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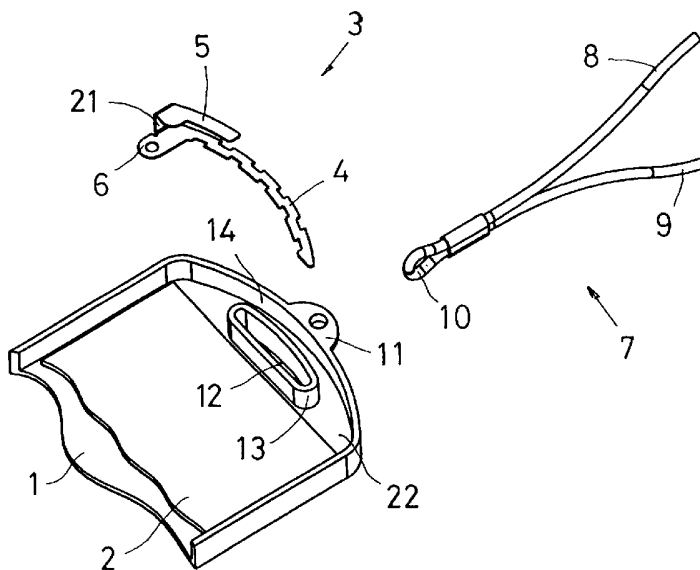
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- Published: — with international search report

[Continued on next page]

(54) Title: ANTENNA DEVICE



(57) Abstract: An antenna device has at least one antenna element (3) with two radiators (4 and 5) disposed on a retainer member (23). The retainer member may be a separate unit but may also constitute an integral part of a casing (1) for a cell or mobile telephone. In order to provide superior antenna performance and simple impedance adaptation, the radiators are connected in parallel (21) and are designed so that they have a surface extend which is shaped to conform closely with the shape of interior surfaces of the casing. In one embodiment, there is an outer radiator (7) which has a connecting portion which is located physically proximal the antenna element (3) in order thereby to realise a capacitative/inductive connection of the outer radiator (7) to the antenna element (3).



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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

ANTENNA DEVICE**TECHNICAL FIELD**

5 The present invention relates to an antenna device for a mobile radio communication apparatus, a so-called cell or mobile telephone, and designed for operation in at least two frequency bands, comprising at least a first antenna element connected to the circuits of the mobile telephone.

10 BACKGROUND ART

The downsizing of mobile telephones has proceeded so far that the space available for the antenna of the mobile telephone is extremely limited. Further, among other things for aesthetic reasons, attempts have been made to avoid antennas which project outside the apparatus casing of the mobile telephone. This entails problems in antenna performance, on
15 the one hand because the radiator components of the antenna are physically to the apparatus itself and, on the other hand, because they are also physically close to the head of the user.

One method of increasing antenna performance would be to employ telescopic rod antennas, but at least in the lower frequency bands that are employed in mobile telephony, even such a rod antenna designed as a quarter wave antenna would hardly have room interiorly inside the apparatus casing, since, for example, in the GSM band, an antenna length of approx. 80 mm would be required. Complex mechanical solutions would be called for to achieve the integration of such an antenna.

25 Many prior art antennas further have an impedance which greatly deviates from the 50 Ω , which is standard. This implies that matching networks must be employed between the antenna and the circuits of the mobile telephone, which is less desirable both with regard to cost and with regard to antenna performance.

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PROBLEM STRUCTURE

The present invention has for its object to design the antenna device intimated by way of introduction such that its performance may be drastically improved without the physical

dimensions of the apparatus casing of the mobile telephone of necessity needing to be increased. The present invention further has for its object to realise an antenna device which obviates the drawbacks inherent in prior art technology. Finally, the present invention has for its object to realise an antenna device which is simple and economical in manufacture and which facilitates impedance adaptation to the circuits of the mobile telephone.

SOLUTION

The objects forming the basis of the present invention will be attained if the antenna device intimated by way of introduction is characterised in that the first antenna element has at least a first and a second radiator of a surface extent which is shaped so as to comply with the configuration of an adjacent part of the inside of a casing in which the mobile telephone is accommodated.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

The present invention will now be described in greater detail hereinbelow, with reference to the accompanying Drawings. In the accompanying Drawings:

- Fig. 1 is, in perspective, an exploded view of a first embodiment of an upper part of a mobile telephone and a wrist strap or neck strap connectable thereto;
- Fig. 2 is a perspective view corresponding to that of Fig. 1 with the components included in the assembled state;
- Fig. 3 schematically illustrates the co-operation between the inner, permanent antenna of the mobile telephone and the outer antenna in a first embodiment;
- Fig. 4 is a view corresponding to that of Fig. 3, but of a modified embodiment;
- Fig. 5 is a view corresponding to that of Fig. 3, in yet a further modified embodiment;
- Fig. 6 is a view corresponding to that of Fig. 3, but in still a further modified embodiment;

Fig. 7 is a perspective view of a second embodiment of an antenna device according to the present invention;

Fig. 8 is a second perspective view of the antenna device according to Fig. 7;

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Fig. 9 shows a first alternative of the interconnection of two radiators included in the antenna device according to Figs. 7 and 8;

Fig. 10 shows a second alternative of the interconnection of two radiators included in the antenna device according to Figs. 7 and 8; and

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Fig. 11 shows a third alternative of the interconnection of two radiators included in the antenna device according to Figs. 7 and 8.

15 DESCRIPTION OF PREFERRED EMBODIMENT

In Fig. 1, reference numeral 1 relates to an upper part of an apparatus casing for a cell or mobile telephone. This casing may be both an inner casing which, in such instance, is included in the mechanically bearing parts of the mobile telephone, and an outer casing which substantially fulfils aesthetic functions. Interiorly in this casing, there is disposed a circuit card 2 with the circuits of the apparatus. A first antenna element 3, which is in the form of an inner or permanent antenna 3, has two radiators 4 and 5, where, for example, the longer radiator, which is designed as a meander, may be dimensioned for GSM bands (880-960 MHz), while the shorter radiator 5 which, in the illustrated embodiment, is a rod antenna, may be dimensioned for the DCS- or PCS bands or both (1710-1880 MHz and 1850-1990 MHz, respectively).

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Both radiators 4 and 5 are interconnected to each other by the intermediary of a connecting member 21 which realises a galvanic parallel connection of the radiators whereby the impedance is reduced to such a low level that a specific matching network may many times be dispensed with. The radiators have a common supply section 6 which is galvanically connected to the two radiators and further galvanically connected to the circuits on the circuit card 2. Between the two radiators 4 and 5, there is a dielectric such as air, glass, a suitable

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plastic material etc. The inner antenna 3 is dimensioned in order alone to be able to function satisfactorily, at least in environments where the reception conditions are good or normal.

5 The first antenna element 3 is disposed in or on and positionally fixed by means of a retainer device which, in this embodiment, is an integral part of the casing 1 of the apparatus. In the illustrated embodiment, the retainer device is formed by the inside 14 of the upper end wall of the casing 1 and a wall 13 projecting from the inside of the casing. In other words, the antenna element is interlockingly fixed in tight connection to the inside 14 of the casing.

10 In addition to the galvanic interconnection of the radiators 4 and 5, the connection 21 realises a separation of the radiators 4 and 5 so that, also in the longitudinal direction of the connecting member, they will be positioned closely adjacent inner surfaces, e.g. a rear surface 22 on the back portion of the casing 1.

15 It will be apparent from Figs. 1 and 2 that the two radiators 4 and 5 are arcuate in shape, whereby their shape is adapted to closely conform with the configuration of adjacent inner surfaces of the casing.

20 An outer antenna 7 is disposed on or together with or integral in a wrist strap, a neck strap or some similar accessory to the mobile telephone itself. The outer antenna 7 may therefore be seen as an accessory which greatly improves antenna performance, and which may be important in areas where reception conditions are less satisfactory. If, for purposes of exemplification of the outer antenna 7, we use a neck strap, this has a first part 8 and a second
25 part 9 which are brought together in an eye 10 which is fixable in an anchorage 11 on the apparatus casing 1 physically close to the inner antenna 3. While not being apparent from Fig. 1, the outer antenna has a lightly flexible, metallic conductor whose dimensioning is such that, when, as a result of its physical proximity to the inner antenna 3, it is capacitatively/inductively connected to it and can operate with half wave operation in the
30 frequency range to which the radiator 4 is set, up to full wave operation in the frequency range to which the radiator 5 is set. In one concrete example, the metallic conductor in the outer antenna 7 may be a thin, lightly flexible metal wire.

It is further apparent from Figs. 1 and 2 that the apparatus casing 1 has, just beneath the anchorage 11, a through-going, elongate aperture 12 which, interiorly in the apparatus casing 1, is defined by the surrounding wall 13. Between the upper side of the surrounding wall 13 and the lower side or inside 14 of the apparatus casing, there is a space which, as was mentioned above, is dimensioned for mechanical retention of the inner antenna 3. Fig. 2 clearly shows how the antenna 3 is placed in this space and how it is shaped according to and follows the inner surfaces 14 and 22 of the casing 1. The through-going and elongate aperture 12 is also intended for the passage of an alternative to the neck strap with the parts 8 and 9, for example a wrist strap.

10

Figs. 3 and 4 show one embodiment where there is disposed in the outer antenna 7, a single conductor 15 which constitutes a second antenna element if the inner antenna 3 is considered as a first antenna element. The conductor 15 has an end region or a coupling portion 16 which is located physically proximal the first antenna element. The distance between the coupling portion 16 and the first antenna element should be of the order of magnitude of 0.01-0.03 wavelengths. In Figs. 1 and 2, the embodiment according to Fig. 3 has its counterpart in a situation where there is disposed in the outer antenna 7 a metallic conductor only in one of the two parts 8 and 9.

15

Fig. 4 shows a similar embodiment with a single conductor 15 which constitutes the second antenna element. In this embodiment, the coupling portion 17 has, however, a different appearance and extends at least partly about the first antenna element 3. In the embodiment according to Figs. 1 and 2, this would imply that the neck strap or the wrist strap is passed through the through-going aperture 12 straight through the apparatus casing 1.

20

Fig. 5 shows an embodiment where a double or duplex conductor 18 is employed as the second antenna element. This has its counterpart in Figs. 1 and 2 by the situation that both the first part 8 and the second part 9 of the neck strap or the wrist strap each have their part of the duplex conductor 18. The region of union between these parts constitutes the coupling portion 19 of the second antenna element. In Figs. 1 and 2, this embodiment has its counterpart in a situation where the outer antenna 7 is secured in the anchorage 11 of the apparatus casing.

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Fig. 6 shows a similar embodiment where the outer antenna 7 is secured in the through-going aperture 12 of the apparatus casing so that the coupling portion 20 of the second antenna element at least partly extends around the first antenna element.

5 In Fig. 1, the inner antenna, i.e. the first antenna element, has been shown as an antenna of sheet metal material produced, for example, by etching. This is not a critical requirement, but the inner antenna element 3 may be produced from a double-sided circuit card, a flexifilm secured on a suitably shaped carrier or vehicle of plastic or other suitable material, or a metalisation of the carrier, the retainer device or the inside of the casing. Further, the first
10 antenna element may be a helical antenna which lies with its longitudinal direction approximately parallel with the width direction of the apparatus casing. Other configurations of the first antenna element are also possible.

According to the present invention, it is also possible to make the uppermost part of the
15 apparatus casing 1 as a loose component which may be snapped in position on the rest of the apparatus casing. In such an embodiment, the counterpart to the anchorage 11 is located on this additional unit, this also accommodating the counterpart to the first antenna element.

A counterpart to the aperture 12 may be disposed either in the additional unit or in the joint
20 between it and the apparatus casing proper, but possibly also in the apparatus casing itself. In addition to the first antenna element 3 interiorly in the additional unit, there may also be an additional antenna device interiorly in the apparatus casing.

In the embodiment according to Figs. 1 and 2, the antenna element 3 is positionally fixed
25 interiorly in the casing 1 by means of a retainer member which is designed as an integral part of the casing of the apparatus. In the described embodiment, the retainer member positionally fixes the antenna element by the intermediary of a mechanical, interlocking engagement. In another embodiment, where the retained member is an integrated part of the casing 1 of the
30 apparatus, the radiators of the antenna element 3 are applied direct on interior surfaces in the apparatus casing 1. The radiators will hereby have a surface extent which is adapted to follow the configuration of these interior portions of the inside of the casing 1.

As a variation on this theme, a construction is conceivable where the radiators are disposed interiorly in the material of the casing.

Figs. 7 and 8 show one embodiment with a retainer member 23 which is designed as a separate unit which is insertable interiorly in the casing 1. The design of the retainer member 23 is such that at least parts of its surfaces connect to and are formed in accordance with adjacent, corresponding interior surfaces in the casing 1.

5

In the illustrated embodiment, the retainer member 23 (see Fig. 8) has an open interior in which a circuit card 2 may be insertable as is intimated by the arrow 24. As a result, the retainer member 23 and the circuit card 2 are joined to form a unit which is insertable interiorly in the casing 1.

10

It will further be apparent from the Figure that the retainer member 23 has a contact device 25 which is intended for contact with a corresponding contact device 26 on the circuit card 2. When the contact device 25 of the retainer member 23 is in communication with radiators 27 and 28 disposed on the retainer member, it will be seen that the radiators can, in a very simple manner, be connected to those circuits which are disposed on the circuit card 2.

15

The two radiators 27 and 28 are, in the illustrated embodiment, produced as meandering or zigzag shaped conductors which, in a practical embodiment, may be disposed on a flexifilm 29 disposed on the retainer member 23.

20

Of the two radiators 27 and 28 illustrated in Fig. 7 and 8, the radiator 27 will also be designated a first radiator, while the radiator 28 will also be designated a second radiator.

25

The first radiator 27 has a first surface portion 30 and a second surface portion 31 which substantially lie in two separate planes that intersect one another possibly, as shown in the Figure, approximately at a right angle. The first surface portion 30 is disposed closely adjacent a side surface of the inside of the casing 1, while the second surface portion 31 is disposed closely adjacent an upper end surface 14 of the inside of the casing 1. The transitional region between the two surface portions 30 and 31 is an arched region, in the embodiment with the flexifilm 29, a single-arched region.

30

Correspondingly, the second radiator 28 has a surface portion 32 which substantially lies in a third plane that intersects the above-mentioned first and second planes, preferably as shown in the Figures at right angles.

The first portion 30 of the first radiator 27 is of a longitudinal extent which is intimated by a broken line 33, and the second radiator 28 is of a longitudinal direction which is intimated by the broken line 34. In the illustrated embodiment, these lines 33 and 34 make approximately a right angle with each other, but the present invention also encompasses embodiments where the second broken line 34 may be turned in accordance with the arrow 35 so that the angle between the two lines 33 and 34 is less than 90° , for example of the order of magnitude of 45° . By such a change of the embodiment, the second radiator 28 will be higher up, i.e. closer to the upper end of the mobile telephone and further away from its circuits.

10 The contact device 25 has a supply section 36 which, in the embodiment illustrated in Fig. 7 and 8, is connected to the ends of the two radiators 27 and 28. This alternative, which is a pure, galvanic parallel connection of the two radiators, is illustrated in Fig. 9.

15 Fig. 10 shows an alternative interconnection of the two radiators 27 and 28 and it will be apparent that the first radiator 27 has its one end connected direct to the contact device 25, while the second radiator 28 has its supply end connected between the ends of the first radiator but preferably in the proximity of that end which is connected to the contact device 25.

20 Fig. 11 shows the reverse situation in relation to Fig. 10, where the second radiator 28 is connected directly to the contact device 25 with its one end while the one end of the first radiator 27 is connected to the second radiator 28 between both of its ends but preferably more proximal that end which is connected to the contact device 25.

25 In all of the embodiments illustrated in Fig. 7 to 11, both of the radiators 27 and 28 have one end free.

In those embodiments which are shown in Figs. 7 to 11, the first radiator 27, i.e. the longer radiator, may be designed for a quarter wave resonance and a half wave resonance, for example quarter wave resonance in the GSM-band and half wave resonance in the DCS- or PCS-bands, while the second radiator 28, the shorter radiator, may be designed for quarter wave resonance in the DCS-band. If, in such instance, the settings in the DCS-band are not made exactly alike as regards the shorter and longer radiator, an increase of the band width will be attained in the higher frequency range.

WHAT IS CLAIMED IS:

1. An antenna device for a mobile radio communication apparatus, a so-called cell or mobile telephone, and designed for operation in at least two frequency bands, comprising at least a first antenna element (3) connected to the circuits of the mobile telephone, **characterised in that** the first antenna element (3) has at least a first (4; 27) and a second (5; 28) radiator with a surface extent (30, 31, 32) which is shaped so as to comply with the configuration of a closely adjacent portion of the inside of a casing (1) in which the mobile telephone is accommodated.
2. The antenna device as claimed in Claim 1, **characterised in that** the antenna element (3) is disposed on or in a retainer member (23) which is disposed to position the antenna element in relation to the portion of the inside of the casing (1).
3. The antenna device as claimed in Claim 2, **characterised in that** the retainer member is provided as an integral part of the casing (1).
4. The antenna device as claimed in Claim 3, **characterised in that** the casing (1), just beneath its upper defining wall (14), has a wall (13) projecting inwards in the casing; and that the antenna element (3) is positionally fixed in the space between the inside of the upper defining wall of the casing and the wall.
5. The antenna device as claimed in Claim 3 or 4, **characterised in that** the antenna element is disposed in the region immediately beneath the upper defining wall (14) of the casing (1) and with its longitudinal direction in the width direction of the casing.
6. The antenna device as claimed in Claim 2, **characterised in that** the retainer member (23) is provided as a separate unit insertable in the casing (1) and having, at least on its surfaces provided with radiators and facing towards the inside of the casing, a design which conforms to the shape of the inside of the casing (1).
7. The antenna device as claimed in Claim 6, **characterised in that** the antenna element includes at least two radiators, of which a first has a first surface portion and a second surface portion, said surface portions lying substantially in two discrete and separate planes that

intersect one another, and of which a second radiator has a surface portion which substantially lies in a third plane intersecting the first and second planes.

8. The antenna device as claimed in Claim 7, **characterised in that** the first, second and third planes are substantially at right angles to one another.
9. The antenna device as claimed in Claim 8, **characterised in that** both radiators are meander- or zigzag shaped.
10. The antenna device as claimed in any of Claims 7 to 9, **characterised in that** the first radiator has a substantially single curved portion between the first surface portion and the second surface portion.
11. The antenna device as claimed in any of Claims 7 to 10, **characterised in that** the first radiator (27) has a supply point (36) at its one end, while the opposite end is free; and that the second radiator (28) has its one end connected to the supply point and its opposite end free.
12. The antenna device as claimed in any of Claims 7 to 10, **characterised in that** the first radiator (27) has a supply point (36) at its one end, while the opposite end is free; and that the second radiator (28) has its one end connected to the first radiator between the ends thereof, while the opposite end is free.
13. The antenna device as claimed in any of Claims 7 to 10, **characterised in that** the second radiator (28) has a supply point (36) at its one end, while the opposite end is free; and that the first radiator (27) has its one end connected to the second radiator between the ends thereof, while the opposite end is free.
14. The antenna device as claimed in Claim 3, **characterised in that** the antenna element (3) is disposed on the surface of the inside of the casing (1).
15. The antenna device as claimed in any of Claims 3 and 6, **characterised in that** the second antenna element (7) which, for the greater part, is disposed outside the casing (1) and which has a connecting portion (16, 17, 19, 20) which extends through an aperture (12) in the

casing, to physical proximity with the first antenna element (3) in order to be capacitatively/inductively connected thereto.

5 16. The antenna device as claimed in Claim 15, **characterised in that** the second antenna element (15, 18) at least partly extends around the first antenna element (3) with its connecting portion (17, 20).

17. The antenna device as claimed in Claim 15 or 16, **characterised in that** the connecting portion (16, 17) is an end portion of the second antenna element (15).

10

18. The antenna device as claimed in Claim 15 or 16, **characterised in that** the connecting portion (19, 20) is a central portion of the second antenna element (18).

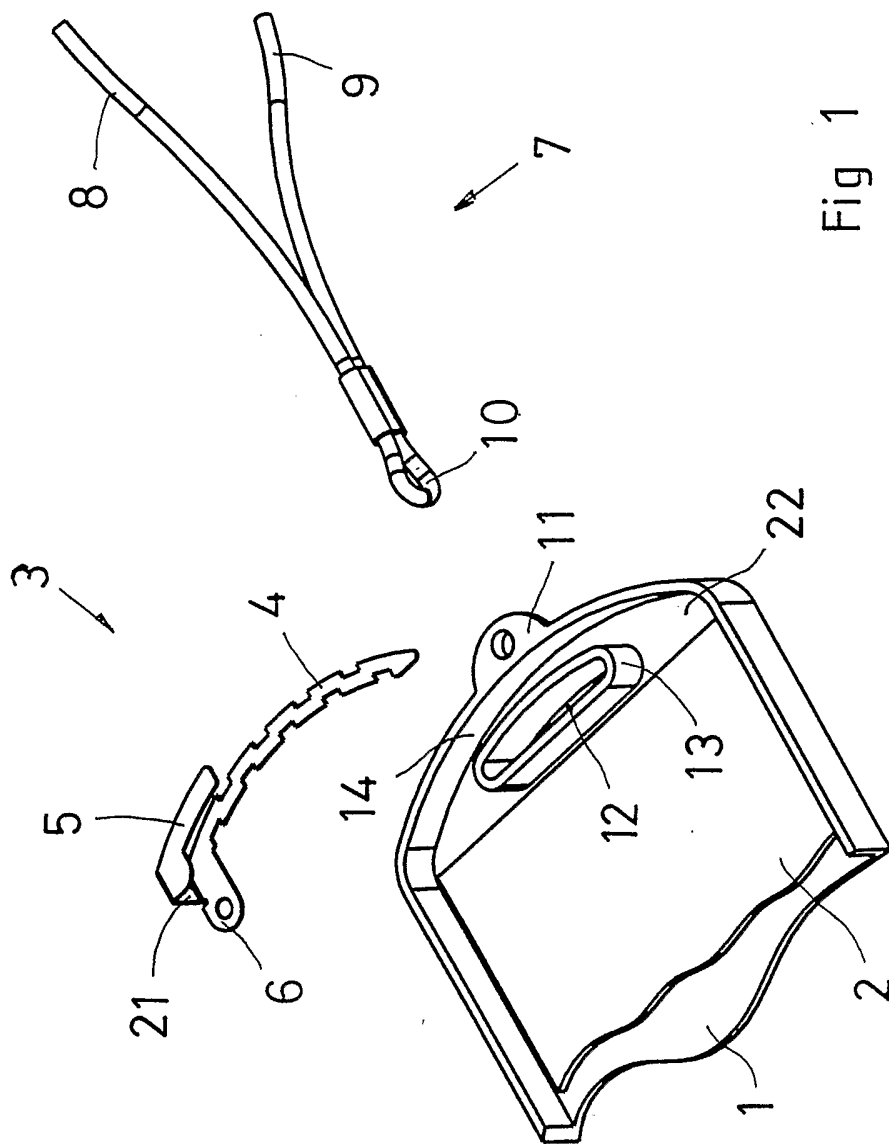


Fig 1

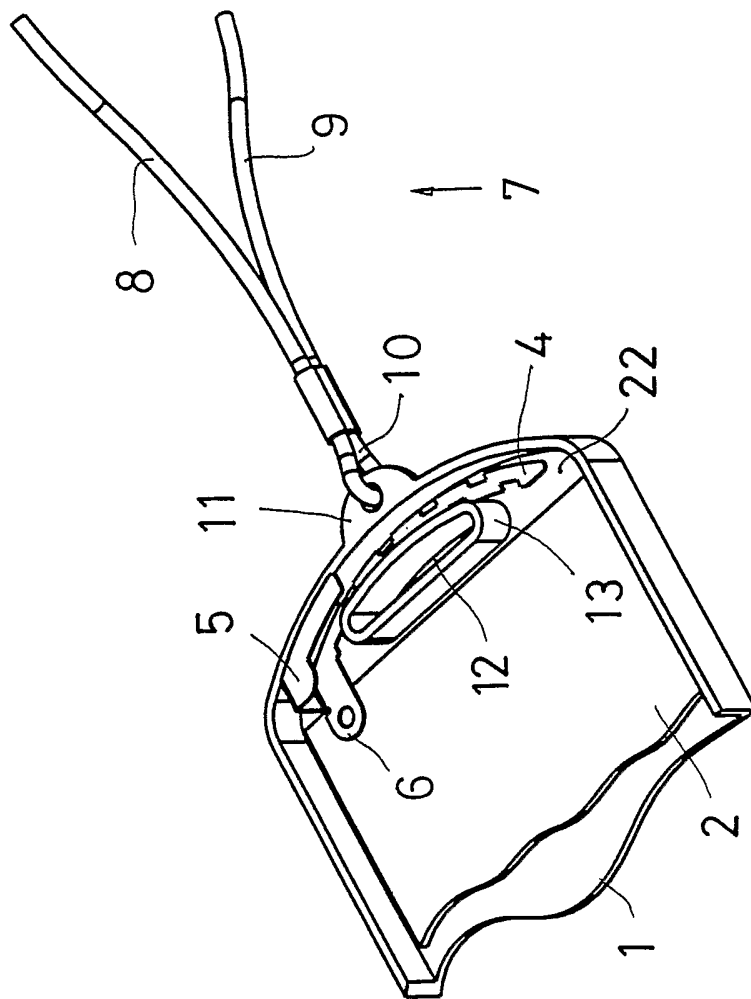


Fig 2

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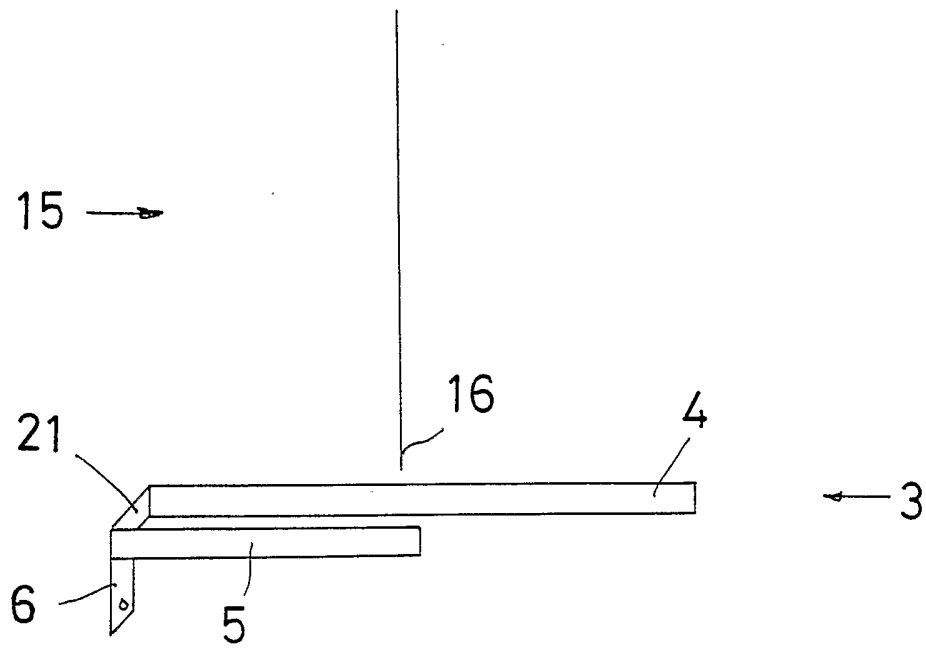


Fig 3

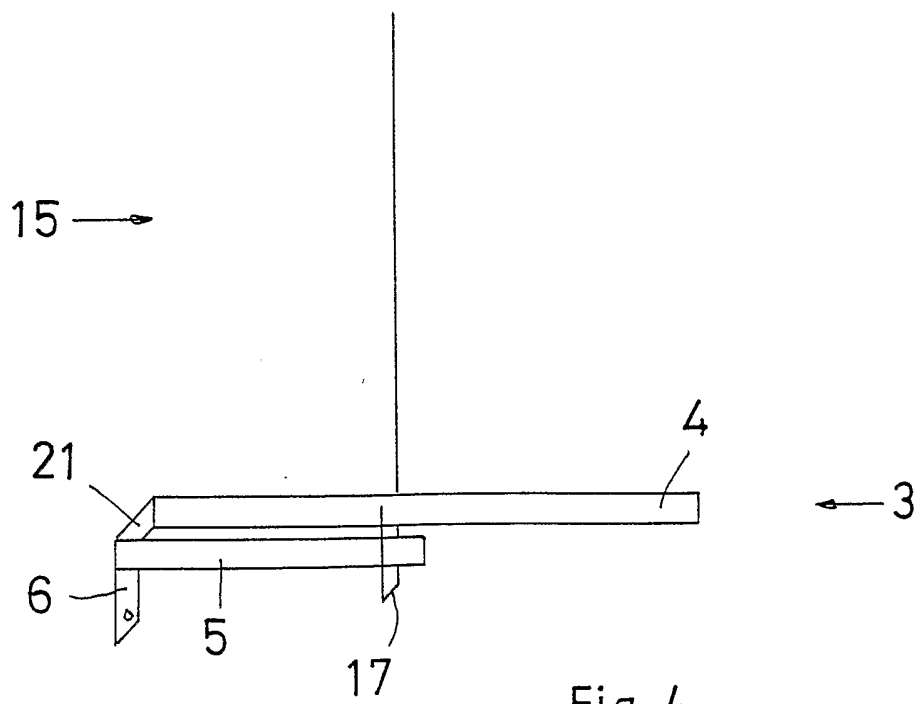


Fig 4

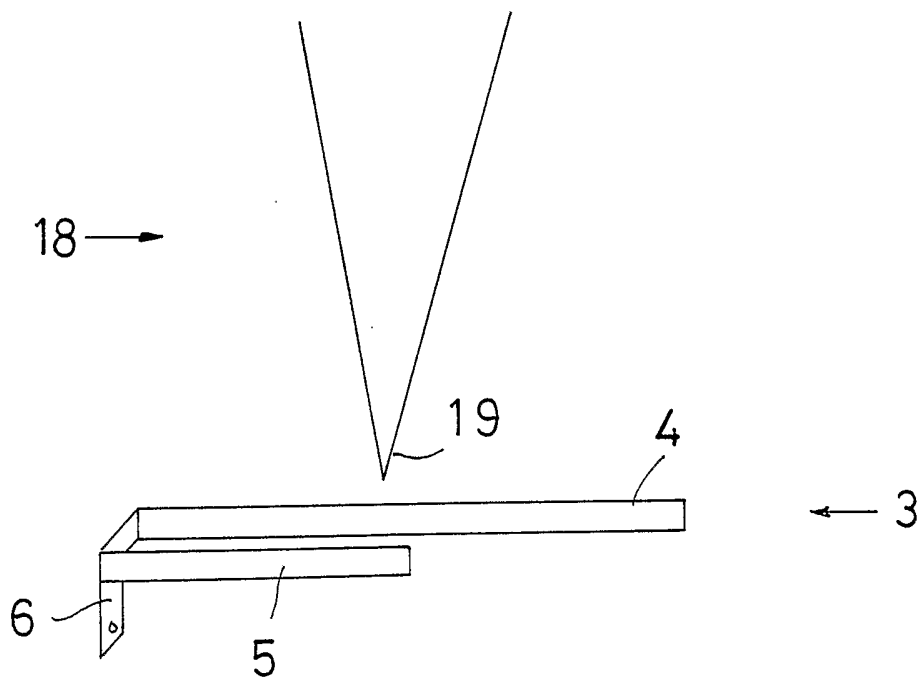


Fig 5

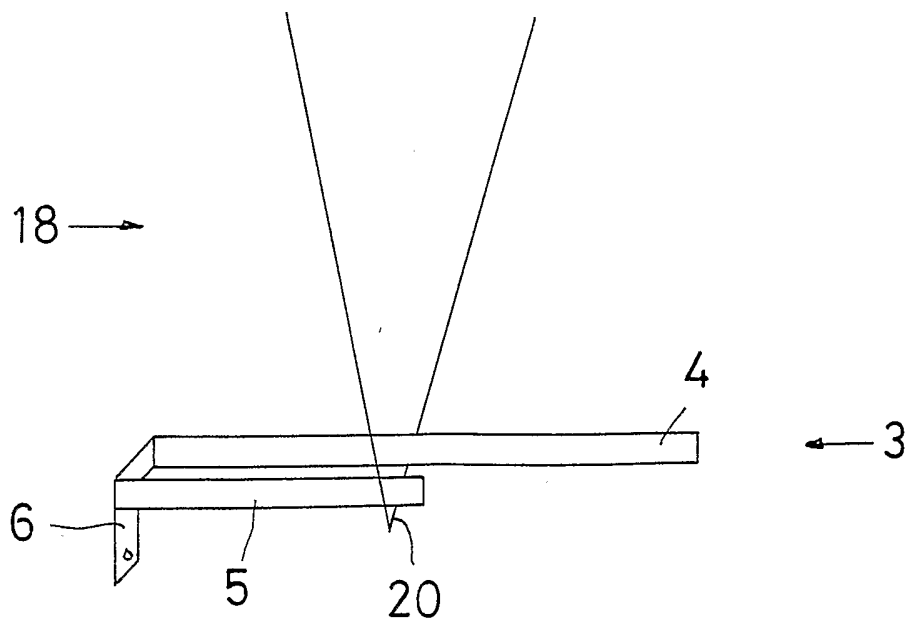
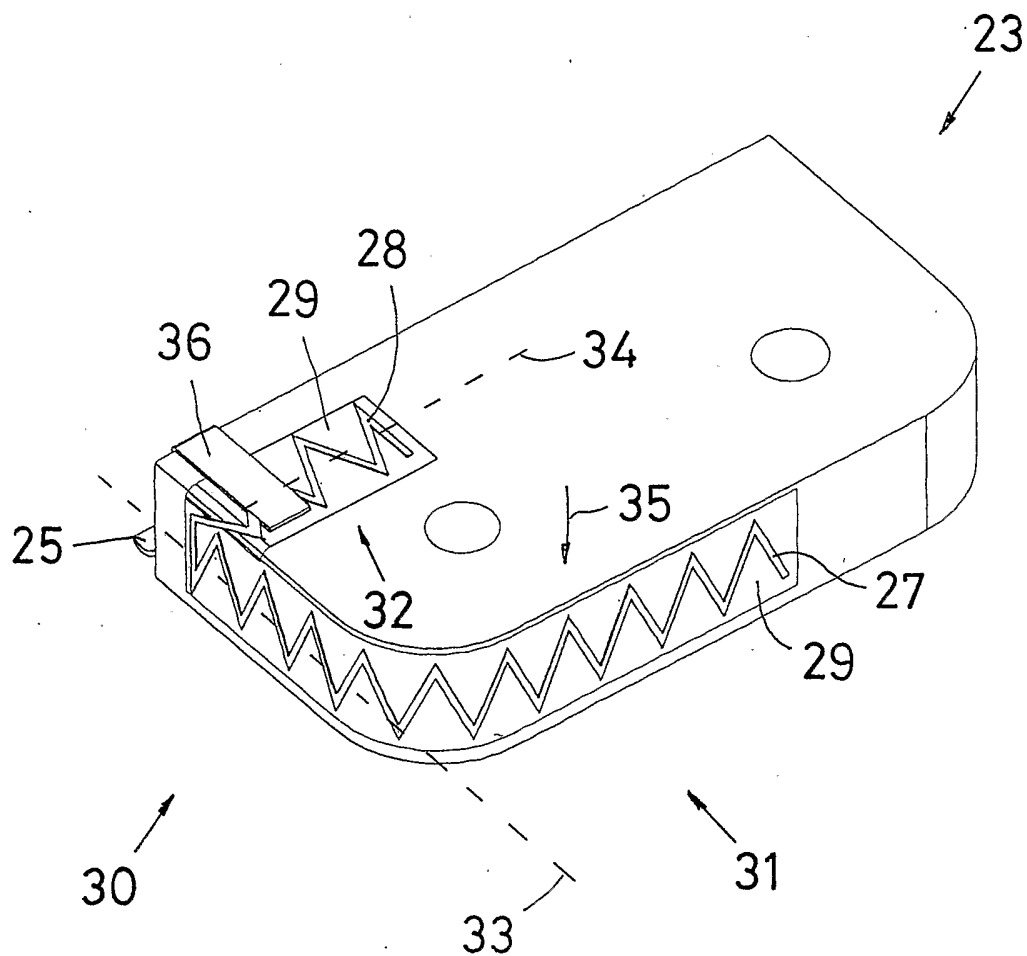


Fig 6

Fig 7



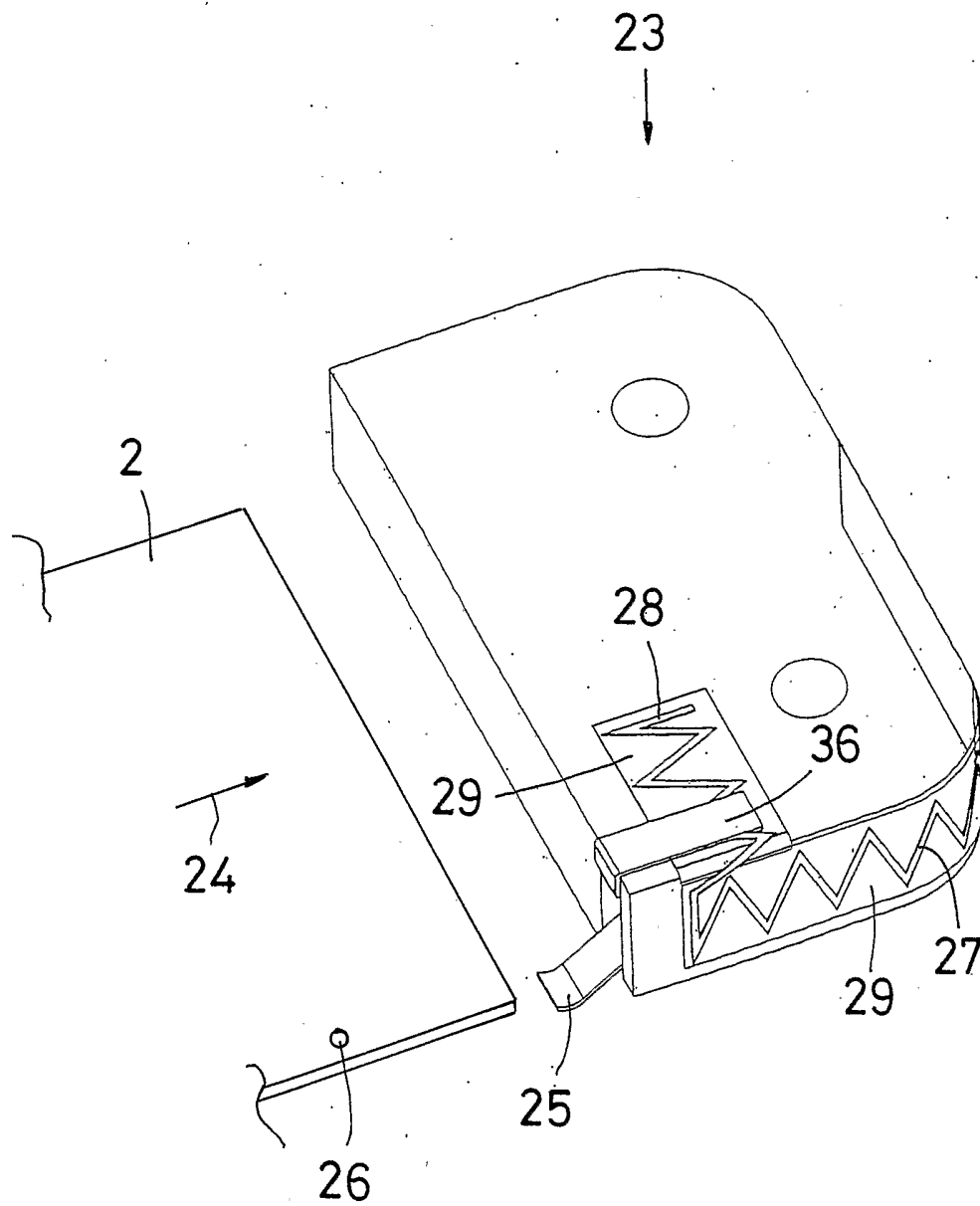


Fig 8

Fig 9

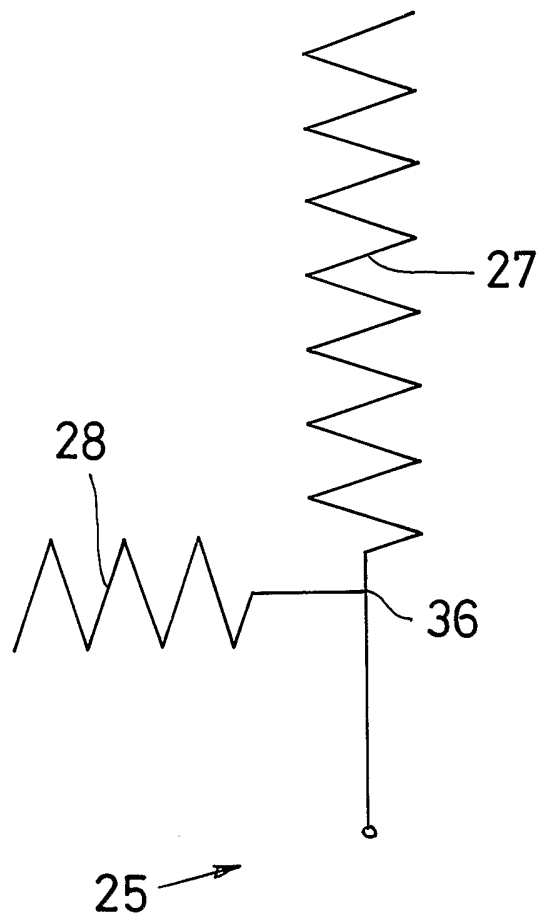


Fig 10

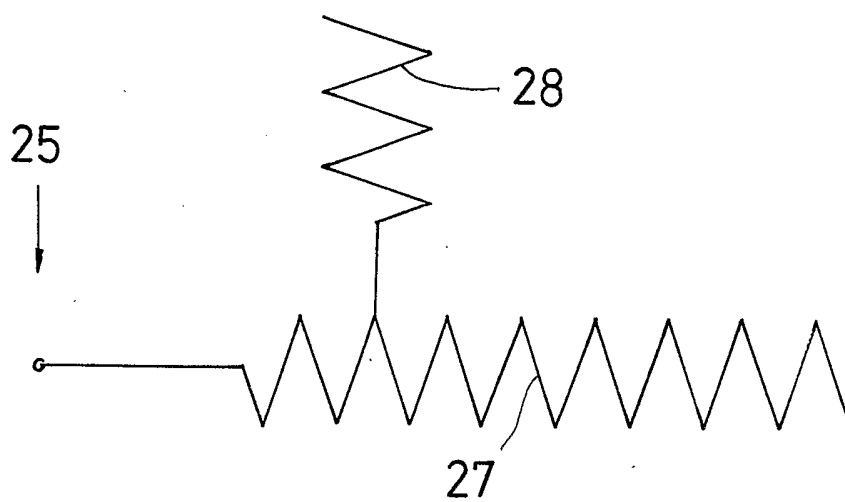
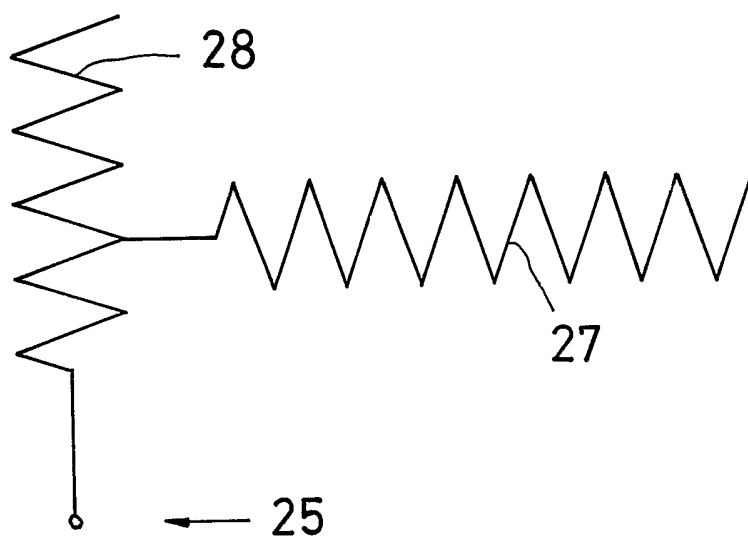


Fig 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 02/02419

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01Q 1/24, H01Q 1/38, H01Q 5/00 // H01Q 1/44
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

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

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9903166 A1 (ALLGON AB), 21 January 1999 (21.01.99), page 9, line 4 - line 11; page 12, line 23 - line 25, figure 7 --	1-3,5-6, 14-15
P,X	WO 0231912 A1 (AVANTEGO AB), 18 April 2002 (18.04.02), page 4, line 29 - line 30; page 5, line 5 - line 6; page 5, line 30 - page 6, line 1 --	1-3,6
X	WO 9967851 A1 (ALLGON AB), 29 December 1999 (29.12.99), page 6, line 30 - line 31; page 10, line 13 - line 17; page 14, line 12 - line 13 --	1-3,6,14

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
 "E" earlier application or patent but published on or after the international filing date
 "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
 "O" document referring to an oral disclosure, use, exhibition or other means
 "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

2 April 2003

Date of mailing of the international search report

04-04-2003

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/02419

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

- 1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

- 2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

- 3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see extra sheet

- 1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
- 2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
- 3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

- 4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

WO 9967851 A1 discloses an antenna device in accordance with claims 1-3 and 6. The subject matter of claims 1-3 and 6 thus lacks novelty. Therefore, the dependent claims 4-5 and 7-18 form four groups of inventions which do not have common special technical features as required by PCT Rule 13.2:

1. Claim: 4

The antenna device according to claim 3, wherein the antenna element is fixed between an upper defining wall of the casing and a wall projecting inwards in the casing.

2. Claim: 5

The antenna device according to e.g. claim 3, wherein the antenna element is disposed immediately beneath the upper defining wall of the casing with its longitudinal direction in the width direction of the casing.

3. Claims: 7-13

The antenna device according to claim 6, wherein the two radiators of the antenna element include surface portions lying in three separate planes.

4. Claims: 15-18

The antenna device in accordance with claim 3 or 6, including a second antenna element, which for the greater part is disposed outside the casing, including a connection portion extending through an aperture in the casing so as to be in proximity with the first antenna element in order to be capacitatively/inductively connected thereto.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 02/02419

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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