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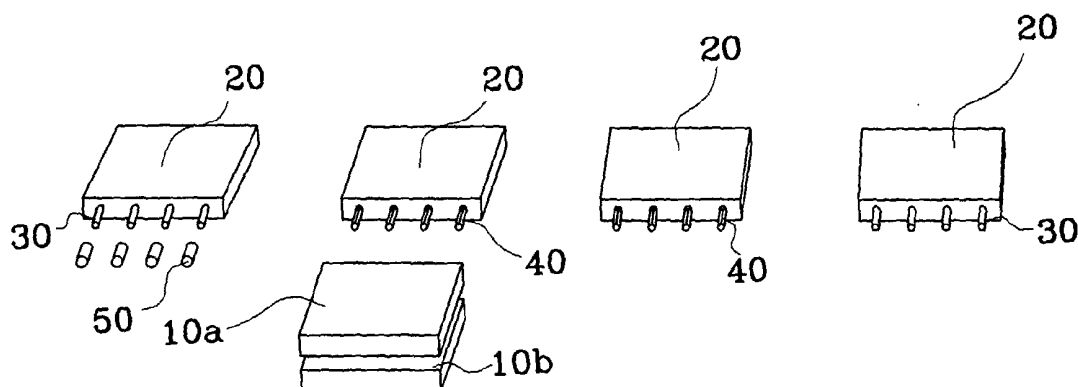
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ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.

(54) Title: AN ANTENNA DEVICE AND A METHOD FOR MANUFACTURING AN ANTENNA DEVICE



(57) **Abstract:** The present invention relates to a method for manufacturing an encapsulated antenna (50; 74) comprising the steps of: arranging at least one antenna element (40; 60) at least partly around a mould core (30), arranging said mould core (30) and antenna element (40; 60) in a mould cavity, injecting plastics material to fill at least a part of said cavity for forming said encapsulated antenna, arranging said at least one antenna element (40; 60) on a flexible film before arranging said antenna element at least partly around said mould core (30), and removing said mould core (30) from said encapsulated antenna (50; 74) thereby creating a hollow portion, after the injection of plastic material, whereby said antenna element (40; 60) constitutes at least a part of a delimiting surface of said antenna (50; 74). The invention also relates to an antenna (50; 74).



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AN ANTENNA DEVICE AND A METHOD FOR MANUFACTURING AN ANTENNA DEVICE

FIELD OF THE INVENTION

The present invention relates to a method for manufacturing an
5 encapsulated antenna according to the preamble of claim 1 and an
encapsulated antenna element according to the preamble of claim
9.

RELATED ART AND BACKGROUND OF THE INVENTION

In current radio frequency applications, such as mobile phones,
10 the antenna structure is a significant factor from the point of
view of the appearance, durability and ease of operation of the
device. The manufacturing costs also contribute to the price of
the radio device. Since modern mobile phones are small and
lightweight, the antenna, too, should be small. The antenna
15 should not be easily damaged, should the user accidentally drop
his/her phone, on the contrary, the antenna as a flexible
element may prevent the phone itself from being damaged. In a
large scale series production of telephones the antenna should
be economical and easy to manufacture, which can be interpreted
20 to mean that the antenna should have only a few parts, the parts
should be simple in form, and the mechanical tolerances should
not be unreasonably exacting.

In order to protect an external antenna element a plastic
material often covers today's external antennas.

25 In GB 2 305 298 is described an antenna device with a plastic-
encased radiating helix. In manufacturing the above mentioned
antenna, a high injection pressure, and a high molten plastic
injection speed inherent in a injection moulding process can
cause undesirable movement and can change the desired dimensions

of the conductive coil on a core pin. The precise dimensional relationships of the helix assembly are critical factors, which govern the radio frequency range and performance of the characteristics of the complete antenna assembly, which is a
5 problem.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method for manufacturing an encapsulated antenna and an encapsulated antenna which overcomes or at least reduces the above mentioned
10 problem.

According to the present invention this object is obtained by providing a method as claimed in claim 1 and by an antenna according to claim 9.

An advantage with the present invention is that the encapsulated
15 antenna can be manufactured with high precision with simple technology.

Another advantage with the present invention is that the manufacturing costs of the encapsulated antenna is relatively low.

20 Yet another advantage of a preferred embodiment of the present invention is that the shape of the encapsulated antenna easily can be varied with the precision maintained.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a perspective view of a first manufacturing
25 step according to the present invention.

Figure 2 shows a perspective view of a second manufacturing step according to the present invention.

Figure 3 shows a perspective view of a third manufacturing step according to the present invention.

Figure 4 shows a perspective view of a fourth manufacturing step according to the present invention.

5 Figure 5 shows a perspective view of a fifth manufacturing step according to the present invention.

Figure 6 shows a perspective view of a sixth manufacturing step according to the present invention.

10 Figure 7 shows a perspective view of a seventh manufacturing step according to the present invention.

Figure 8 shows a perspective view of a eighth manufacturing step according to the present invention.

Figure 9 shows a perspective view of a ninth manufacturing step according to the present invention.

15 Figure 10 shows an exploded view of an embodiment of the encapsulated antenna.

Figure 11 shows a partly cross sectional view of the encapsulated antenna as shown in figure 10.

20 Figure 12 shows an antenna element using in the second embodiment of the encapsulated antenna.

Figure 13 shows a cross-sectional view of a cover of the second embodiment of the encapsulated antenna.

Figure 14 and 15 shows perspective views of the second embodiment of the encapsulated antenna.

Figure 16 shows a perspective view of a fitting to the second embodiment of the encapsulated antenna.

Figure 17 shows a cross-sectional view of the assembled antenna according to a second embodiment.

5 DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 shows a perspective view of a first manufacturing step according to the present invention. In said figure it is shown a mould 10 comprising a top member 10a and a bottom member 10b and a support structure 20 comprising four mould
10 cores 30. The mould cores 30, in this specific example, have a shape of a rod with an essentially circular cross sectional area. Alternatively the cross sectional area may be triangular, rectangular, any other polygonal shape or elliptical. The rod may be tapered or non-tapered.

15 Figure 2 shows a perspective view of a second manufacturing step according to the present invention. In this figure the rods 30, belonging to one of the two support structures 20, are at least partly covered with antenna elements 40. The antenna elements 40 are arranged on top of at least one
20 surface of a flexible film. The antenna element 40 may comprise for example a meander shaped portion. The flexible film comprising said antenna element is arranged at least partly around the mould core 30. The flexible film may for example be fixed to the mould core 30 by means of tape, glue,
25 ultrasonic welding, heat-sealing overlap joint etc. The material of the flexible film may for example be plastics material or any other suitable non-conductive material.

Figure 3 shows a perspective view of a third manufacturing step according to the present invention. In this figure the
30 rods 30, belonging to two of the three support structures 20

are at least partly covered with antenna elements 40. The antenna elements 40 are arranged on top of at least one surface of a flexible film as described in connection with figure 2. In said figure the top member 10a and the bottom member 10b of the mould 10 are separated by a distance
5 suitable for fitting the mould cores 30.

Figure 4 shows a perspective view of a fourth manufacturing step according to the present invention. In this figure the rods 30 comprising said antenna elements 40, belonging to one
10 of the three support structures 20, are arranged between the separated top member 10a and the bottom member 10b of the mould 10.

Figure 5 shows a perspective view of a fifth manufacturing step according to the present invention. In this figure the top member 10a and the bottom member 10b of the mould 10 are
15 sealed around said mould cores 30 comprising said antenna elements 40, belonging to one of the three support structures 20. An indentation in said bottom and top member defines a moulding cavity in which said mould cores 30 are located. Said
20 cavity may be of any shape. When the mould 10 is closed, sealing said mould cores 30 as defined above, the moulding process may start. Moulding material is injected into said cavity in order to cover said antenna element 40 arranged on said flexible film where said flexible film is at least partly
25 enclosing said mould core 30. Said moulding process is well known to a man skilled in the art and therefore needs no further attention in this disclosure.

Figure 6 shows a perspective view of a sixth manufacturing step according to the present invention. In this figure the moulding process has ended and the bottom 10b and top 10a
30 member of the mould 10 are separated.

Figure 7 shows a perspective view of a seventh manufacturing step according to the present invention. In this figure the rods 30 comprising encapsulated antennas 50, belonging to one of the three support structures 20, are dislocated from said
5 mould. Said encapsulated antennas may have the form of said mould cavity.

Figure 8 shows a perspective view of a eighth manufacturing step according to the present invention. In this figure another set of rods 30 comprising said antenna elements 40,
10 belonging to one of the four support structures 20, are arranged in front of the separated top member 10a and the bottom member 10b of the mould 10.

Figure 9 shows a perspective view of a ninth manufacturing step according to the present invention. In this figure the
15 encapsulated antennas 50 belonging to one of the four support structures 20 are separated from the mould cores 30. The encapsulated antennas will have a hollow portion. Said hollow portion has a cross sectional area defined by said mould core 30.

Figure 10 shows an exploded view of an embodiment of the encapsulated antenna 50. Said encapsulated antenna 50 comprises a contact clip 45, the antenna element 40 and an encapsulated part 42. The contact clip contacts the antenna element 40 to the circuitry in the mobile telephone (not
20 shown). The antenna element is arranged on the mould core 30 and thereafter said contact clip 45 is arranged outside and partly enclosing said antenna element 40. In order to fix said contact clip to said mould core 30, a first wing 46 and a second wing 47 have a shape corresponding to the mould core
25 30. In this embodiment the shape of said wings 46 and 47 are cylindrical. An open end of the encapsulated part is forming

the interface 43 for engaging said encapsulated antenna to a casing of the mobile telephone. In this embodiment said interface 43 is in the form of a snap on interface, of course other alternatives are possible like for example threaded
5 interfaces.

Figure 11 shows a partly cross sectional view of the encapsulated antenna 50 as shown in figure 10. From this figure it is clear that the contact clip 45 is arranged outside and partly enclosing said antenna element 40. We can
10 also see that the encapsulated antenna has a hollow portion corresponding to the shape of the mould core 30. The contact clip 45 and the antenna element 40 form part of the encapsulated antenna 50 and are fixed in said encapsulated antenna.

15 Figure 12-17 shows a second embodiment of an encapsulated antenna that might be manufactured using the method described in connection with figures 1-9.

Figure 12 shows a preferred antenna element 60 comprising a meander pattern 61 arranged on a flexible film 62. The antenna
20 element 60 is also provided with a tongue 63 having a conductive pattern 64 in contact with the meander pattern 61. The antenna element 60 is arranged within a hollow portion of a cover 65, which is described in connection with figure 13.

Figure 13-15 shows a cover 65 for holding the antenna element
25 of figure 12. Figure 13 is a cross-sectional view and figure 14 and 15 are two perspective views pointing out details of said cover. The cover is made from a non-conductive material, such as plastics.

A hollow portion 66 with an opening 67 is provided in the
30 cover 65, where two grooves 68 are provided on the inside of

the hollow portion 66, near the opening 67. These grooves are to be used to hold a fitting, as described in connection with figure 16. The inside of the hollow portion is also provided with an anti-rotation bar 69 to prevent the fitting to rotate
5 when mounted. Further, a pocket 70 is provided on the inside of the hollow portion 66 near the opening 67, where the tongue 63 of the antenna element 60 is placed when mounted inside the hollow portion 66.

Figure 14 shows a perspective view where the anti-rotation bar
10 69 clearly may be seen, stretching in an axial direction from the opening 67 along the hollow portion 66.

Figure 15 shows a perspective view where the pocket 70 for holding the tongue 63 clearly may be seen stretching in an axial direction from the opening 67 and past the grooves 68.

Figure 16 shows a perspective view of a fitting 71, preferably
15 may from an electrically conductive material, such as a metal, having two ridges 72 and a recess 73 for holding the anti-rotation bar 69 when mounted to the cover 65. The ridges are designed to be snap-fitted to the grooves 68 when mounted, and
20 a thread is provided for mounting the fitting to the casing of a mobile telephone.

Figure 17 shows a cross-sectional view of the second embodiment of the encapsulated antenna 74, comprising the cover 65, the fitting 71 and the antenna element 60. The
25 antenna element 60 is mounted within the hollow portion 66 of the cover 65, in such a way that the tongue 63 is placed in the pocket 70 during the assembling process. The fitting is inserted through the opening guided by the anti-rotation bar 69 and snap-fitted by using the grooves/ridges provided.

The fitting 71 deforms the conductive pattern 64 on the tongue 63, when inserted that an electric contact 75 is created between them.

Other manufacturing techniques than described in connection to
5 figures 1-9 may also be used, where the cover 65 of the antenna first is moulded in a non-conductive material. The antenna element 60 is inserted into the hollow portion of the cover and attached, preferably by using glue, to the surface of the hollow portion 66. The tongue 63 of the antenna element
10 60 is arranged in the pocket 70 to avoid unintentional deforming of the conductive pattern 64 on the tongue 63 when the fitting 71 is inserted in the opening 67 of the hollow portion 66.

The antenna element in both described embodiments constitutes
15 at least a part of a delimiting surface of said antenna, i.e. forming a part of the surface of the hollow portion.

CLAIMS

1. A method for manufacturing an encapsulated antenna (50; 74) comprising the steps of

- arranging at least one antenna element (40; 60) at least

5 partly around a mould core (30),

- arranging said mould core (30) and antenna element (40; 60) in a mould cavity,

- injecting plastics material to fill at least a part of said cavity for forming said encapsulated antenna, **characterised in**

10 **that** said method further comprising the steps of:

- arranging said at least one antenna element (40; 60) on a flexible film before arranging said antenna element at least partly around said mould core (30), and

15 - removing said mould core (30) from said encapsulated antenna (50; 74) thereby creating a hollow portion, after the injection of plastic material,

whereby said antenna element (40; 60) constitutes at least a part of a delimiting surface of said antenna (50; 74).

2. The method according to claim 1, further comprising the
20 step of arranging an adhesive agent on at least one side of the flexible film.

3. The method according to claim 1 or 2, wherein said antenna element (40; 60) comprises a meander shaped pattern.

4. The method according to any of claims 1-3, further
25 comprising the step of arranging a contact clip (45) in said encapsulated antenna (50) for contacting said antenna element (40) to circuitry in a mobile telephone.

5. The method according to any of claims 1-3, further comprising the steps of arranging a tongue (63), connected to
30 said antenna element (60), in a pocket (70) and inserting a

fitting (71) into the opening (67) of the hollow portion (66) thereby contacting said antenna element (60) to circuitry in a mobile telephone via the fitting (71) and the tongue (63).

6. The method according to any of claims 1-5, further
5 comprising the step of arranging an interface on the encapsulated antenna for engaging said encapsulated antenna to a casing of the mobile telephone.

7. The method according to any of claims 1-6, where said mould
10 core (30) has a cross sectional area being selected from the group consisting of essentially circular, elliptical and polygonal.

8. The method according to any one of claims 1-7, where said mould core is tapered.

9. An encapsulated antenna comprising a hollow portion with a
15 delimiting surface to which a antenna element (40; 60) is arranged, **characterised in** that said antenna element (40; 60) is arranged on a flexible film, said antenna element (40; 60) is attached to said antenna (50; 74) by injection moulding, whereby said antenna element (40; 60) constitutes at least a
20 part of said delimiting surface of said antenna (50; 74).

10. The antenna according to claim 9, where a radiating portion of said antenna element (40; 60) is at least partly freely located in said hollow portion.

11. The antenna according to claim 9 or 10, wherein said
25 radiating portion of said antenna element (40; 60) comprises a meander shaped portion.

12. The antenna according to any of claims 9-11, further comprising a contact clip (45) in said encapsulated antenna

(50) for contacting said antenna element (40) to circuitry in a mobile telephone.

13. The antenna according to any of claims 9-11, further comprising a tongue (63), connected to said antenna element
5 (60), arranged in a pocket (70) and a fitting (71) inserted into the opening (67) of the hollow portion (66), thereby contacting said antenna element (60) to circuitry in a mobile telephone via the fitting (71) and the tongue (70).

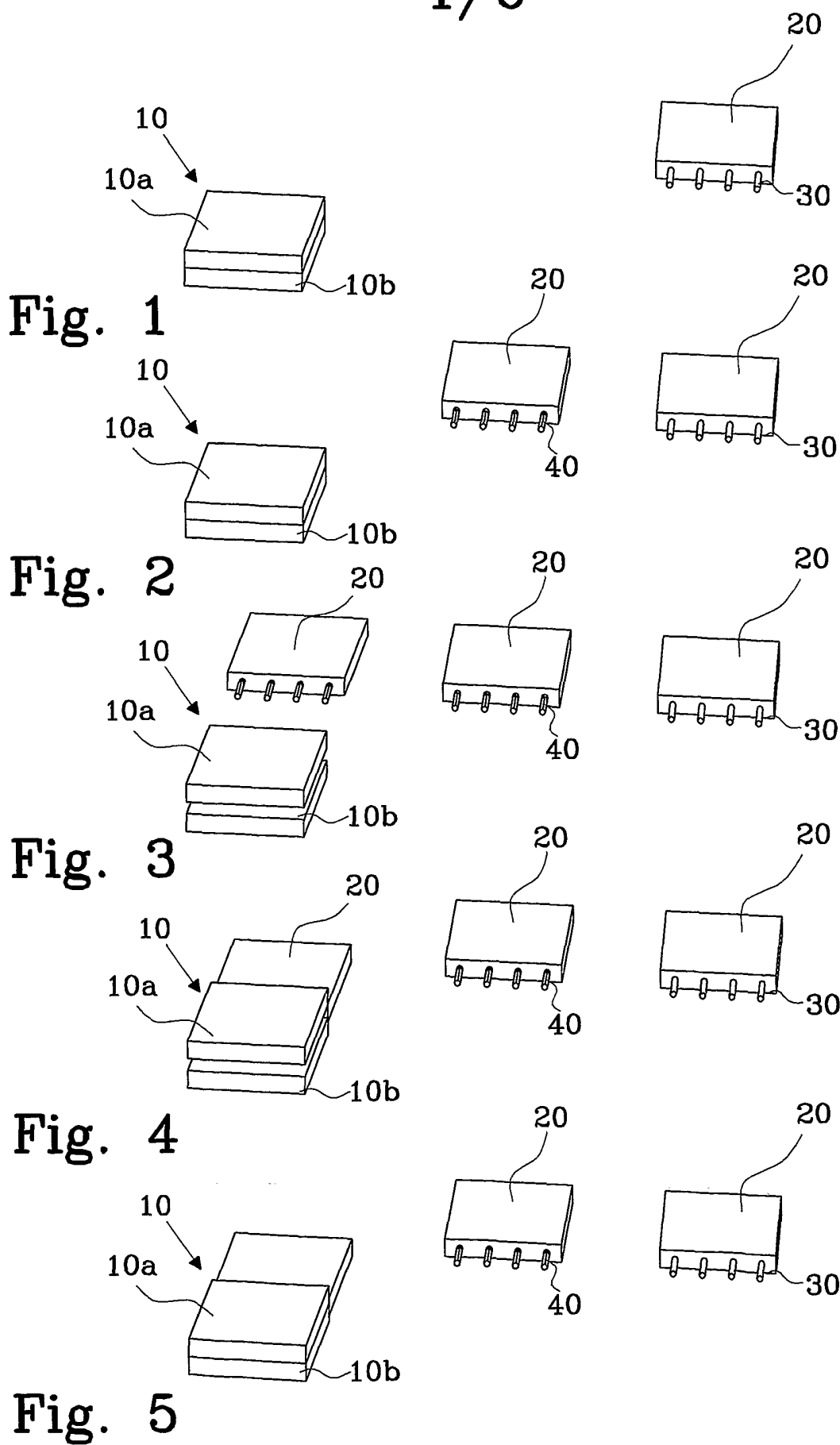
14. The antenna according to any of claims 9-13, further
10 comprising an interface (43) on the encapsulated antenna (50; 74) for engaging said encapsulated antenna (50; 74) to a casing of the mobile telephone.

15. The antenna according to any of claims 9-14, wherein said hollow portion has a cross sectional area being selected from
15 the group consisting of essentially circular, elliptical and polygonal.

16. The antenna according to any of 9-15, wherein said hollow portion is tapered.

17. The antenna according to any one of claim 9-16, wherein
20 said antenna element arranged on said flexible film is integral with an encapsulating part (42).

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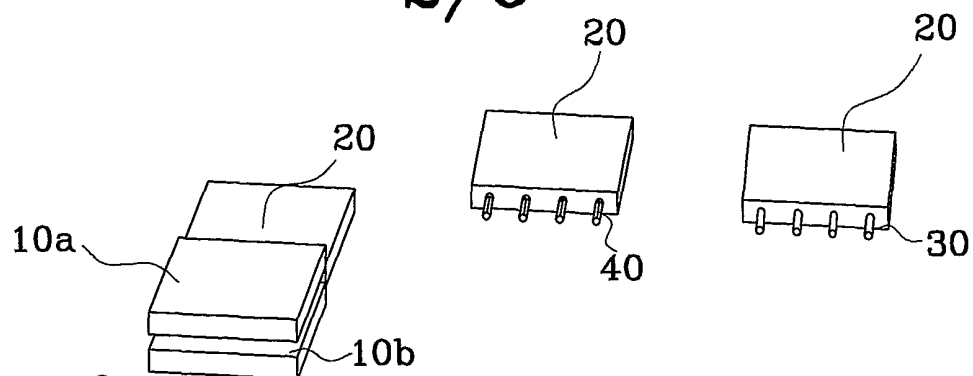


Fig. 6

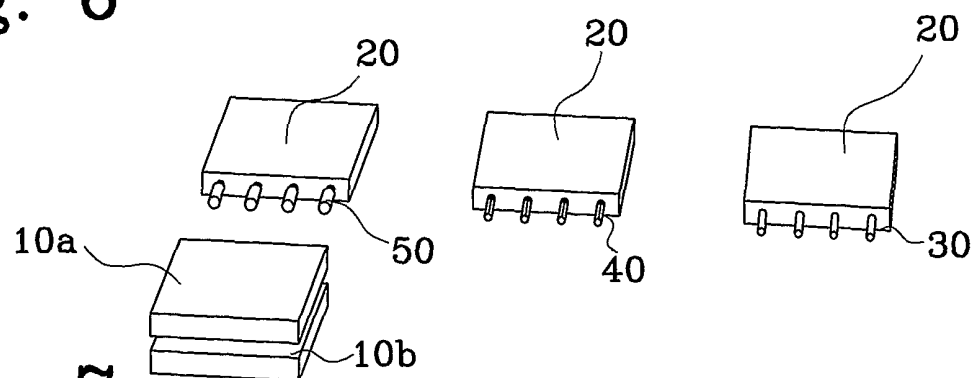


Fig. 7

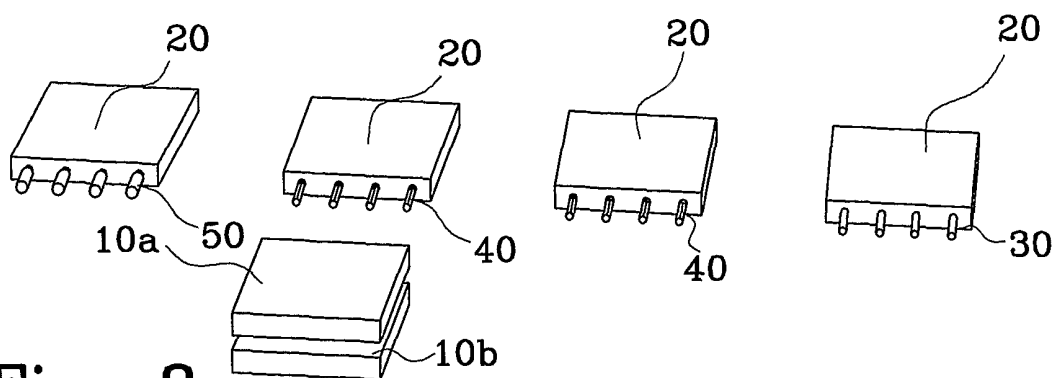


Fig. 8

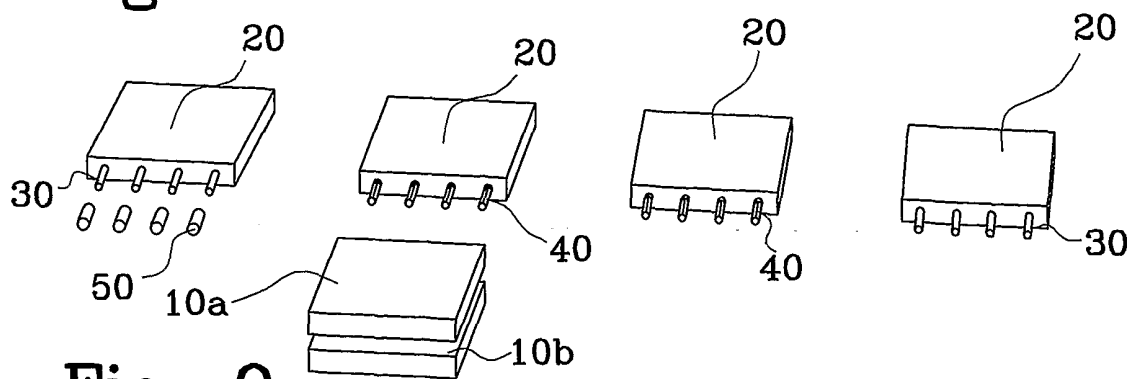
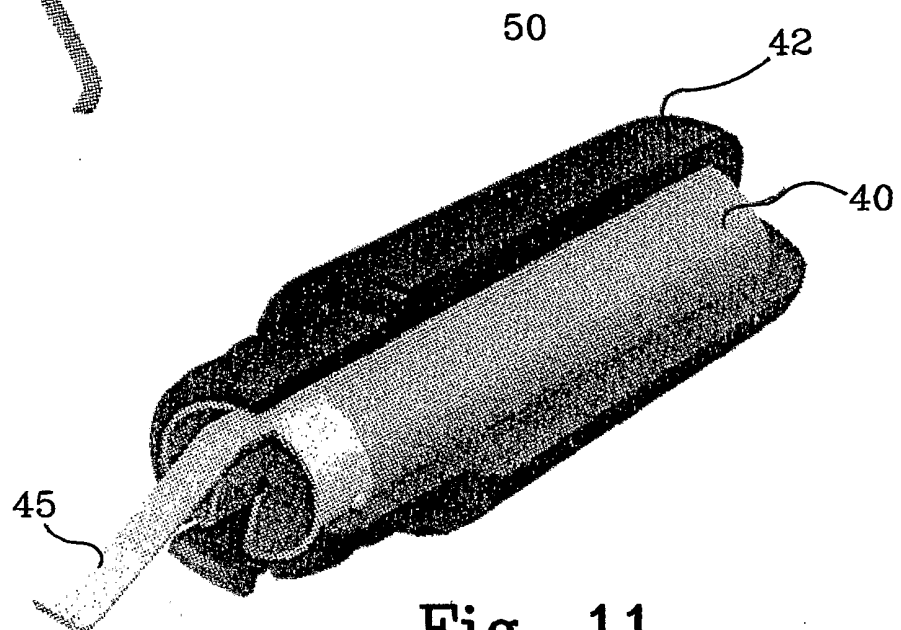
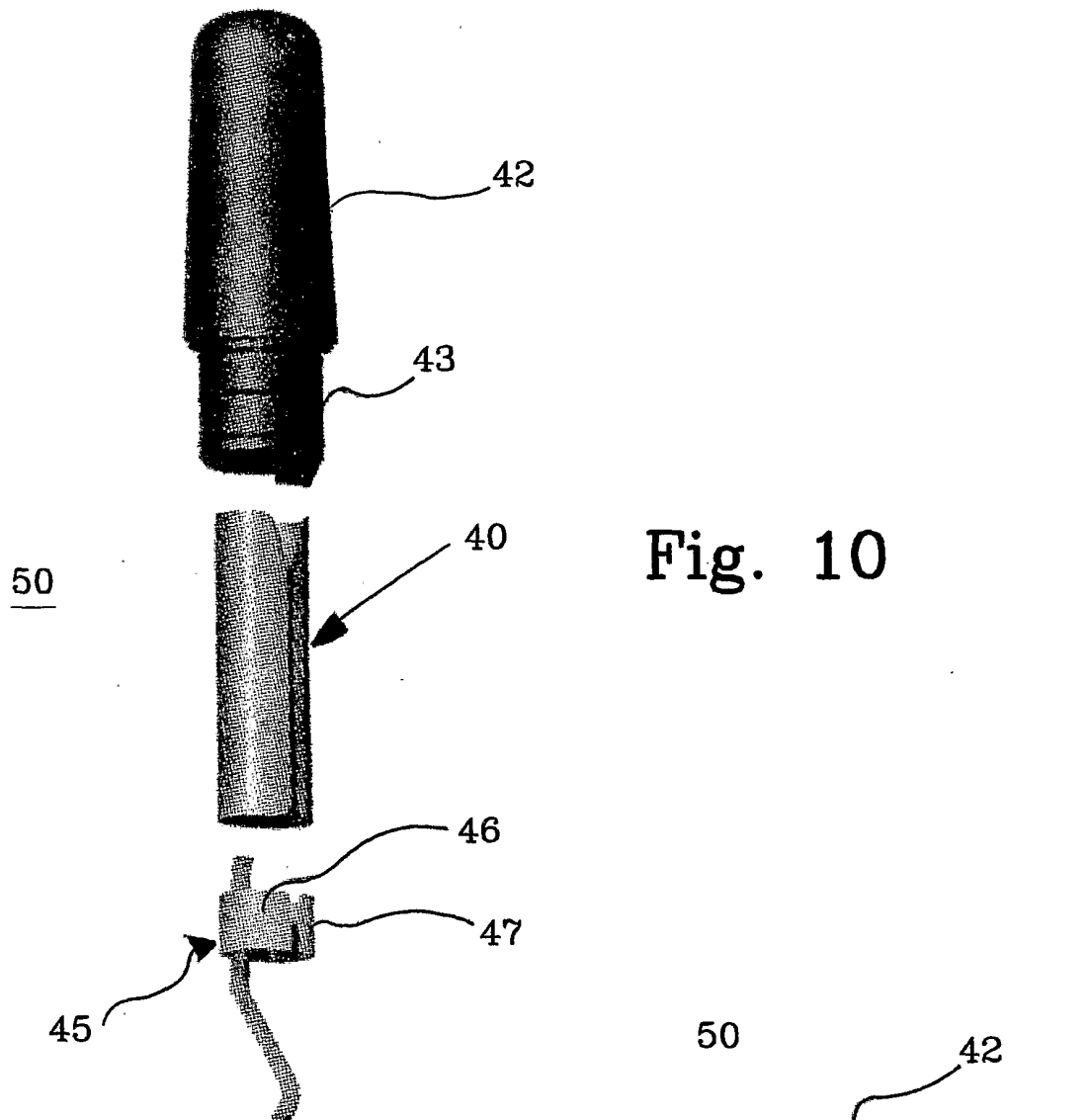


Fig. 9

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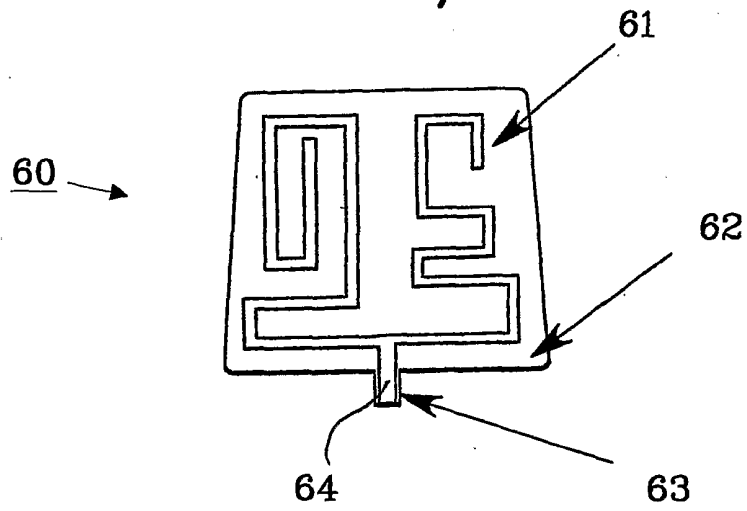


Fig. 12

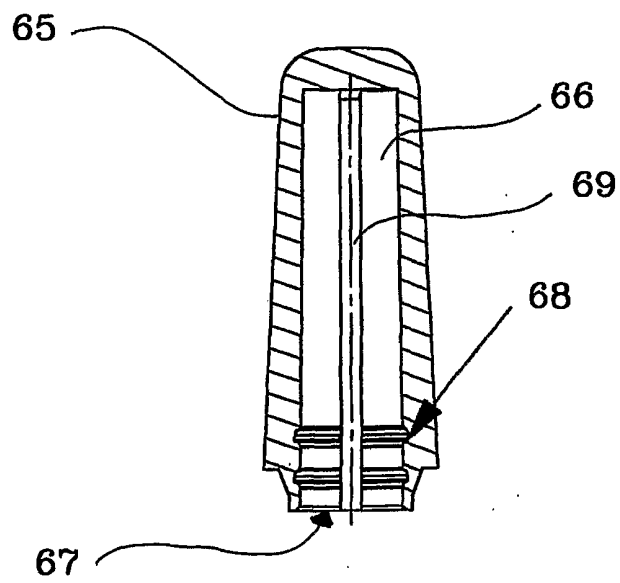


Fig. 13

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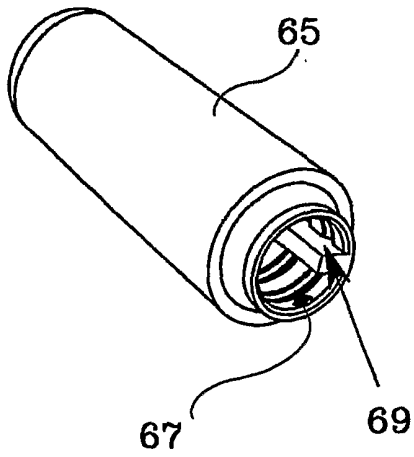


Fig. 14

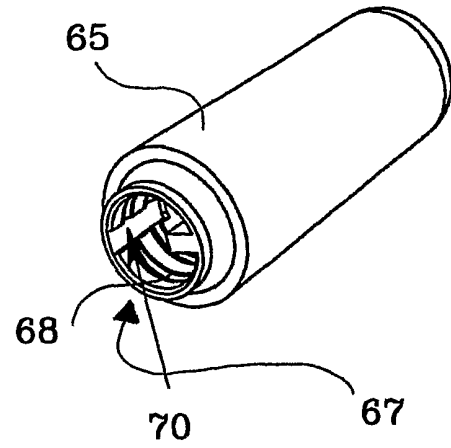


Fig. 15

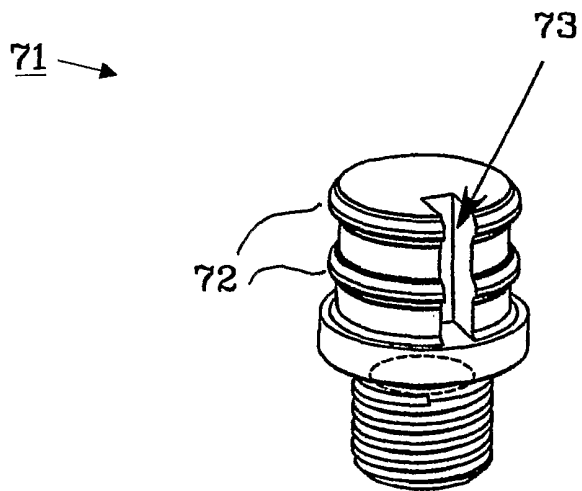


Fig. 16

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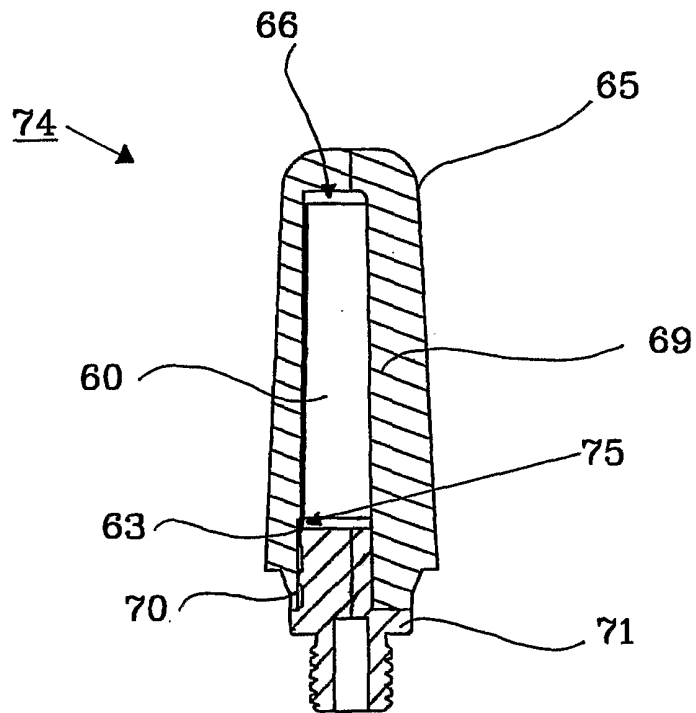


Fig. 17

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 01/01746

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01Q 1/24, H01Q 1/38, B29C 45/14

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)

IPC7: H01Q, B29C

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 9950927 A1 (ALLGON AB), 7 October 1999 (07.10.99), page 13, line 19 - line 22; page 10, line 25 - line 29; page 11, line 19 - line 22, figures 1-16 --	1-17

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

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INTERNATIONAL SEARCH REPORT

International application No.

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Information on patent family members

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