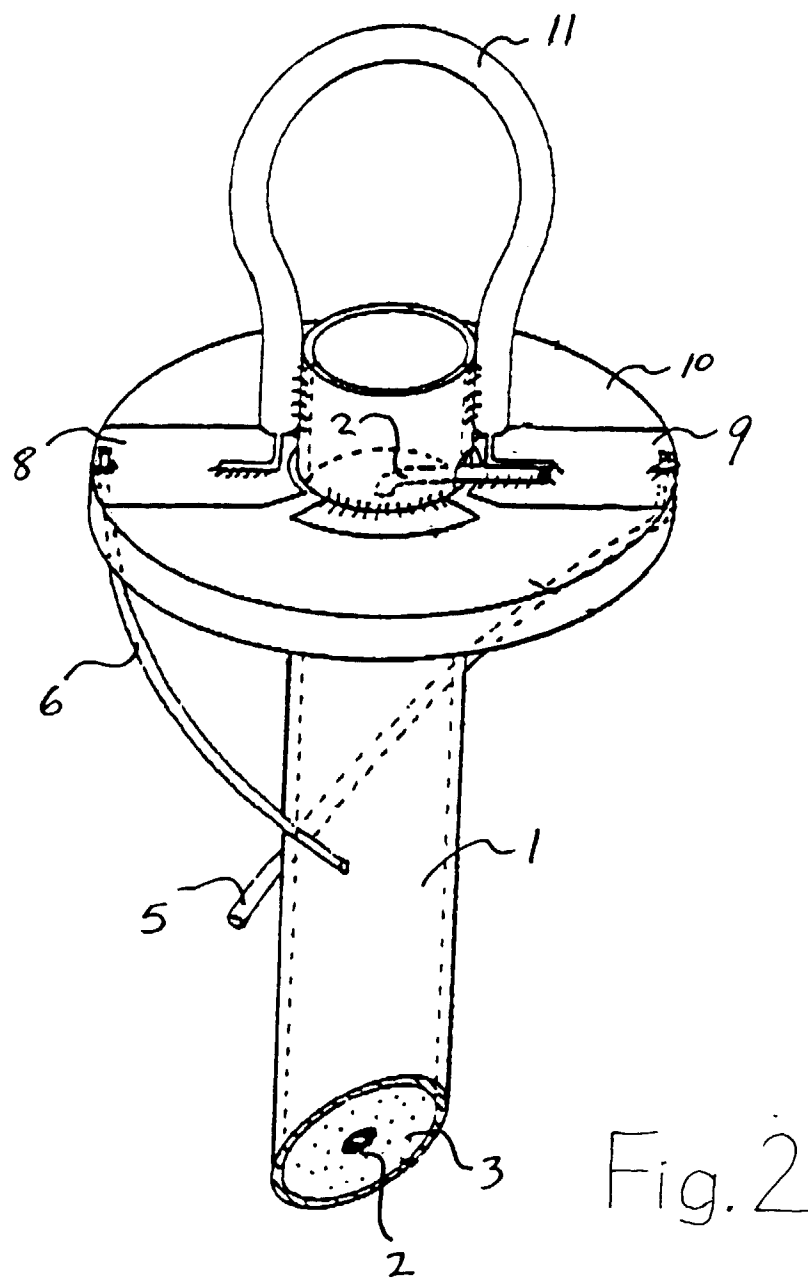
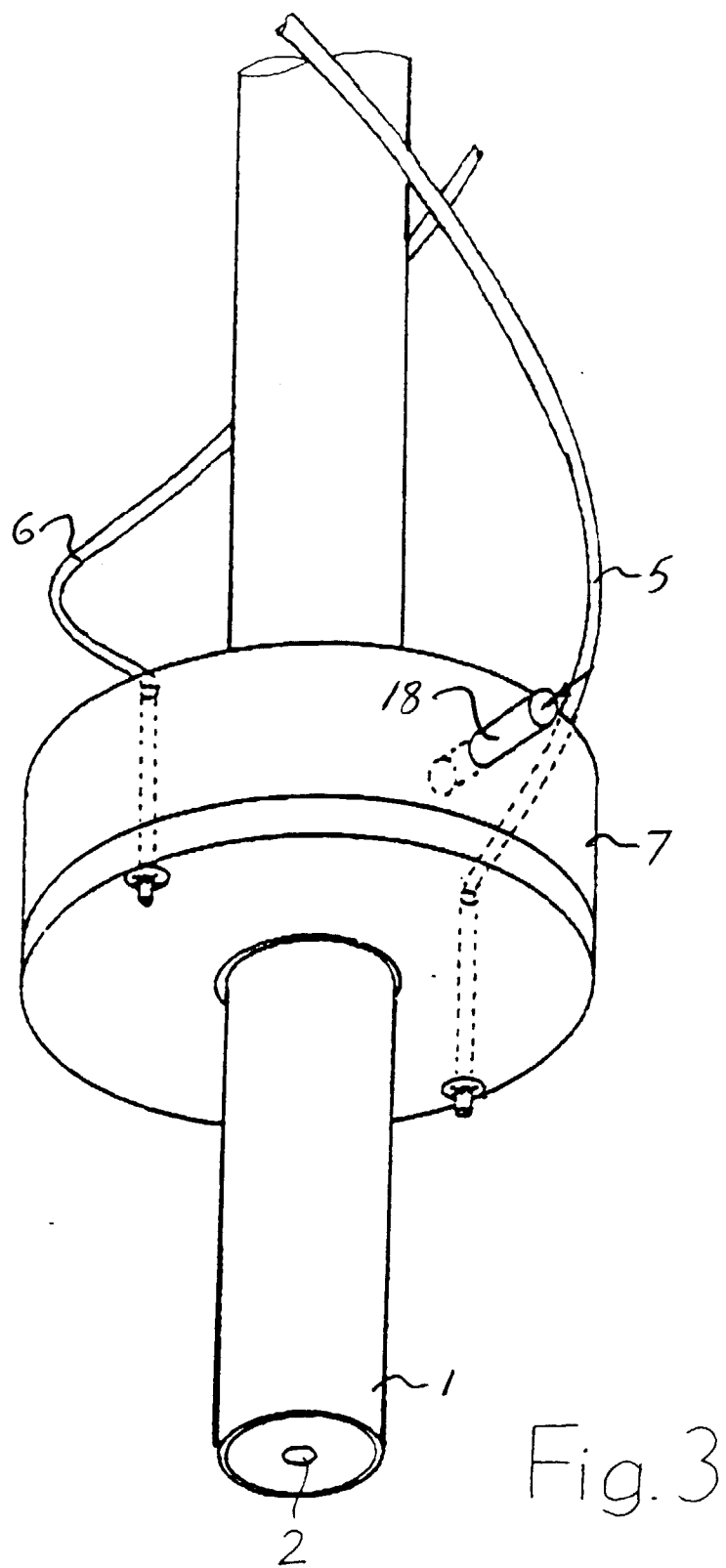


Fig. 1





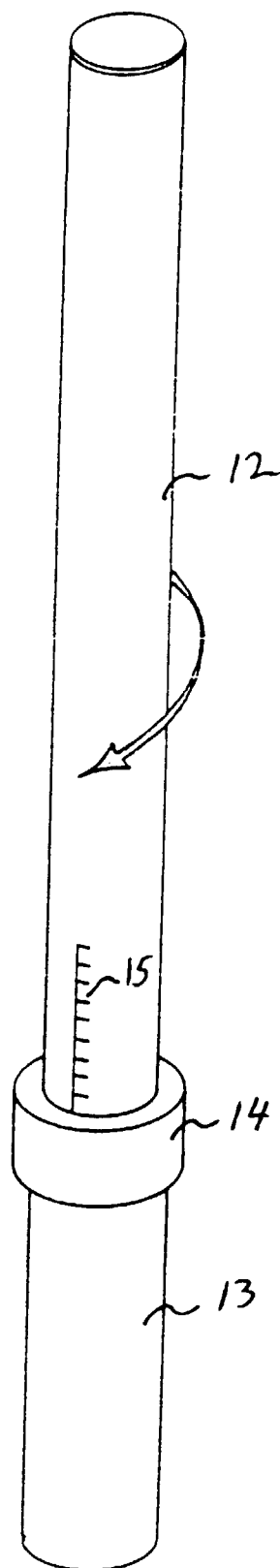


Fig. 4

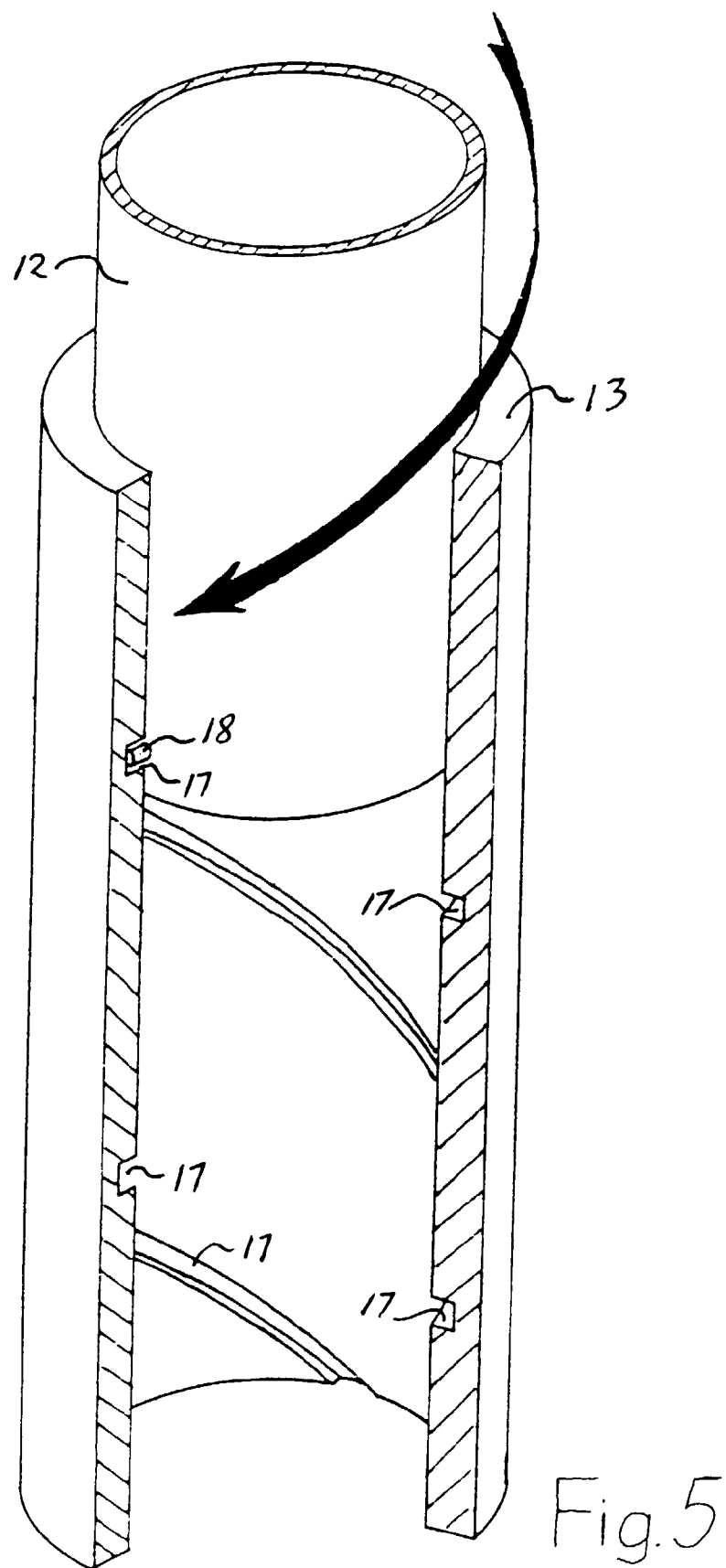


Fig. 6

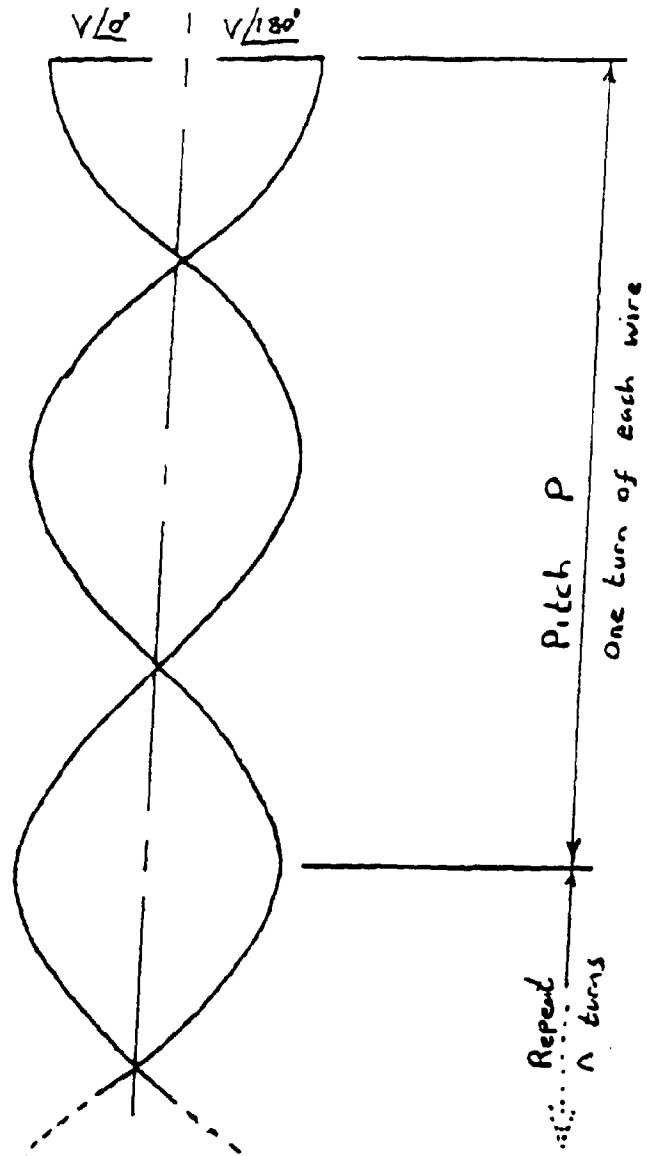


Fig. 6a

Elevation Radiation Pattern

