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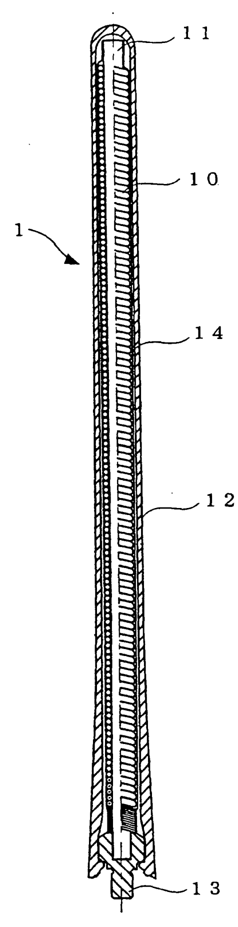
(54) HELICAL ANTENNA

(57) A supporting member comprising a flexible resin rod is inserted into a helical element. The helical element is made into a helix by tightly winding a wire, the core of which is covered with an insulating covering material, and the bottom end portion thereof is constituted in a state, wherein the covering material is removed, and the core wire is exposed. The bottom end of the supporting member is mounted in a fixed condition by being fitted to a fitting hole formed in a metal element fitting, and when fitted thereto, the bottom end portion of the helical element, where the core wire is exposed, is electrically connected to the element fitting. A screw portion for mounting the helical antenna 1 to an antenna support portion is formed on the bottom portion of the element fitting. Thus, the winding pitch of the helical element will not change even during long-term use, and, in addition, electrical characteristics will be less likely to change even if the helical antenna is bent.

Fig. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a helical antenna.

2. Description of the Related Art

[0002] Since the physical length of the antenna can be made shorter than the effective length of the antenna, helical antennas have been used for some time as antennas for portable applications, and antennas for mobile applications. Because of the danger of the antenna itself striking an obstacle, a helical antenna used as an antenna for a portable application or an antenna for a mobile application is ordinarily constituted so as to have flexibility. Helical antennas which are known to have such flexibility include a helical antenna, which is constituted such that a helical element is covered with a contractile tube as disclosed, for example, in U.S. Patent No. 2880936, and a helical antenna, for which insert molding is performed inside an insulating resin pipe by integrally molding a helical element with a flexible resin beforehand, and inserting a core wire comprising a flexible insulating resin into the inside thereof, as disclosed in Japanese Patent Application Laid-open No. H 10-215116.

[0003] However, in a conventional helical antenna having flexibility, because a helical element is wound into a helix at a predetermined winding pitch, upon being bent, the spacing between the windings of the helical element, which are wound on the bent side, becomes smaller, and the spacing between the windings of the helical element on the opposite side becomes larger. In extreme cases, it becomes such that the windings of the helical element make contact with one another. Thus, the electrical characteristics of a helical antenna will change in accordance with changes in the spacing between the windings of the helical element, and the electrical length of a helical antenna will change by the windings of the helical element coming into contact with one another. In other words, the problem in a conventional helical antenna having flexibility is that the electrical characteristics of the helical antenna change when the helical antenna is bent.

[0004] Further, the winding pitch of a helical antenna is ordinarily wound at a fixed winding pitch, making it necessary to maintain a fixed winding pitch to stabilize the electrical characteristics during a period of use. However, the problem in a conventional helical antenna was that the winding pitch was apt to become uneven and the electrical characteristics were apt to change, due to repeated bending during a period of use, and so on. Furthermore, the problem with a method, which involves affixing a helical element by insert molding, was that the winding pitch fluctuated in accordance with the molding pressure at insert molding.

SUMMARY OF THE INVENTION

[0005] Accordingly, an object of the present invention is to provide a helical antenna in which the winding pitch does not change even during long-term use, and, in addition, the electrical characteristics are not apt to change even if the helical antenna is bent.

[0006] A helical antenna of the present invention comprises a helical element, which is constituted by tightly winding a wire, the core wire of which is covered with an insulating covering material, into a helix; and a flexible and insulating supporting member, which is inserted into the inside of this helical element, and is constituted such that the winding pitch of the above-mentioned helical element is determined by the thickness of the covering material covering the above-mentioned wire.

[0007] Therefore, the winding pitch can be determined by the thickness of a covering material. Further, it becomes possible to maintain a fixed winding pitch even when the helical antenna is bent. Furthermore, because the winding pitch is determined by the thickness of a covering material, it is possible to prevent the winding pitch from changing even during long-term use.

[0008] Further, in the above-mentioned helical antenna of the present invention, a conductive element fitting may be comprised, in which the bottom end portion of the above-mentioned supporting member is fitted, and, in addition, in which the bottom end portion, where the above-mentioned core wire of the above-mentioned helical element is exposed, is connected, and this element fitting can be mounted in a fixed condition to an antenna support portion.

[0009] Furthermore, in the above-mentioned helical antenna of the present invention, the bottom end portion of the element cover, which covers the above-mentioned helical element which is inserted into the above-mentioned supporting member, can be fitted to the above-mentioned element fitting.

[0010] And furthermore, in the above-mentioned helical antenna of the present invention, the cross-sectional shape of the above-mentioned wire, the core wire of which is covered with an insulating covering material, can be a flat shape. Thus, by changing the shape of the covering material on the wire, and making the cross-sectional shape of the wire flat, during tight winding it becomes possible to use various winding pitches according to the degree of flatness.

[0011] And furthermore, in the above-mentioned helical antenna of the present invention, the above-mentioned wire can be constituted as a wire having a plurality of core wires arranged at practically equal intervals. Thus, by tightly winding a wire having double or triple core wires, it becomes possible to readily achieve a double-winding or triple-winding helical antenna.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 is a cross-sectional view showing half of the overall constitution of a helical antenna of the present invention;
Fig. 2 (a) is a cross-sectional view showing an enlargement of the constitution of the bottom portion of a helical antenna of the present invention, and Fig. 2 (b) is a bottom view thereof;
Fig. 3 is a diagram showing the constitution of a helical element in a helical antenna of the present invention;
Fig. 4 (a) is a cross-sectional view showing half of the constitution of an element fitting in a helical antenna of the present invention, and Fig. 4 (b) is a bottom view of an element fitting;
Fig. 5 is a cross-sectional view showing the constitution of an element cover in a helical antenna of the present invention;
Fig. 6 (a) is a diagram showing the constitution of a first wire constituting a helical element in a helical antenna of the present invention, Fig. 6 (b) is a diagram showing the constitution of a second wire, Fig. 6 (c) is a diagram showing the constitution of a third wire, and Fig. 6 (d) is a diagram showing an example of a constitution of a helical element using the third wire;
Fig. 7 (a) is a diagram showing a first process of an assembly process for a helical antenna of the present invention, Fig. 7 (b) is a diagram showing a second process, and Fig. 7 (c) is a diagram showing a third process; and
Fig. 8 (a) is a diagram showing a fourth process of an assembly process for a helical antenna of the present invention, Fig. 8 (b) is a diagram showing a fifth process, and Fig. 8 (c) is a diagram showing a sixth process.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] Half of the overall constitution of a helical antenna of the present invention is shown in Fig. 1 in a cross-sectional view.

[0014] As shown in Fig. 1, a helical antenna 1 of the present invention is constituted from a helical element 10, a supporting member 11, an element cover 12, and an element fitting 13. A cylindrical cross-section supporting member 11 comprising an insulating resin rod is inserted inside of the helical element 10. This helical element 10, as will be explained hereinbelow, is made into a helix by tightly winding a wire, the core wire of which is covered with an insulating covering material, and the bottom end portion thereof is constituted in a condition, wherein the core wire is exposed by removing the covering material. The bottom end of the supporting member 11 is mounted in a fixed condition by being fitted into a fitting hole formed in the metal element fitting 13, and is constituted such that, when fitted thereto, the exposed core wire bottom end portion of the helical element 10 is electrically connected to the element fitting 13. A screw portion for mounting the helical antenna 1 to an antenna support portion is formed in the bottom portion of the element fitting 13.

[0015] The bottom portion of the helical antenna 1 is partially enlarged and shown in Fig. 2 (a).

[0016] As shown in Fig. 2 (a), the helical element 10 is constituted by a wire, which comprises a core wire 10a and a covering material 10b for covering the core wire 10a, being tightly wound into a helix. The bottom end of the supporting member 11, which is inserted inside the helical element 10, is fitted by being inserted inside the element fitting 13 from the top. The element fitting 13 is formed such that a pipe-shaped drawn portion 13c protrudes from the top thereof, and the exposed core wire part of the bottom end portion of the helical element 10 is inserted inside this drawn portion 13c. A plurality of soldering holes, which penetrate to the inside, are formed in the outside surface of the drawn portion 13c, and solder 15 is applied via these soldering holes. Thus, the bottom end of the helical element 10 becomes securely connected to the element fitting 13.

[0017] Furthermore, a contractile tube 14 can be put over the helical element 10 so as to cover the entire outer surface. Further, the element cover 12 is mounted to the element fitting 13 in a fixed condition by mating a ring-shaped protruding portion 12c formed at the bottom end of the element cover 12 to the bottom portion of the element fitting 13. Furthermore, Fig. 2 (b) is a bottom view of the helical antenna, and as shown in this figure, 4 protruding portions are formed on the element fitting 13, and 4 indented portions formed on the inner surface of the bottom portion of the element cover 12 are mated with these 4 protruding portions. Thus, the element cover 12 can be rotatably fastened to the element fitting 13.

[0018] Furthermore, the supporting member 11 is formed using a flexible resin material, which is capable of recovering even if bent, and the element cover 12 is also a flexible resin, which is capable of recovering in the same manner when bent.

[0019] Because a helical antenna 1 of the present invention constitutes a helical element 10 formed by winding a wire, the core wire 10a of which is covered with an insulating covering material 10b, into a helix, the winding pitch can be determined by the thickness of the covering material 10b. Therefore, the winding pitch can remain constant even when the helical antenna 1 is bent. Further, because the winding pitch is determined by the thickness of the covering material 10b, it is possible to prevent the winding pitch from changing even when repeatedly bent and used for a long period of time.

[0020] Thus, a helical antenna 1 of the present invention can stabilize electrical characteristics for a long period even while having flexibility.

[0021] Next, the constitution of each part constituting a helical antenna 1 of the present invention will be explained.

[0022] A helical element 10 is shown in Fig. 3, and the helical element 10 is constituted from an element portion 10c, which is formed into a helix by a covered wire, and an element fitting inserting portion 10d, which is constituted as a helix by only the core wire 10a with the covering material 10b having been removed. The length of the element portion 10c is regarded as L1, and the diameter and length L1 thereof are determined by the frequency to be received. Further, the length of the element fitting inserting portion 10d is regarded as L2, and is constituted as a length corresponding to drawn portion 13c of the element fitting 13. The core wire 10a of the helical element 10 is constituted from a copper wire or steel wire, and the wire is formed by molding a resin covering material 10b constituting polyamide or the like onto the core wire 10a. By tightly winding this wire at a predetermined diameter, it is possible to achieve a helical element 10 of a winding pitch resulting from the thickness of the covering material 10b.

[0023] An element fitting 13 is shown in Figs. 4 (a) and (b). Fig. 4 (a) is a half cross-sectional view of a plan view, and (b) of the same figure is a bottom view.

[0024] As shown in these figures, a screw portion 13a for mounting a helical antenna 1 onto an antenna mounting portion not shown in the figures is formed on the bottom portion of the metal element fitting 13, and 4 protruding portions 13b are formed on the sides of the center portion. Furthermore, a pipe-shaped drawn portion 13c is formed so as to protrude from the top surface. A plurality of soldering holes, for example, two holes, is formed in the outside surface of the drawn portion 13c.

[0025] An element cover 12 is shown in Fig. 5. The element cover 12 is constituted from a tubular cover portion 12a, the bottom end surface of which is open, and the top end surface of which is closed. The space inside the element cover 12 is constituted in a size enabling the positioning of a helical element 10 into which a supporting member 11 is inserted. Further, 4 indented portions 12b are formed in the inner surface of the bottom portion for rotational fastening, and the 4 protruding portions 13b formed on the element fitting 13, respectively, are constituted so as to mate with the indented portions 12b thereof. Furthermore, a ring-shaped protruding portion 12c is formed on the inner surface of the bottom end of the element cover 12, and is constituted such that the element cover 12 is fitted to the element fitting 13 by mating the ring-shaped protruding portion 12c thereof with the bottom surfaces of the four indented portions 12b of the element fitting 13.

[0026] The constitutions of wires 16, which form a helical element 10, are shown in Figs. 6 (a), (b) and (c).

[0027] Fig. 6 (a) shows an example of a constitution of a first wire 16a, and the cross-sectional shape of the covering material 10b constituting the wire 16a is constituted approximately circularly. A core wire 10a is positioned in the center of this covering material 10b. The winding pitch, when constituting a helical element 10 using the first wire 16a thereof, becomes practically the size of the diameter of the covering material 10b thereof.

[0028] Fig. 6 (b) shows an example of the constitution of a second wire 16b, and the wire 16b constitutes a double wire. When a helical element 10 is constituted using the second wire 16b thereof, it is possible to achieve a double-winding helical element 10. Similarly, when a helical element 10 is constituted by forming a triple wire, which arranges three core wires 10a at approximately equal intervals, it is possible to achieve a triple-winding helical element 10.

[0029] Fig. 6 (c) shows an example of a constitution of a third wire 16c, and the cross-sectional shape of the covering material 10b constituting the wire 16c is constituted in a flat shape. A core wire 10a is positioned in the center of the covering material 10b thereof. A cross-section of a part of the constitution of a helical element 10, when the helical element 10 is constituted using this third wire 16c, is shown in Fig. 6 (d). As shown in this figure, the winding pitch P1 of the helical element 10 becomes practically equivalent to the width of the wire 16c. In other words, since the winding pitch P1 can be determined in accordance with the degree of flatness of the wire 16c, it is possible to achieve helical elements 10 of a variety of winding pitches P1 by changing the degree of flatness of the wire 16c.

[0030] Furthermore, the cross-sectional shape of the covering material 10b is not limited to a flat shape, and can also be an oblong rectangular shape, an oval shape or other such modified shape.

[0031] Next, an assembly process of a helical antenna 1 of the present invention will be explained while referring to Figs. 7 (a), (b) and (c) and Figs. 8 (a), (b) and (c).

[0032] First, a helical element 10 is formed by a wire 16 being wound into a helix. Next, in a first process shown in Fig. 7 (a), an insulating supporting member 11 is passed through the helical element 10. Next, in a second process shown in Fig. 7 (b), the bottom end of the supporting member 11 is fitted to an element fitting 13 by inserting the bottom end of the supporting member 11, which has been passed through the helical element 10, inside the drawn portion 13c of the element fitting 13. At this time, the element fitting inserting portion 10d, in which the core wire 10a of the helical element 10 is exposed, is inserted into the drawn portion 13c.

[0033] Next, in a third process shown in Fig. 7 (c), a hexagonal crimp is applied to the drawn portion 13c such that the drawn portion 13c constitutes a cross-sectional hexagon. Thus, the element fitting inserting portion 10d of the helical element 10, which is inserted inside the drawn portion 13c, is electrically and mechanically mounted to the drawn portion 13c in a fixed condition. Furthermore, in a fourth process shown in Fig. 8 (a), solder is applied, via soldering holes 13d formed in the hexagonally crimped drawn portion 13c, to the element fitting inserting portion 10d of the helical element 10, which faces the inside of the soldering holes 13d. Thus, the element fitting 13 and the helical element 10 become securely connected electrically.

[0034] Next, in a fifth process shown in Fig. 8 (b), an element cover 12 is placed on the helical element 10 from the tip thereof so as to cover the helical element 10 through which the supporting member 11 passes. Thus, the 4 indented portions 12b formed on the inner surface of the bottom portion of the element cover 12 are mated with the 4 protruding portions 13b formed on the element fitting 13, and, in addition, the ring-shaped protruding portion 12c formed on the inner surface of the bottom end of the element cover 12 mates with the bottom surfaces of the 4 protruding portions 13b formed on the element fitting 13. Furthermore, in a sixth process shown in Fig. 8 (c), an adhesive is applied to the mated parts of the ring-shaped protruding portion 12c formed on the element cover 12 and the protruding portions 13b formed on the element fitting 13, and the assembly of the helical antenna 1 is complete.

[0035] Thereafter, an inspection is performed, and the helical antenna 1 becomes a finished product.

[0036] As explained hereinabove, since the present invention constitutes a helical element formed by winding a wire, the core wire of which is covered with an insulating covering material, into a helix, the winding pitch can be determined by the thickness of the covering material. Therefore, it becomes possible to maintain a fixed winding pitch even if the helical antenna is bent. Further, because the winding pitch is determined by the thickness of the covering material, it is possible to prevent the winding pitch from changing even during long-term use.

[0037] Thus, a helical antenna of the present invention can stabilize electrical characteristics over a long period of time even while having flexibility.

[0038] Furthermore, by changing the shape of the covering material on the wire, and making the cross-sectional shape of the wire flat, it becomes possible to achieve a variety of winding pitches according to the degree of flatness at winding time.

[0039] And furthermore, by tightly winding a wire having a double or triple core wire, it becomes possible to achieve a double-winding or triple-winding helical antenna.

Claims

1. A helical antenna, comprising:

   a helical element, which is constituted by tightly winding a wire, the core wire of which is covered with an insulating covering material, into a helix; and
   a flexible and insulating supporting member, which is inserted into the inside of this helical element,
   wherein the winding pitch of said helical element is determined by the thickness of the covering material covering said wire.

2. The helical antenna according to claim 1, comprising a conductive element fitting, in which the bottom end portion of said supporting member is fitted, and, in addition, in which the bottom end portion of said helical element, where said core wire is exposed, is connected, wherein this element fitting is mounted in a fixed condition to an antenna support portion.

3. The helical antenna according to claim 2, wherein the bottom end portion of an element cover, which covers said helical element which is inserted into said supporting member, is fitted to said element fitting.

4. The helical antenna according to claim 1, wherein the cross-sectional shape of said wire, the core wire of which is covered with an insulating covering material, constitutes a flat shape.

5. The helical antenna according to claim 1, wherein said wire is constituted as a wire having a plurality of core wires arranged at practically equal intervals.

Fig. 1

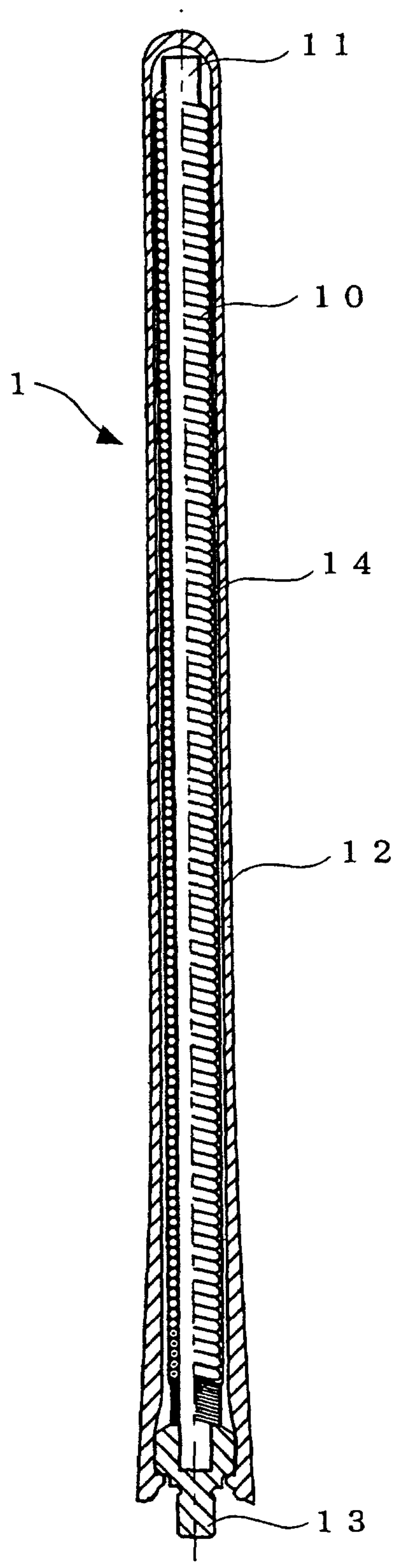


Fig. 2a

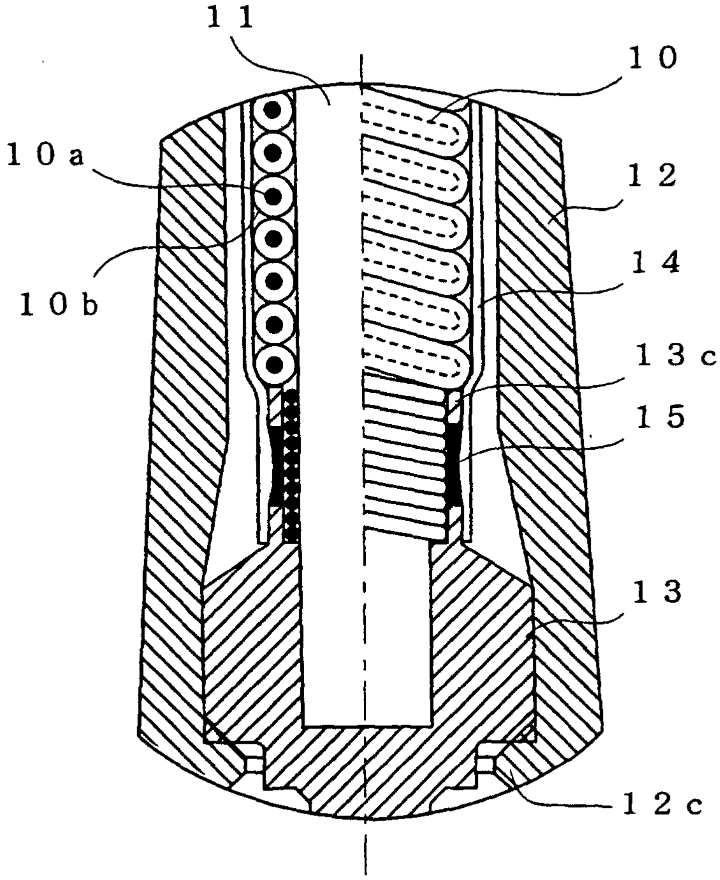


Fig. 2b

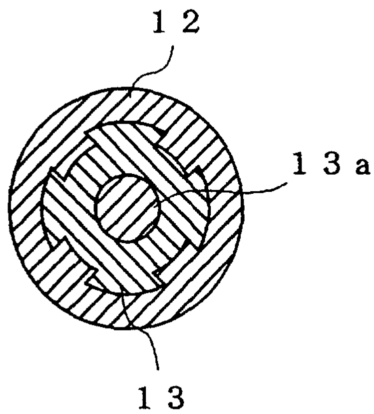
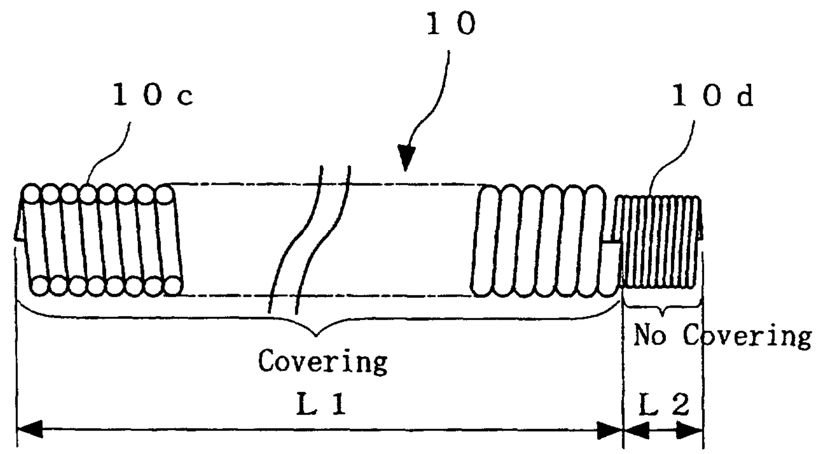


Fig. 3



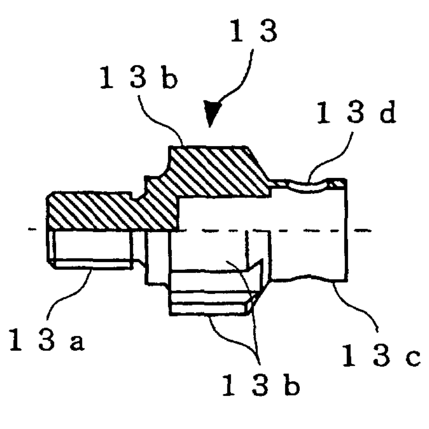


Fig. 4a

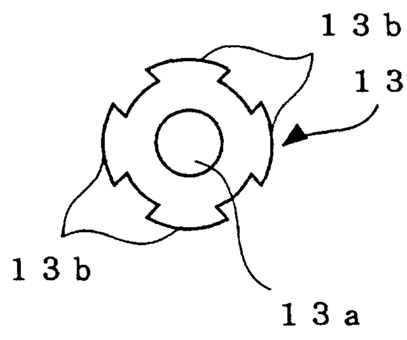


Fig. 4b

Fig. 5

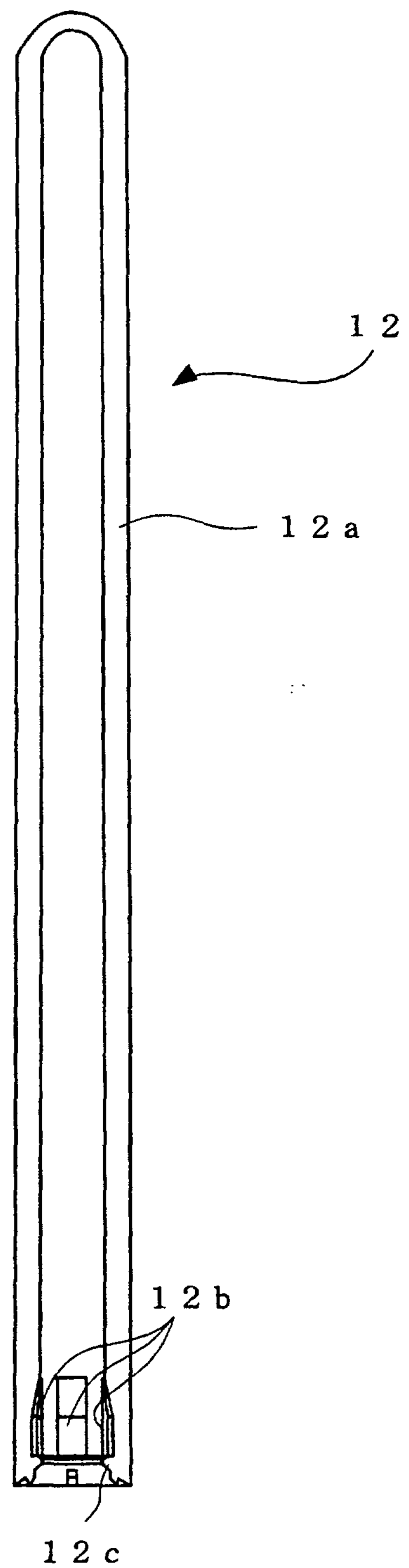


Fig. 6a

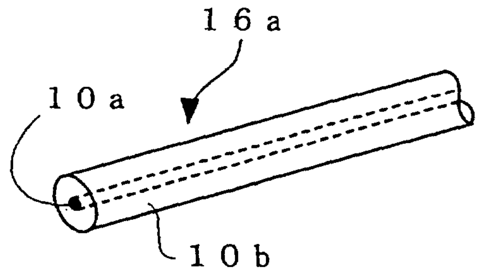


Fig. 6b

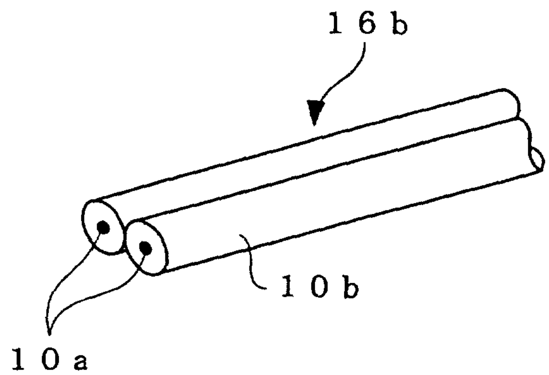


Fig. 6c

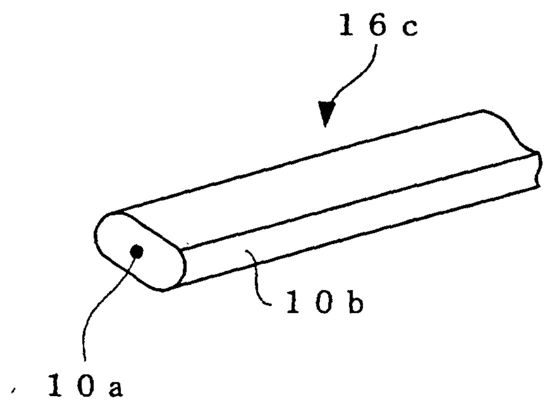
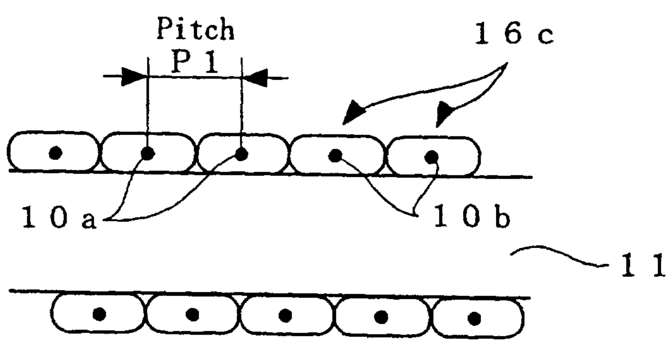


Fig. 6d



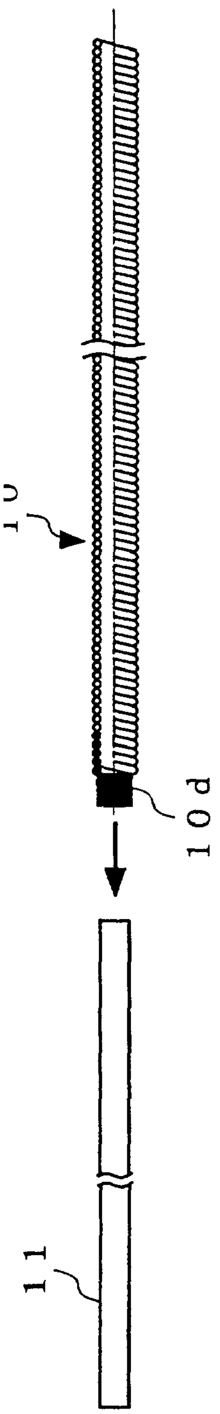


Fig. 7a

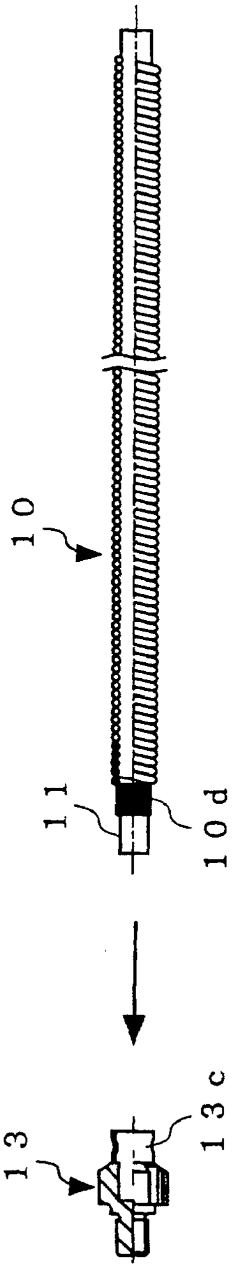


Fig. 7b

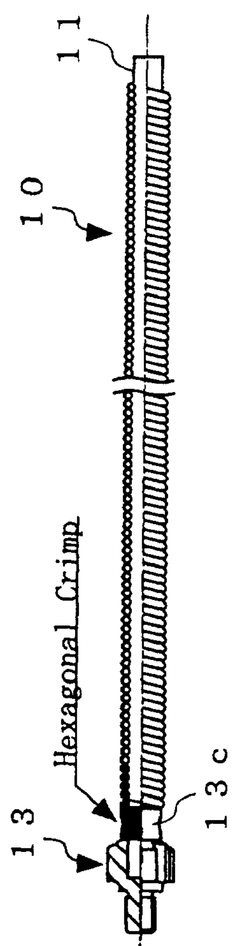


Fig. 7c

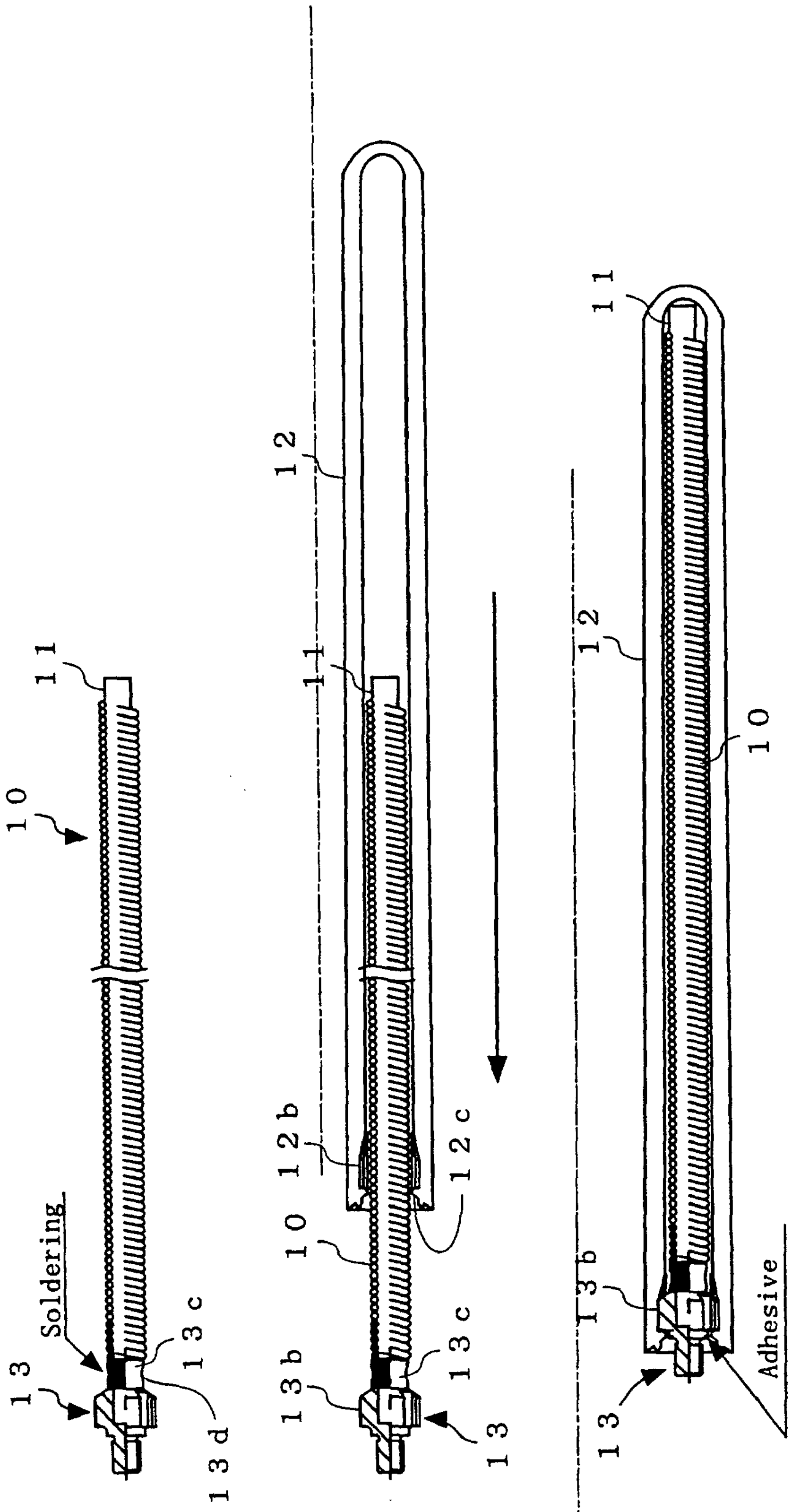


Fig. 8a

Fig. 8b

Fig. 8c

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/07346

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl^7. H01Q1/36, H01Q1/40

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl^7. H01Q1/00-/52, H01Q5/00-11/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Toroku Jitsuyo Shinan Koho	1994-2000
Kokai Jitsuyo Shinan Koho	1971-2000	Jitsuyo Shinan Toroku Koho	1996-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	WO, 9833232, A1 (YOKOWO CO., ltd.), 30 July, 1998 (30.07.98) & JP, 10-215116, A & JP, 10-215113, A	
Y	page 11, line 1 to page 12, line 25; Fig. 11	1-3
A		4,5
	JP, 11-154819, A (Furukawa Electric Co., Ltd.), 08 June, 1999 (08.06.99) (Family: none)	
Y	Full text; all drawings	1-3
A		4,5
	JP, 11-154820, A (Furukawa Electric Co., Ltd.), 08 June, 1999 (08.06.99) (Family: none)	
Y	Par. Nos. 24 to 29; Figs. 11 to 16	1-3
A		4,5
	JP, 54-103544, A (Matsushita Electric Works, Ltd.), 15 August, 1979 (15.08.79) (Family: none)	
A	Full text; all drawings	1-5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search 26 December, 2000 (26.12.00)	Date of mailing of the international search report 16 January, 2001 (16.01.01)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)