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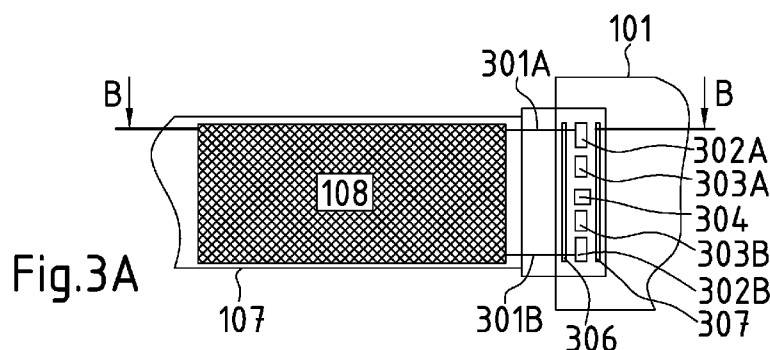
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(54) **Title:** PORTABLE ELECTRONIC DEVICE WITH STRAP



(57) **Abstract:** The invention proposes a portable electronic device (100) having a housing (101) and a strap (107) that is mechanically attached to the housing. The housing encompasses electronic components and protects them from ambient influences. The strap bears further electronic components (108), whereby an electrically conductive connection (301A, 301B) exists between the housing and the strap. The strap is mechanically attached to the housing by means of a form-fitting connection (304), whereby the connection is oriented appropriately such that a tensile force acting on the strap in the strap's longitudinal direction generates a force component that aims to push the strap onto the housing. The strap can be mounted easily on the housing and establishes a mechanical and electrical connection between the housing and the strap in a single assembly step. The mechanical connection between the strap and the housing also resists tensile forces without forces acting on the electric contacts that might lead to a disconnection of the electrical connection between the strap and the housing.



PORTABLE ELECTRONIC DEVICE WITH STRAP

Field of the invention

The invention relates to a portable electronic device that can be worn on the body
5 by means of the strap. The device comprises a housing that is electrically and mechanically connected to the strap.

Background of the invention

Portable electronic devices that are worn on the body by means of a strap are known, for example, in the form of so-called smart watches.

10 For example WO 2015/079096 A1 describes a smart watch, in which the physical activity of the user is displayed through the change of the appearance of the wrist strap of the smart watch. The change of the appearance is accomplished through electrochromic displays in the wrist strap, whose colour can be changed by application of an electrical voltage. The sensors for measuring the physical
15 activity of the user are situated in the housing of the smart watch such that there is a need for an electrical connection between the housing and the wrist strap. However, it may well be advantageous to have individual sensors or parts of the analytical electronics situated in the strap, since the strap has pronounced contact, for example, to the arm of the user and, in particular, to the inside of the
20 wrist. This means, again, that electrical signals and the supply of power need to be exchanged between the housing and the strap.

Based on the aforementioned, the invention proposes a novel solution for the mechanical and electrical connection between a strap and the housing of an electronic device that is worn on the body by means of the strap.

25 Summary of the invention

To solve the stated object, the invention proposes a portable electronic device having a housing and a strap that is mechanically attached to the housing. The housing encompasses electronic components and protects them from ambient

influences. The strap bears further electronic components, whereby an electrically conductive connection exists between the housing and the strap. The proposed electronic device is characterised in that the strap is mechanically attached to the housing by means of a form-fitting connection, whereby the connection is oriented appropriately such that a tensile force acting on the strap in the strap's longitudinal direction generates a force component that aims to push the strap onto the housing. The proposed electronic device is advantageous in that the strap can be mounted easily on the housing and in that a mechanical and electrical connection between the housing and the strap can be produced in a single assembly step. The mechanical connection between the strap and the housing also resists tensile forces without forces acting on the electric contacts that might lead to a disconnection of the electrical connection between the strap and the housing.

In an exemplary embodiment, the mechanical connection is secured through a latching mechanism.

In an exemplary embodiment, the mechanical connection is secured through a rotary or sliding mechanism. In another exemplary embodiment, the strap comprises a projecting mechanical element that engages a corresponding recess in the housing. Alternatively, in another exemplary embodiment, a projecting mechanical element is provided on the housing and engages a corresponding recess in the strap.

In an actual embodiment, the projecting mechanical element is designed in the shape of a fin or a peg. Multiple fins or pegs may be provided just as well.

The projecting mechanical element can be a fin whose one side surface forms an angle of less than 90° with one main surface of the strap. The side surface touches against the recess such that a tensile force acting on the strap in the strap's longitudinal direction generates a force component that aims to push the strap onto the housing.

In an exemplary embodiment, the strap comprises an electrical plug contact with a contact pin that engages a contact socket that comprises at least one contact

spring in order to establish the electrical connection between the strap and the housing.

In one exemplary embodiment, the contact pin is pushed against the at least one contact spring by the action of the tensile force acting on the strap in the strap's longitudinal direction.

In an advantageous embodiment, the latching mechanism is designed to be detachable for disconnection of the mechanical connection between the strap and housing.

Another exemplary embodiment provides for arranging a gasket, sections of which are conductive. The conductive sections of the gasket form contact surfaces for the electrical connection.

In an exemplary embodiment, the gasket is arranged between the strap and the housing on surfaces that are pushed against each other by the action of a tensile force acting on the strap in the strap's longitudinal direction.

In an advantageous exemplary embodiment, an electrical energy storage system is accommodated in the strap. The energy storage system can be a flexible battery. Both individual and multiple batteries can be used. The batteries can be rechargeable just as well as non-rechargeable. In certain applications, it may make sense to use a combination of rechargeable and non-rechargeable batteries.

Short description of the figures

The drawing shows exemplary embodiments of the invention, whereby identical or corresponding elements are identified with identical or similar reference signs. In the figures:

Figure 1: shows a perspective view of an electronic device according to the invention;

Figures 2A and 2B show the electronic device of Figure 1 in a partial top view from above;

Figure 3A shows a detail of Figure 1 in a partial elevation view;

Figure 3B shows a cross-section through Figure 3A;

Figure 3C shows a normal force decomposition;

Figures 4A to 4D show design variants of a form-fitting connection between strap
5 and housing;

Figures 5A to 5D show detail views of the electrical contacts;

Figure 6 shows an alternative plug contact;

Figures 7A to 7C show embodiments of electrical contacts; and

Figures 8A to 8C show a cross-sectional view of the connection region between
10 strap and housing.

Detailed description

Figure 1 shows a perspective view of an electronic device 100 that is worn on the body, in the form of a so-called smart watch. However, it needs to be noted that the invention is not limited to a smart watch, but can be used with all electronic
15 devices that comprise a housing that is worn on the body by means of a strap as long as both a mechanical and an electrical connection is required between the housing and the strap.

The smart watch 100 comprises a housing 101 that protects the electronic components (not shown) of the smart watch from ambient influences such as, for
20 example, dirt or water. The smart watch 100 comprises a display 102 on the upper side and control elements 104A and 104B on a long side 103 of the housing 101.

According to the present embodiment, the strap can be composed of two distinct pieces, one end of each piece being connected to the housing, the remaining ends being connected through a connecting mechanism such as a buckle, or can
25 be composed of one piece comprising an elastic or extendable section allowing a user to extend the perimeter of the strap when putting on the smart watch.

A strap 107 is connected to the housing 101 on the short sides 106A and 106B.

As a particularity, the strap 107 comprises a display 108 which serves, for example, for matching the appearance of the smart watch to the taste of the user or for indicating, in rapidly recognisable manner, to the user additional information through certain colours without the user having to read alphanumerical information on the display 102. The display 108 is designed, for example, as an electrochromic display. However, the invention is not limited to a certain type of display as long as the display 108 is well-suited for attachment on a more or less flexible strap 107. In particular, displays for alphanumerical display of information on the strap 107 can be used just as well.

Figure 2A shows the smart watch 100 of Figure 1 in a schematic top view from above, whereby only one half of the strap 107 is shown in Figure 2A. In the exemplary embodiment shown in Figure 2A, a single display 108 extends across the entire surface of the one half of strap 107.

Figure 2B schematically shows a further exemplary embodiment of the smart watch 100 that differs from the exemplary embodiment shown in Figure 2A in that multiple displays 108A to 108C are attached on the upper side of the one half of the strap 107.

The displays 108, 108A to 108C are controlled electrically. For this purpose, electrical cables are provided in the strap 107 that are connected to the electronic components on the inside of the housing 101 by means of an electrical connection, such as shall be explained in more detail in the following.

Figure 3A shows a detail of an exemplary embodiment of the smart watch 100 in a partially elevated view. The elevated view in Figure 3A shows electrical connecting cables 301A, 301B that extend from the display 108 to plugs 302A and/or 302B. The electrical connecting cables 301A, 301B are well-suited for conducting both electrical signals and electrical currents for the energy supply of electronic components. The plugs 302A and 302B establish an electrical connection to the electronic components on the inside of the housing 101. Dashed lines at 303A and 303B indicate regions, in which further plugs can be arranged, if needed. Moreover, a latching mechanism 304 latching the strap 107 to the housing 101 is shown. The surface of the strap 107 facing the viewer in

Fig. 3A shall be called the main surface 305 of the strap 107 hereinafter. Fins 306, 307 are arranged in the region of the strap 107 that is to be mechanically connected to the housing 101; the function of the fins will be explained in more detail in the context of Figure 3B.

5 Figure 3B shows a cross-section of the exemplary embodiment of Figure 3A along the line B-B shown in Figure 3A. It is evident from Figure 3B that the watch strap 107 is placed against the housing 101 of the smart watch 100 in the arrow direction 311, whereby the latching mechanism 304 snaps in and the watch strap is mechanically fixed to the housing 101. The latching mechanism 304 prevents
10 the watch strap 107 from detaching from the housing 101 when there are no tensile forces acting. In this context, the previously mentioned fins 306 and 307 engage corresponding recesses 308 and 309 in the housing 101. A form-fitting connection that is additionally secured is formed between the watch strap 107 in the housing 101 by this means. The magnified detail in Figure 3B shows the fin
15 306 engaging recess 308. Moreover, the magnification shows that the side surfaces 312A, 312B of the fin 306 are inclined and form an angle ϕ and/or ϕ' with respect to the main surface 305 that is different from a right angle.

The tensile force is generated e.g. by a proper adjustment of the strap length to the body part to which it is to be attached, by elastic elements in the strap which
20 tighten the strap appropriately or by other means.

The side surfaces 312A, 312B of the fin 306 are inclined appropriately such that they form thrust surfaces for correspondingly inclined side surfaces of the recess. Since the side surface 312A has an angle of inclination of $\phi < 90^\circ$, a tensile force acting between the strap 107 and the housing 101 in the direction of the arrow
25 313 shown in Figure 3B also has a force component 314 (Figure 3C) that pushes the fin 306 and/or the strap 107 toward the housing 101 and/or onto the housing, in the manner of two interlocked fish scales. This correlation is illustrated in Figure 3C by a normal force decomposition. The force component 315 is received by the side surface of the recesses 308 that are opposite to the side surface 312A. The
30 same applies to the effect of the fin 307.

With the height of the fin 306 being 1 mm and at an angle of $\phi=75^\circ$, the resulting sinus is 0.25. This means that a tensile force of 10 Newton in the strap leads to the generation of a retention force 314 of 2.5 Newton towards the inside. Simultaneously, an angle of $\phi=75^\circ$ leads to a displacement of 0.15 mm of the strap 107 with respect to the housing 101 while it is being placed against it. This displacement must be taken into account in the dimensions of contact sockets and contact and, as is explained below.

It is at the discretion of a person skilled in the art and it depends on the requirements on the electronic device whether a single fin or multiple fins are provided in a certain exemplary embodiment. Alternatively, the person skilled in the art can exchange the arrangement of fin and recess, i.e. the recess can be arranged on the strap and the fin can be arranged on the housing. Moreover, the person skilled in the art can combine the two alternatives, i.e. fin and recess are arranged to alternate on the strap and housing.

Moreover, there is some freedom of design in the detailed provision of the fins as long as the provision of a form-fitting connection between the strap 107 and the housing 101 is ensured. Figures 4A to 4D show design variants of the form-fitting connection between the strap 107 and the housing 101.

Figure 5A shows a magnified cross-section through the plug connector 302A. The flat contact pin 501 arranged on the strap 107 engages a flat contact socket 502 when the strap 107 is placed against the housing 101 appropriately such that the fins 306, 307 engage the recesses 308, 309. When the strap 107 is placed in the housing 101, the strap performs a small longitudinal motion due to the side surfaces of the fins in Figure 5A being inclined (towards the left in Figure 5A). To permit said longitudinal motion, all contact sockets 502 on the housing are wider than the contact pins 501 on strap 107. In the actual case shown in Figure 5A, the right edge of the contact pin 501 is flush with the right edge of the contact socket 502, whereas a gap remains between the left edges of the contact pin 501 and/or contact socket 502, when the left edges of the fins 306, 307 are flush with the left edges of the recesses 308, 309. In the example mentioned, with the height of the fins being 1 mm and an angle $\phi=75^\circ$, said gap is approximately 0.15 mm. When

the strap 107 is placed against the housing 101, the contact pin 501 moves from the right edge of the contact socket 502 towards the contact socket's left edge.

Figure 5B shows a cross-sectional view through the contact socket 502 along the line A-A in Figure 5A. As is evident from Figure 5B, the contact socket 502
5 comprises a springy groove 503 in order to establish good electrical contact to the contact pin 501. The contact socket 502 is connected to the electrical components on the inside of the housing 101 by an electrical conductor 504.

As an alternative to the cambered form of the contact socket shown in Figures 5A and 5B, the spring effect can be attained in another exemplary embodiment
10 by mounting the contact socket while it is in a pretensioned state. The contact socket 502 comprises one or two electrical contact surfaces, whereby at least one exerts the aforementioned spring effect on the contact pin 501. As an alternative to the embodiments described above, the spring effect can also be attained through a cambered contact pin 501.

15 Gaskets 504 are provided on the strap 107 and protect the electrical contact region from dirt and moisture when the strap 107 is inserted into the housing 101 (Figure 5D).

Figure 5C shows a top view of the contact socket 502 without (left) and with contact pin 501 plugged in (right). Lastly, Figure 5D shows the situation, in which
20 the strap 107 is inserted into the housing 101.

Figure 6 shows another alternative embodiment of the electrical contacts between strap 107 and housing 11. In this embodiment, the contact pins 501 are provided to be round and are pushed successively against springy contacts in the contact sockets due to the thrust surfaces between the fins 306, 307 and
25 recesses 308, 309 being inclined, as is evident from Figure 6.

The use of a pluggable element such as a pin further secures the connection between strap and housing.

Figures 7A to 7C show further alternative embodiments of the electric contacts, in which the electrical contact is provided by a compressive force between the

pairs of contacts. In the variants shown in Figures 7A to 7C, the installation height decreases successively starting from a short pin 701 with socket 702 (Figure 7A) via two contacts 703 that are provided in the form of an elevation (Figure 7B) to two contact surfaces 703, 704, whereby only contact surface 703 is provided as
5 an elevation (Figure 7C).

In yet another variant, the gasket 504 is used as a contact. The gasket 504 is produced, in alternating manner, from conductive elastic material and insulating elastic material. The conductive sites thus also serve as contacts. However, a contact of this type requires a reliable retention force over the entire length of the
10 gasket. Electrically conductive rubber materials that are suitable for this purpose are commercially available and are used mainly in the area of EMC and in keys. They make sense when the signal currents are small. The shape of the contacts integrated into the gasket 504 must be appropriate for unambiguous and precise mounting such that the conductive sites are placed on each other correctly.

15 In the figures of the drawing, the contacts have been shown magnified on purpose such the workflows of inserting, guiding through fins and recess and the latching of the latching mechanism take place independent of each other and consecutively for improved illustration. In one practical embodiment, fins with a height of 0.5 mm and contacts with a length of 0.5 mm have proven to be
20 expedient.

Figure 8 shows the latching mechanism 304 in more detail. The latching mechanism 304 comprises a spring tongue 801 with a hook 802. The spring tongue 801 is firmly connected to the strap 107. Different types of attachment, such as welding, gluing or the like, are conceivable for this purpose. Moreover,
25 the spring tongue 801 and the strap 107 can be produced in the form of a single part. In this context, the spring effect is generated by the spring tongue 801 as such or in the connecting site between the spring tongue 801 and strap 107. The housing 101 has an undercut recess 803 provided in it, which is engaged by the spring tongue 801 when the strap 107 is placed against the housing 101. The
30 recesses 803 comprise a latching surface 804. In the fully inserted stage shown in Figure 8C, the hook 802 of the spring tongue 801 reaches behind the latching

surface 804. When the spring tongue 801 is latched into the recess 803, it can be detached again only by inserting a tool 806. In this context, the tool 806 pushes the spring tongue 801 away from the latching surface 804 against the acting spring force such that the spring tongue 801 gets released and the strap 107 can
5 be taken off the housing.

It is insignificant for the invention at which site the latching mechanism 304 is provided. Moreover, more than a single latching mechanism 304 can be provided just as well. A person skilled in the art is aware and will select for the individual application further latching mechanisms, including those that can be released
10 without a tool or those that are fixed by means of a rotary or sliding motion.

Finally, an exemplary embodiment of the invention can also have an electrical energy store accommodated in the strap, for example one or more battery or batteries. In particular, the energy store can be provided in the form of a flexible battery. The one or more battery or batteries are primary or secondary batteries.
15 The batteries are connected, for example, to the electronic components in the housing 101 by means of the electrical connecting cables 301A, 301B.

List of reference numbers

100 Smart watch	313 Tensile force
101 Housing	314 Force
102 Display	315 Force
101 Long side of the housing	501 Contact pin
104A, 104B Control elements	502 Contact socket
107 Strap	503 Groove
108 Display	504 Gasket
108A to 108C Displays	701 Contact pin
301A, 301B Connecting cables	702 Contact socket
302A, 302B Plug	703 Elevated contact surface
304 Latching mechanism	704 Contact surface
305 Main surface	801 Spring tongue
306, 307 Fin	802 Hook
308, 309 Recesses	803 Recess
311 Arrow	804 Covered surface
312A, 312B Side surfaces of the fin	806 Tool

CLAIMS

1. Portable electronic device (100) having a housing (101) and a strap (107) that is mechanically attached to the housing, whereby the housing (101) encompasses electronic components; whereby
5 the strap bears further electronic components; and whereby an electrically conductive connection exists between the housing and the strap; characterised in that the strap is mechanically attached on at least one of its ends to the housing by
10 means of a form-fitting connection, whereby the connection is oriented appropriately such that a tensile force acting on the strap in the strap's longitudinal direction generates a force component (314) that aims to push the strap onto the housing.
- 15 2. Device according to claim 1, characterised in that the mechanical connection is secured through a latching mechanism (304).
3. Device according to claim 1, characterised in that the mechanical connection is secured through a rotary or sliding mechanism.
20
4. Device according to claim 1, characterised in that the strap comprises a projecting mechanical element (306, 307) that engages a corresponding recess (308, 309) in the housing.
- 25 5. Device according to claim 1, characterised in that a projecting mechanical element (306, 307) is provided on the housing and engages a corresponding recess (308, 309) in the strap.
6. Device according to claim 4 or 5, characterised in that the projecting
30 mechanical element is designed in the shape of a fin (306, 307) or a peg.
7. Device according to any one or more of the preceding claims, characterised in that the projecting mechanical element (306, 307) and the recess

(308, 309) each comprise thrust surfaces that touch against each other and are designed appropriately such that a tensile force acting on the strap in the strap's longitudinal direction generates a force component (314) that aims to push the strap onto the housing.

5

8. Device according to claim 7, characterised in that the projecting mechanical element (306, 307) is a fin whose one side surface (312A) and a main surface (305) of the strap (107) form an angle smaller than 90° , in that the side surface (312A) touches against the recess such that a tensile force acting on the strap in the strap's longitudinal direction generates a force component (314) that aims to push the strap on to the housing.

9. Device according to claim 1, characterised in that the strap comprises an electrical plug contact with a contact pin (501) that engages a contact socket (502) that comprises at least one contact spring in order to establish the electrical connection between the strap and the housing.

10. Device according to claim 9, characterised in that the contact pin (501) is pushed against the at least one contact spring by the action of the tensile force acting on the strap in the strap's longitudinal direction.

20

11. Device according to claim 2, characterised in that the latching mechanism (304) is designed to be detachable for disconnection of the mechanical connection between the strap and housing.

12. Device according to to any one of the claims 1 to 8, characterised in that a gasket (504), sections of which are conductive, is arranged between the strap (107) and the housing (101), whereby the conductive sections of the gasket form contact surfaces for the electrical connection.

13. Device according to claim 12, characterised in that gaskets (504) are arranged between the strap and the housing (101) on surfaces that are pushed against each other by the action of a tensile force (314) acting on the strap in the strap's longitudinal direction.

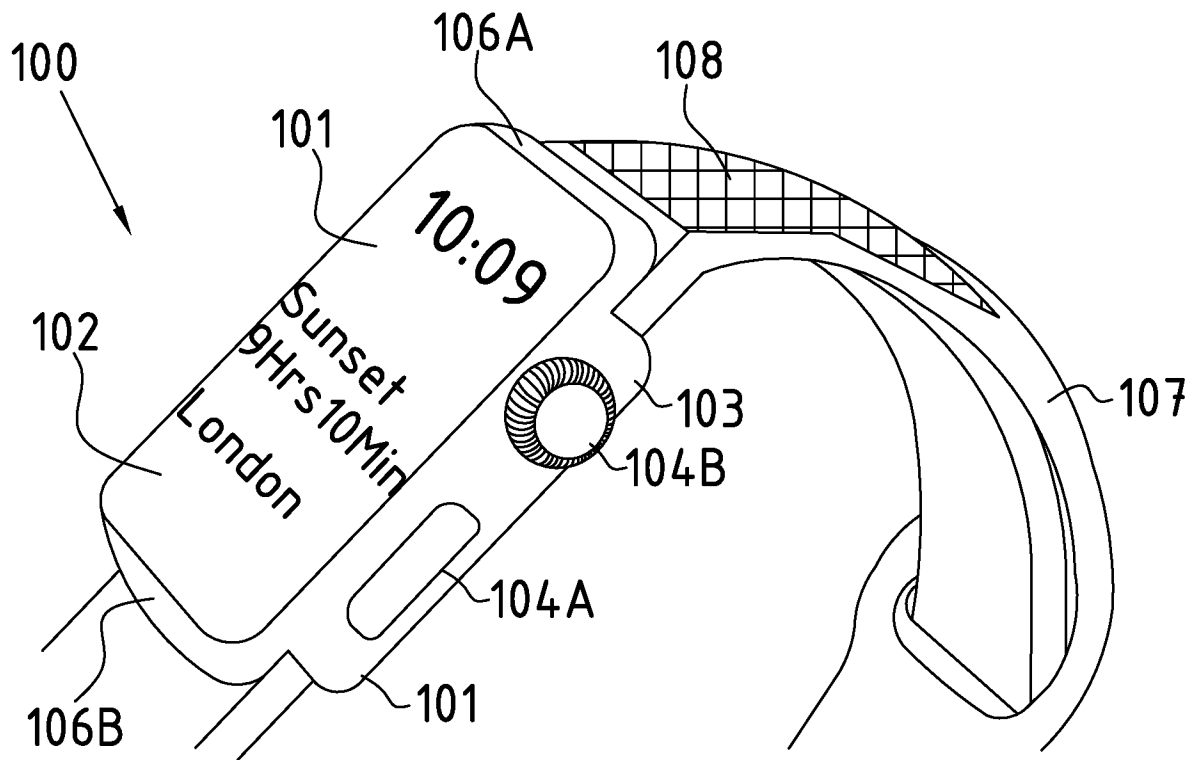


Fig.1

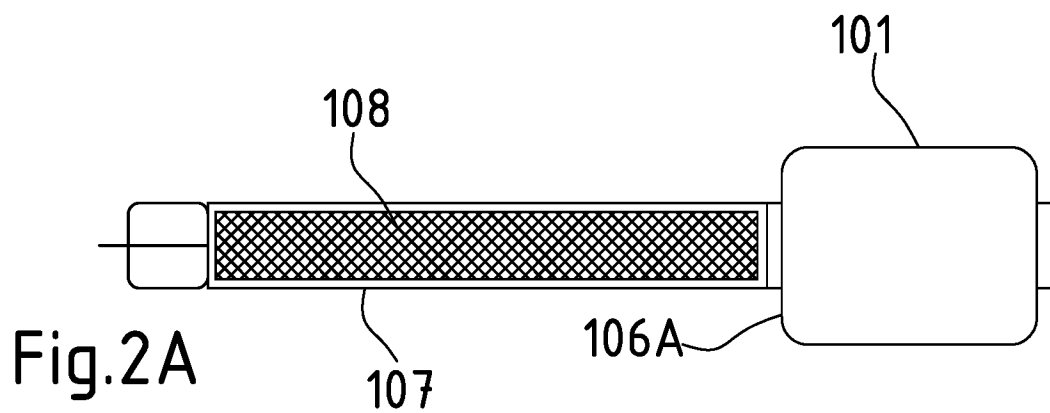


Fig.2A

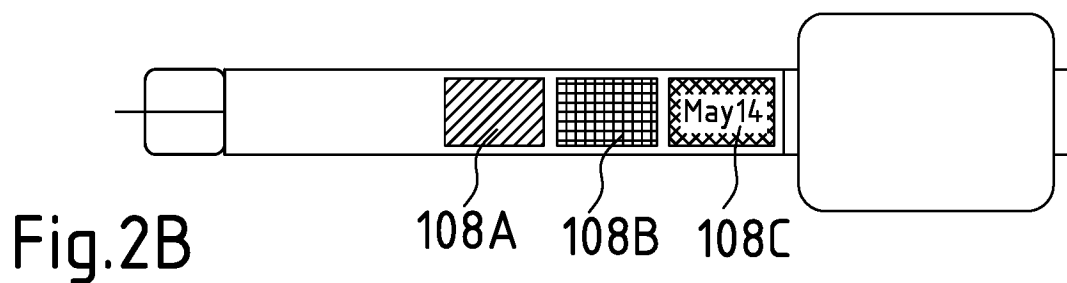


Fig.2B

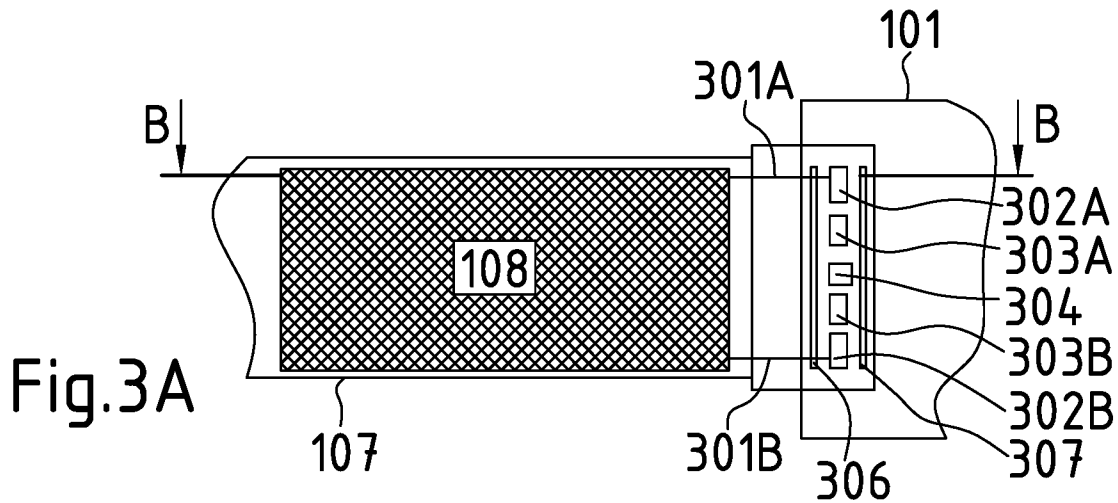


Fig.3A

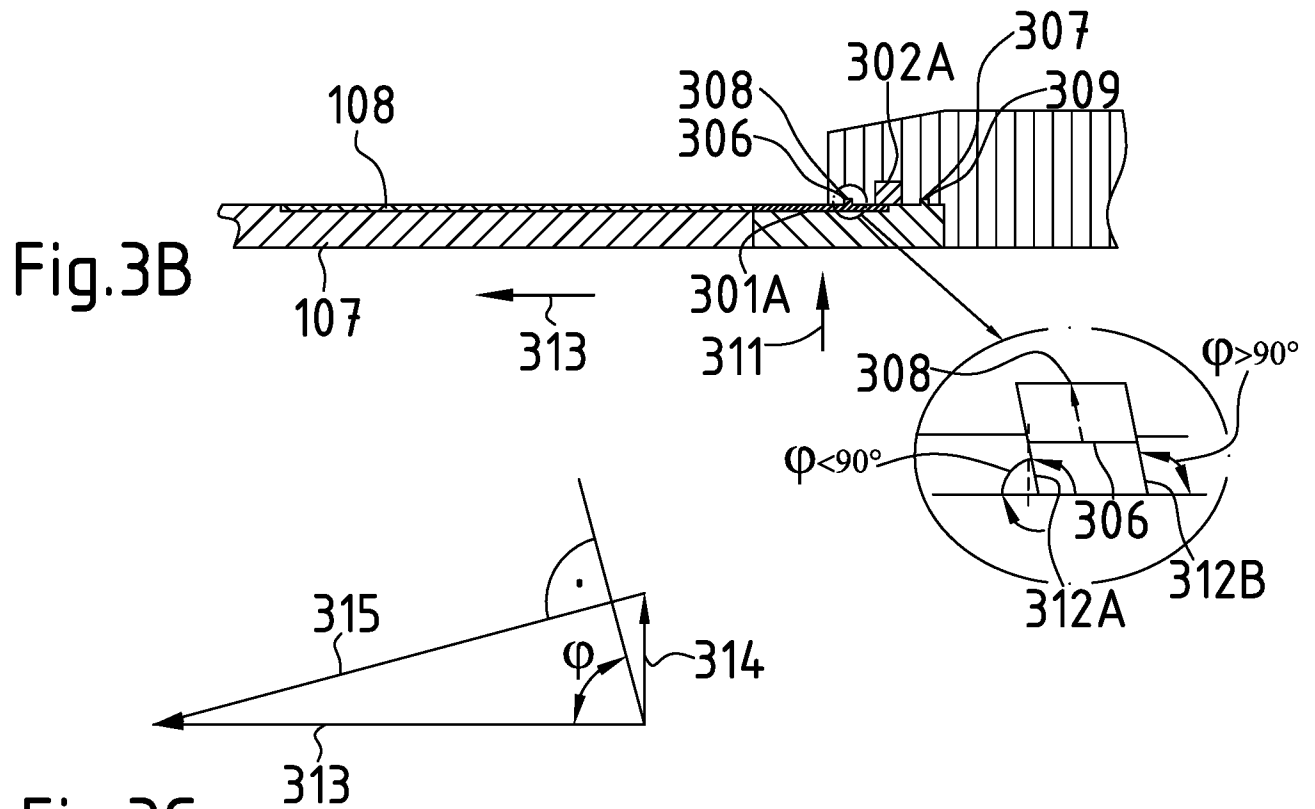


Fig.3C

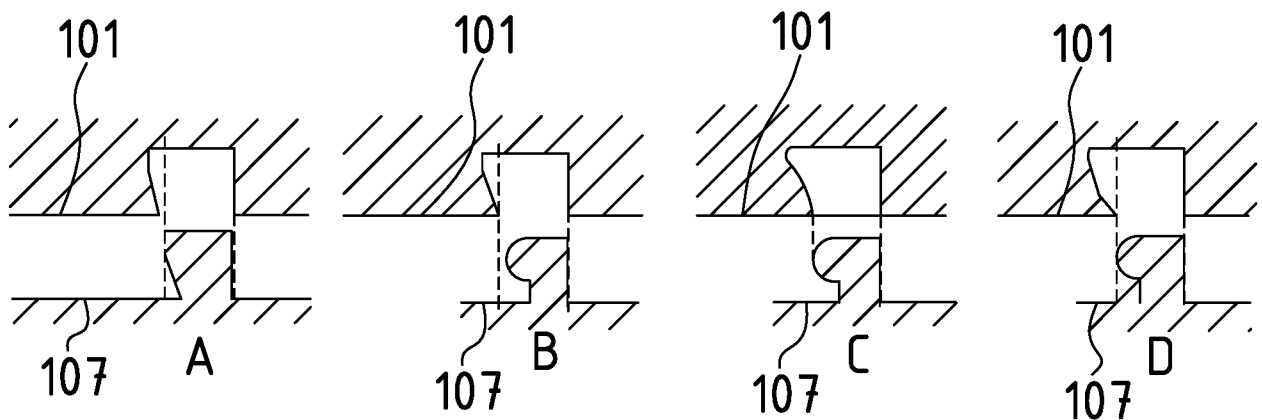


Fig.4

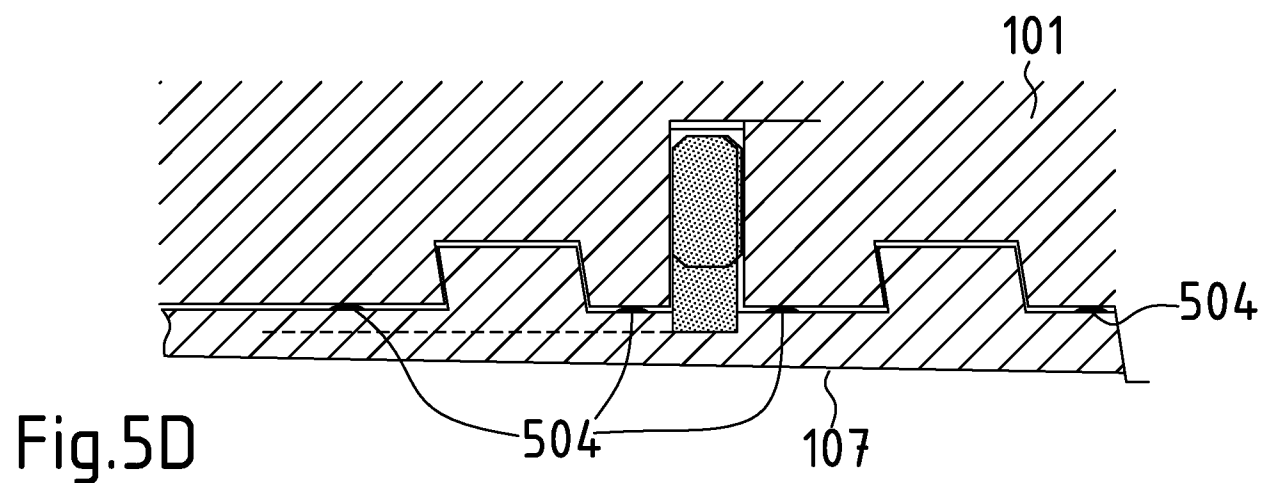
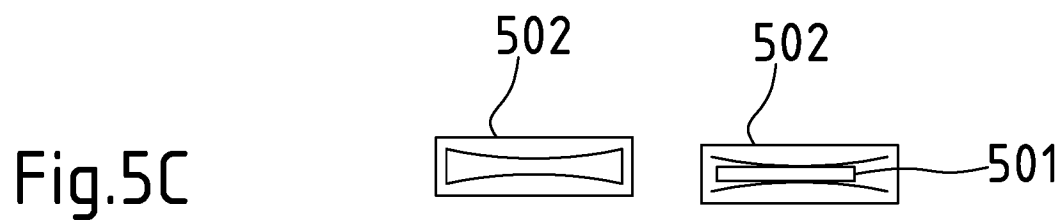
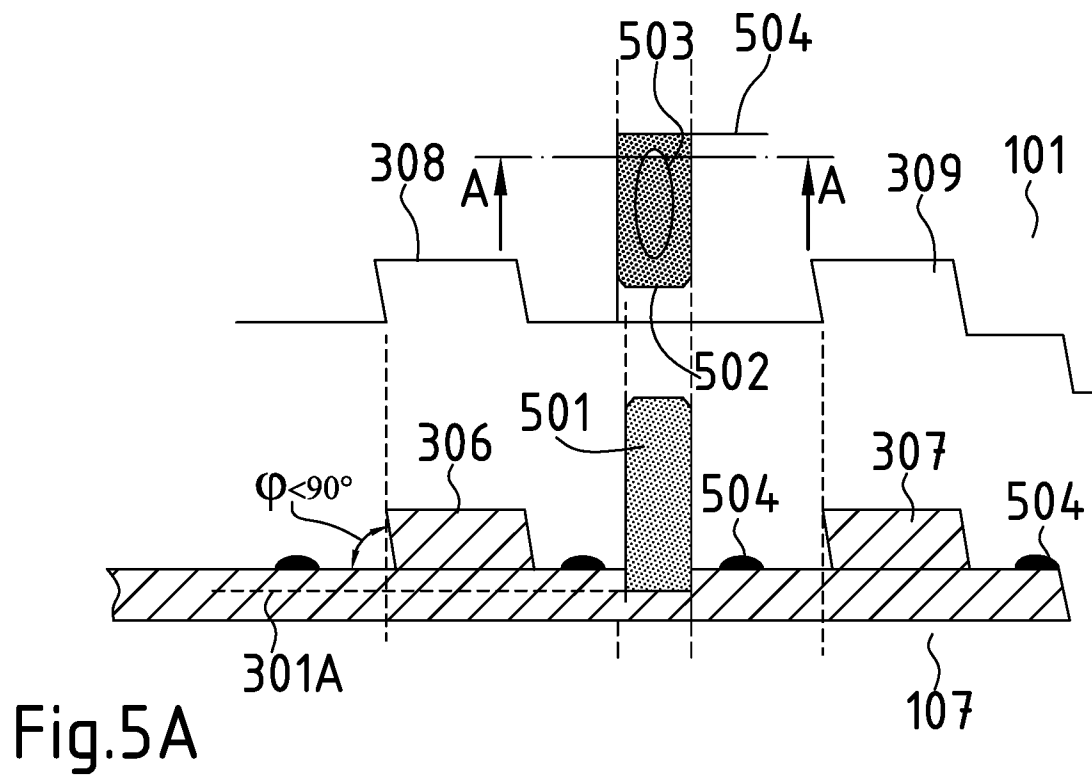
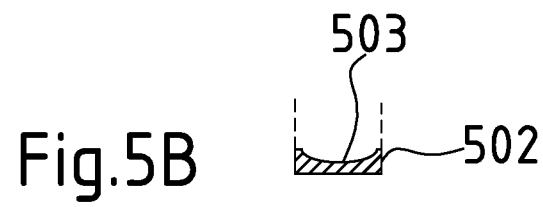


Fig.6

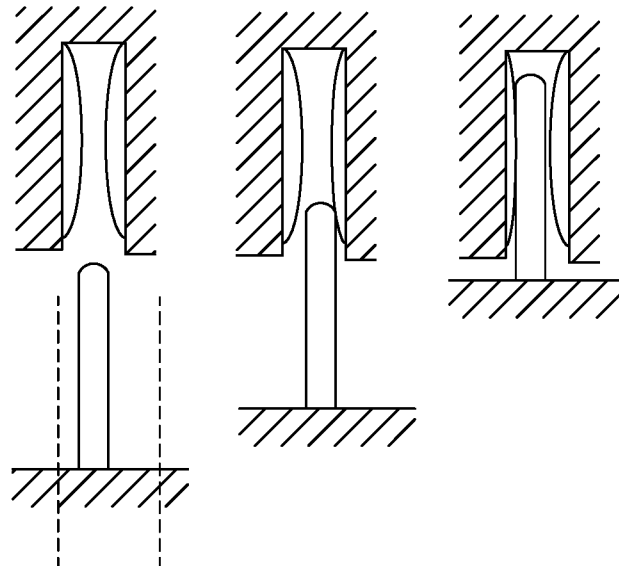
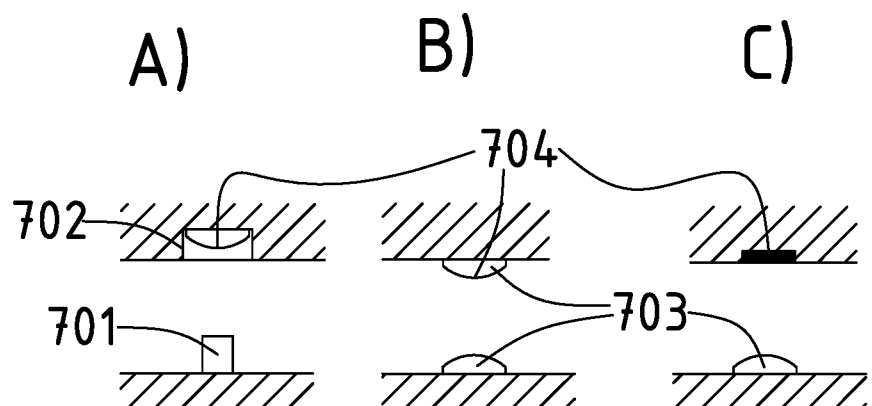
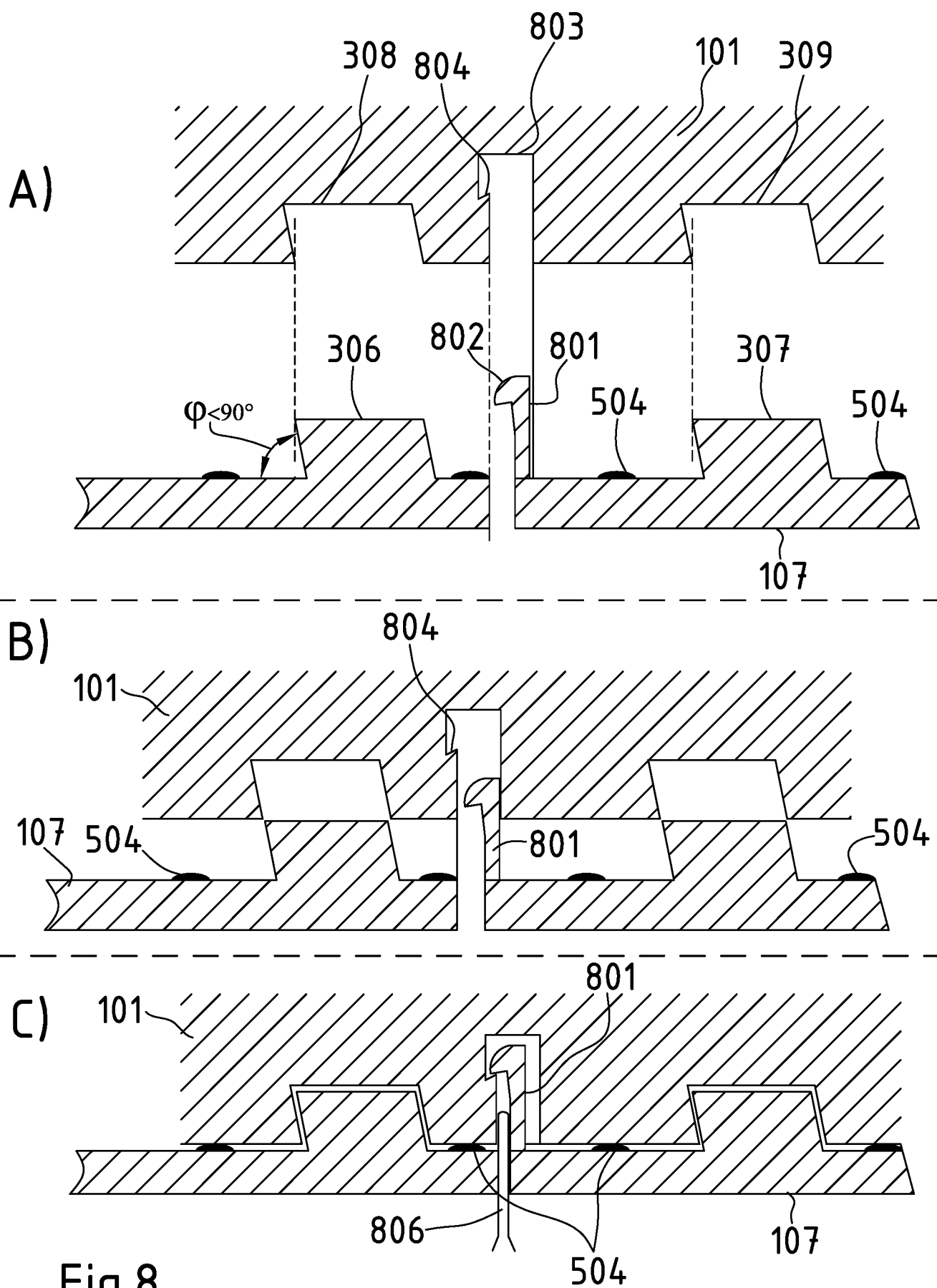


Fig.7





INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2016/077160

A. CLASSIFICATION OF SUBJECT MATTER

INV. A44C5/14

ADD.

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)

A44C

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/097517 A1 (STEPHENSON JEFFREY JAMES [US]) 9 April 2015 (2015-04-09) paragraph [0016] - paragraph [0029]; figures 1,2,3A,3B -----	1-13
X	US 2006/058695 A1 (CHEN TONG-PIE [TW]) 16 March 2006 (2006-03-16) paragraph [0011] - paragraph [0015]; figures 1-4 -----	1-13
X	US 2003/116596 A1 (TERASAWA DAI [JP]) 26 June 2003 (2003-06-26) paragraph [0006] - paragraph [0027]; figure 1A -----	1-13
A	CN 204 191 756 U (SHENZHEN BUYDEEM CRATAL TECHNOLOGY CO LTD) 11 March 2015 (2015-03-11) the whole document -----	1-13



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

28 February 2017

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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