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(71) Applicant: ALCATEL N.V.
Burgemeester Elsenlaan 170
NL-2288 BH Rijswijk (NL)

(72) Inventor: McDonald, Noel A., Dr.
6 Narool Court
Croydon,
3136 Victoria (AU)
Inventor: Harris, Mark Andrew
3 Rebecca Close
Wheelers Hill,
3150 Victoria (AU)

(74) Representative: Döring, Roger, Dipl.-Ing.
Kabelkamp 20
D-30179 Hannover (DE)

(54) Antenna assembly.

(57) A mast-type antenna assembly for earth mobile stations which communicate via a geostationary satellite. The antenna assembly incorporates an arrangement which permits selective adjustment of the elevation angle of the antenna's radiation lobe for optimum gain from any geographic location.

According to the invention, the assembly comprises a bifilar helix (5,6) arranged within a radome (12) whose end co-operates with screw tracks (17,18) in a tubular base member (13) such that by twisting the radome the helix is deformed and the pitch (p) of the helix is changed, thereby changing the elevation angle (ϕ) of the radiation lobe radiating from the antenna.

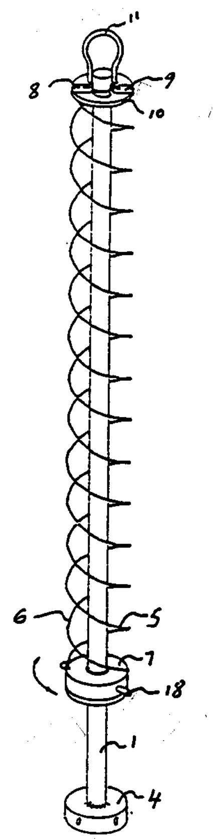

Fig 1

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This invention relates to an antenna for a mobile communication system using a geostationary satellite as a link between a plurality of mobile earth stations, and in particular to an antenna arrangement which permits selective orientation of the antennas directional pattern of electromagnetic waves for optimum gain.

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°.

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.

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.

According to the invention there is provided an antenna assembly for transmitting or receiving RF signals of a given wavelength, said assembly comprising a metal feed tube member having a co-axial inner conductor for connexion to an RF signal source at one end thereof, and two wire helices of predetermined length, diameter and pitch arranged co-axially about said feed tube member in a bifilar manner one end of each helix being commonly coupled to the inner conductor's other end and the other end of each helix being separately fixed to a first annular-shaped support member of dielectric material slidably encircling said feed tube member, wherein said antenna assembly further includes a calibrated adjustment means arranged to selectively move said first annular-shaped support member at least in an axial direction whereby at least said pitch of each sail helix is charged by a predetermined distance thereby changing the elevation angle of an omni-directional pattern of electromagnetic waves radiating from said antenna assembly at said given wavelength to a desired angle of elevation corresponding to a selected calibration.

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:

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

Figure 2 shows the top section of the antenna element of Figure 1.

Figure 3 shows the bottom section of the antenna element of Figure 1.

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

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

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

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

Referring to the drawings, the antenna element comprises a copper feed tube 1 within which is a coaxial 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 3.

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.

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.

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.

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 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.

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:

$$D=\frac{1}{\Pi}\sqrt{\lambda}(\lambda\text{-}2\ P\ Sin\ \phi)\text{-}P^2\ COS^2\ \phi$$

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.

As shown in the above formulae 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.

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 caller 14.

While the present invention has been described with regard to many particulars, it is understood that equivalents may be readily substituted without departing from the scope of the invention.

Claims

1. An antenna assembly for transmitting or receiving RF signals of a given wavelength, said assembly comprising a metal feed tube member having a co-axial inner conductor for connexion to an RF signal source at one end thereof, and two wire helices of predetermined length, diameter and pitch arranged co-axially about said feed tube member in a bifilar manner one end of each helix being commonly coupled to the inner conductor's other end and the other end of each helix being separately fixed to a first annular-shaped support member of dielectric material slidably encircling said feed tube member, wherein said antenna assembly further includes a calibrated adjustment means arranged to selectively move said first annular-shaped support member at least in an axial direction whereby at least said pitch of each sail helix is charged by a predetermined distance thereby changing the elevation angle of an amni-directional pattern of electromagnetic waves radiating from said antenna assembly at said given wavelength to a desired angle of elevation corresponding to a selected calibration.

2. Am antenna assembly as claimed in claim 1, wherein said calibrated adjustment means is arranged such that, in addition to moving said first annular-shaped support member in an axial direction, said support member is caused to partially rotate about said metal feed tube member in a predetermined direction, whereby the diameter of each helix remains substantially unaltered.

3. An antenna assembly as claimed in claim 3, wherein said calibrated adjustment means comprises 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, wherein said tubular base member includes 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.

4. An antenna assembly as claimed in any one of the preceding claims, including a second annular-shaped support member fixed to an end section of said metal feed tube, said second annular-shaped support member including contact means for coupling said one end of each helix to said the inner conductor's said other end.

5. An antenna assembly as claimed in claim 4, wherein said contact means comprises two contact zones each of which is respectively connected to a said one end of a helix, one said contact zone being further connected to said the inner conductors said other end, said contact zones being coupled by a balun cable means of a predetermined length.

6. An antenna assembly as claimed in any one of claims 3 to 5, wherein said tubular housing member includes calibration means thereon.

7. An antenna assembly as claimed in claim 6, wherein said calibration means comprise markings indicating geographic locations.

8. An antenna assembly as claimed in any one of claims 3 to 7, including locking means for releasably locking said tubular housing member to said tubular base member.

9. An antenna assembly as claimed in any one of the preceding claims, wherein said wire helices are formed from beryllium copper wire.

10. An antenna assembly substantially as herein described with reference to Figures 1 - 6a of the accompanying drawings.

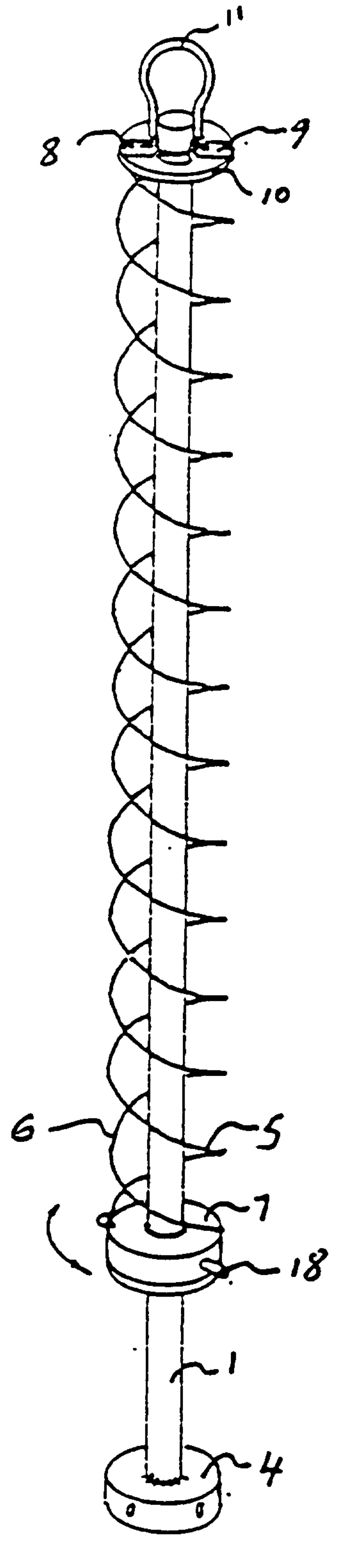


Fig 1

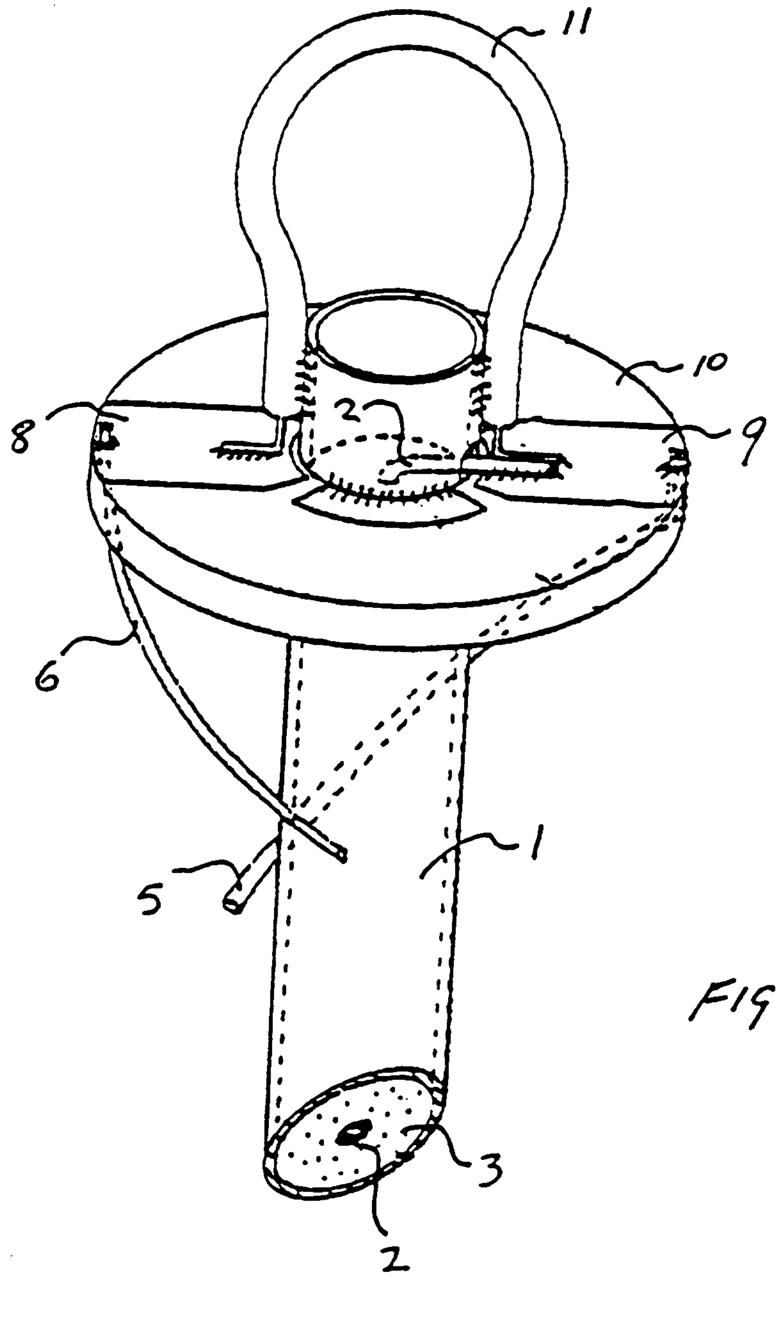


FIG 2.

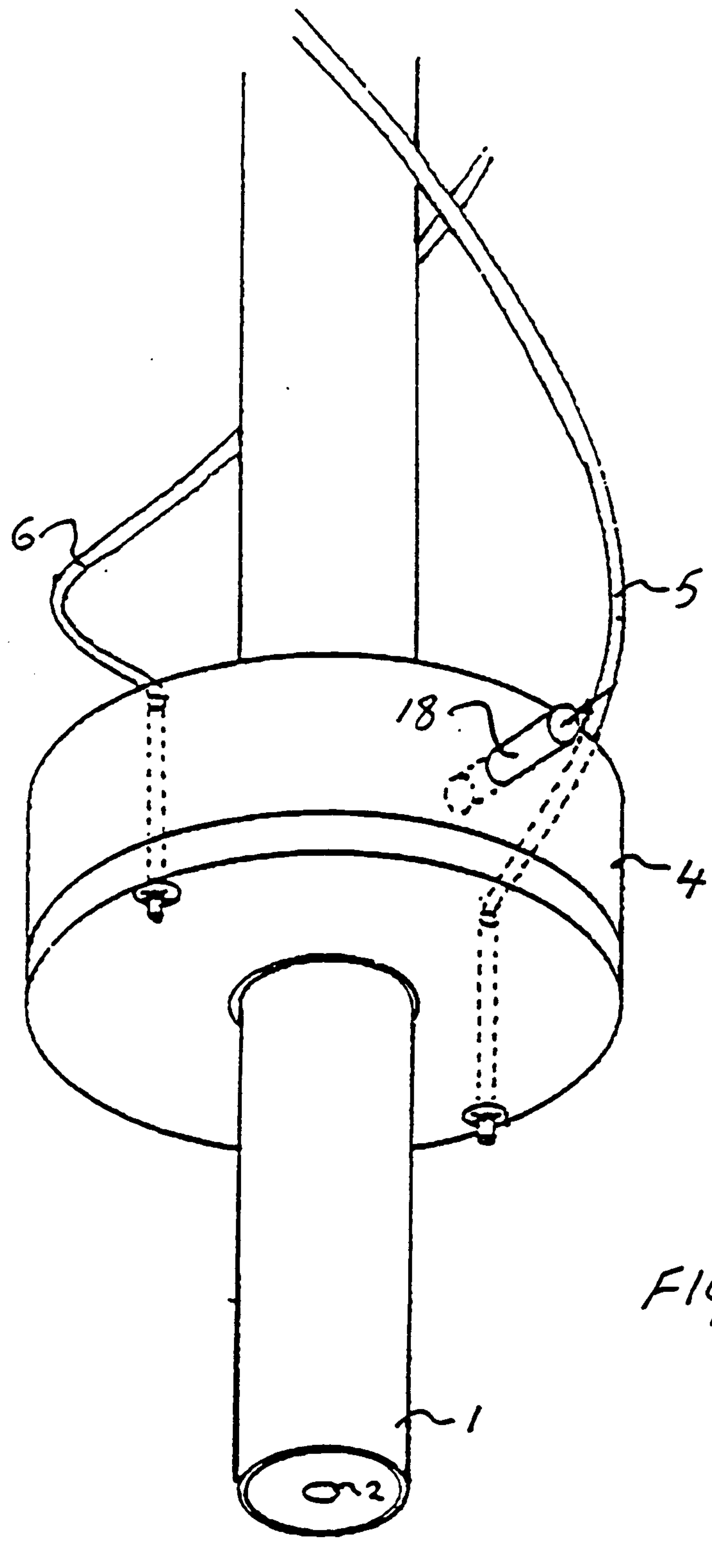


FIG 3

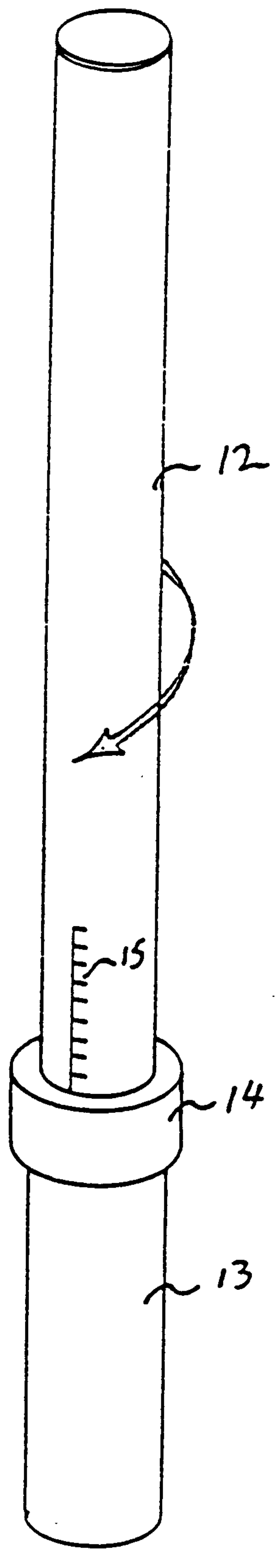


FIG 4

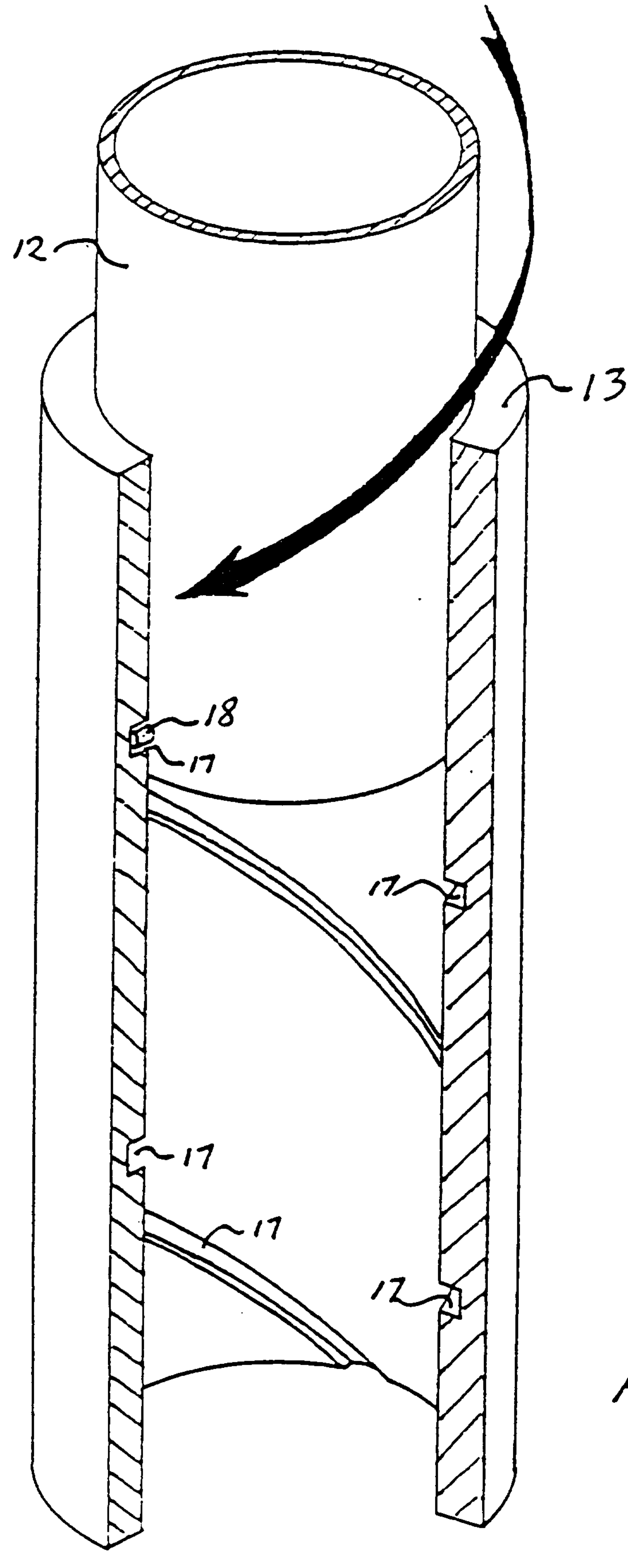


Fig 5

FIG 6

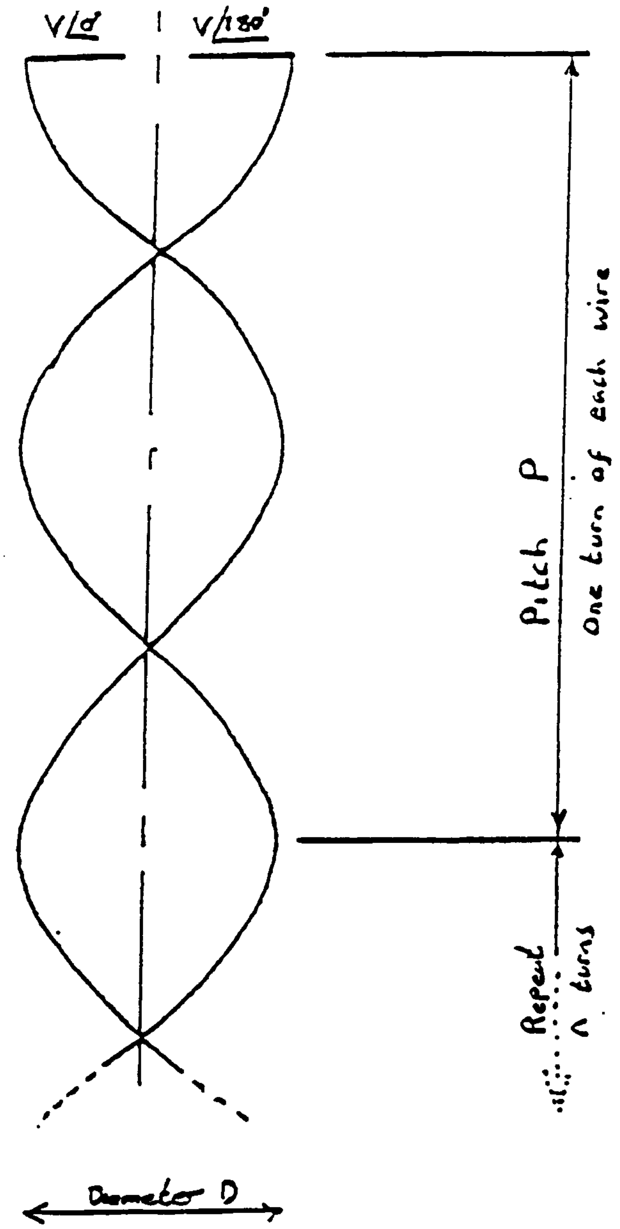
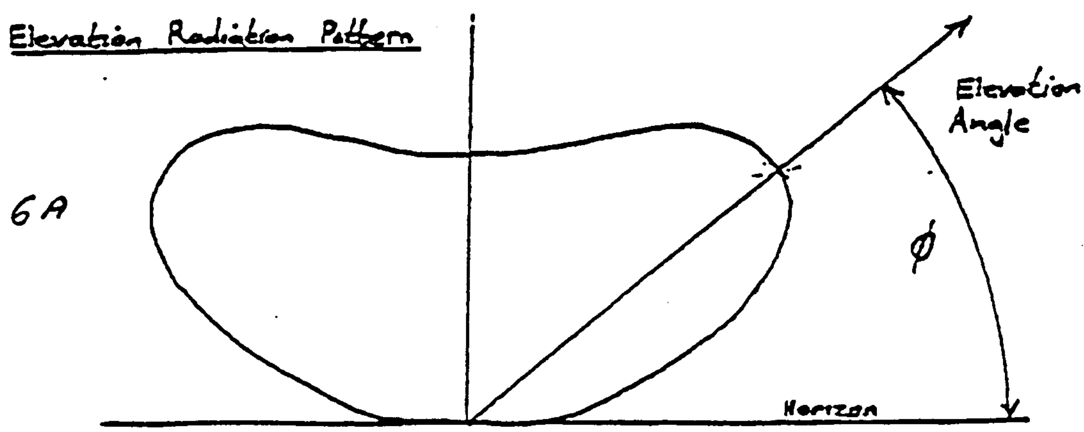

V∠0°
V∠180°
Pitch P
One turn of each wire
Repeat n turns
Diameter D

FIG 6A


Elevation Radiation Pattern
Elevation Angle
ϕ
Horizon

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 8241

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
E	WO-A-94 27338 (AMERICAN MOBILE SATELLITE) * page 7, line 27 - page 12, line 19; figures 2,2A-4B *	1,10	H01Q11/08 H01Q1/36
Y A	WO-A-93 22804 (DELTEC NEW ZEALAND) * page 3, line 14 - line 32 * * page 11, line 18 - page 14, line 14; figures 8A-10 *	1,10 2-9	
Y	US-A-4 725 845 (PHILLIPS) * column 3, line 29 - column 4, line 39; figures 1,2 *	1,10	
A	WO-A-93 06631 (ALLIED-SIGNAL) * abstract * * page 3, line 25 - page 5, line 33; figures 1-9 *	1-10	
A	DE-A-40 40 223 (AKG AKUSTISCHE U.KINO-GERÄTE) * column 5, line 19 - column 6, line 7; figures 1-3 *	1-10	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 March 1995	Angrabeit, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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