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(54) **EXPLOSION-PROOF PUSH-BUTTON PANEL FOR REMOTE ELECTRIC CONTROL VIA CABLE**

(57) An explosion-proof push-button panel for remote electric control via cable is described, which comprises:

- a hollow base (1) and a cover (2);
- a board (6), internal to said hollow base (1);
- one or more electric switches having non-explosion-proof characteristics (3), secured to said board inside said hollow base (1);
- one or more movable cylinders (4) for each one of said electric switches (3) inside said hollow base (1), said movable cylinders (4) being adapted to control the opening and closing of corresponding switches to which they are secured;
- one or more pistons (5) capable of sliding through corresponding holes (7) in said cover (2), said pistons being adapted to engage against corresponding cylinders (4) and to be actuated from the outside of the push-button panel for causing said cylinders to move;
- one or more elastic silicone bands (9) secured to the inner surface of the cover, in correspondence with said holes (7), so as to elastically adhere to the base of the piston (5) and ensure that the latter will elastically return into the idle position following actuation;
- said hollow base (1) and said cover (2) being adapted to form an operationally closed metal enclosure having explosion-proof characteristics.

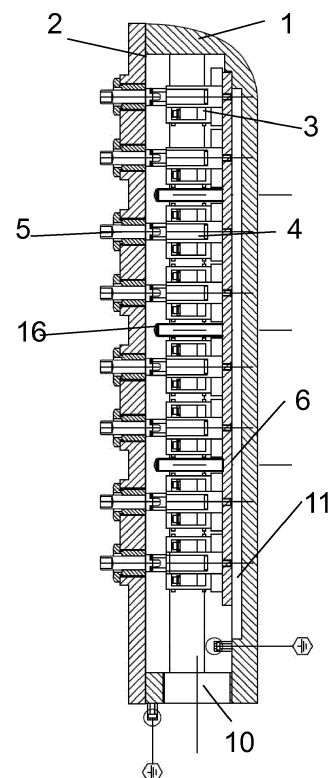


FIG. 1

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Description

Field of the invention

[0001] The present invention relates to an explosion-proof push-button panel for remote electric control via cable.

Background art

[0002] Electric apparatuses are commonly used in potentially explosive environments. An explosion may occur in the presence of potentially explosive atmosphere conditions.

[0003] A potentially explosive atmosphere may be composed of a mixture of air and inflammable substances in the form of gas, vapour, mist or dust, in which, after ignition, combustion propagates rapidly (by explosion) at atmospheric pressure.

[0004] Electric apparatuses must therefore be so designed as to avoid the risk of an explosion that might be generated by sparks or electric discharges caused, for example, by the switching of electric switches; therefore, they must have explosion-proof characteristics.

[0005] The push-button panels known in the art for remote electric control via cable, for use in a potentially explosive environment, comprise a number of electric switches, each one having explosion-proof characteristics and controllable from the outside, enclosed in an enclosure having non-explosion-proof characteristics.

[0006] However, such configurations are not optimal to ensure an adequate level of explosion-proof protection.

[0007] Furthermore, particular characteristics in terms of ergonomics, lightness, strength, compactness, ease of use, manoeuvrability, service life, ease of assembly and disassembly are also required.

Summary of the invention

[0008] It is therefore one object of the present invention to provide an explosion-proof push-button panel for remote electric control via cable, which can solve the above-mentioned problems.

[0009] The present invention relates to an explosion-proof push-button panel for remote electric control via cable, characterized in that it comprises:

- a hollow base and a cover;
- a board, internal to said hollow base;
- one or more electric switches having non-explosion-proof characteristics, secured to said board inside said hollow base;
- one or more movable cylinders, for each one of said electric switches, inside said hollow base, said movable cylinders being adapted to control the opening and closing of corresponding switches to which they are secured;

- one or more pistons capable of sliding through corresponding holes in said cover, said pistons being adapted to engage against corresponding cylinders and to be actuated from the outside of the push-button panel for causing said cylinders to move;
- one or more elastic silicone bands secured to the inner surface of the cover, in correspondence with said holes, so as to elastically adhere to the base of the piston and ensure that the latter will elastically return into the idle position following actuation;
- said hollow base and said cover being adapted to form an operationally closed metal enclosure having explosion-proof characteristics.

[0010] It is a particular object of the present invention to provide a push-button panel for remote electric control via cable in an explosion-proof environment as set out in detail in the claims, which are an integral part of the present description.

Brief description of the drawings

[0011] Further objects and advantages of the present invention will become apparent from the following detailed description of an example of embodiment thereof and from the annexed drawings, which are only supplied by way of non-limiting example, wherein:

Figure 1 shows a sectional side view of the push-button panel of the invention;

Figure 2 shows a sectional side view of the hollow base of the push-button panel;

Figure 3 is a sectional side view of the push-button panel with a part thereof magnified, showing some details of the switches;

Figure 4 is a top view of the two parts that make up the push-button panel, i.e. the hollow base and the cover;

Figure 5 shows a variant of the cover and board of the push-button panel, which includes two sets of electric switches;

Figure 6 shows one example of embodiment of the band;

Figure 7 shows one example of embodiment of a push-button covering ring;

Figure 8 shows three views of the cover, to which the bands can be applied;

Figure 9 shows some views of one variant of the hollow base and of the cover of the push-button panel.

[0012] In the drawings, the same reference numerals and letters identify the same items or components.

Detailed description

[0013] With reference to the drawings, the push-button panel comprises a hollow base 1 and a cover 2. In oper-

ation, the cover is closed directly onto the base by means of screws 15. It is not necessary to put any gaskets on the sealing edge; one may possibly apply some grease to effect a water-resistant closure in compliance with the IP66 standard.

[0014] The push-button panel comprises a number of electric switches 3, each one comprising a movable cylinder 4 adapted to control the opening and closing of the electric switch through a reciprocating vertical motion within the switch 3. The switches are advantageously of the non-explosion-proof type. The head of the cylinder 4 has a cavity 4'. The switches and the corresponding cylinders are internal to the hollow body, and hence internal to the push-button panel, when the latter is closed.

[0015] The cover 2 has a number of holes 7, through each one of which a piston 5 can slide, the head 5' of which protrudes past the outer edge of the cover and can thus be actuated from the outside. Conversely, the terminal part of the piston, which is inside the hollow body and hence inside the push-button panel when the latter is closed, has a protrusion 5" adapted to engage into the cavity 4' of a corresponding cylinder 4, so as to either stop or allow the flow of current towards the switch. Therefore, the cylinders and the pistons are in corresponding positions in the push-button panel, when the latter is closed.

[0016] In the holes 7, through which the pistons 5 can slide, bushings 13 are provided for supporting the pistons. The bushings have a hollow T-shape. In the cavity, the corresponding piston can slide. The size of the cavity is such as to minimize the width difference with respect to the piston, with controlled tolerance. The bushings are preferably screwed into the corresponding holes of the cover, so that the wider upper portion of the bushing will adhere to the outer part of the cover.

[0017] The switches 3 are secured onto a board 6, to which the electric wires connected to the switch are connected to ensure the flow of current.

[0018] The piston 5 must be able to elastically engage, in a retractable manner, from a non-actuation position, e.g. the retracted position, proximal to the outside of the push-button panel, to an actuation position, e.g. a position in which it protrudes more into the push-button panel. In order to ensure the elastic movement of the cylinder, an elastic silicone band 9 is secured to the inner surface of the cover in correspondence with the hole through which the piston can slide (one band per piston), so as to elastically adhere to the piston base 5". The pressure exerted by the piston from the outside causes the band to elastically extend, and when the piston is released the band will return into the idle position, resulting in the piston also returning into the idle position. Advantageously, each piston is fitted with a corresponding band.

[0019] Silicone is a high-performance, long-lasting elastic material which is not subject to modification of its elastic properties or to deformation, and which can resist to a wide range of temperatures, from - 60 to + 180°, thus being able to ensure an operating temperature range of

the push-button panel from - 40° to + 60°. Its characteristics, therefore, provide an improvement over the known use of a spring between the piston and the cylinder. In fact, the spring might come out of position or be lost while opening or closing the cover during assembly or repair work, because it lies unconstrained in a recess of the cylinder. Moreover, the duration and elasticity characteristics of the spring can easily deteriorate over time. The silicone band can be obtained from a silicone sheet having a thickness of, for example, 1 mm.

[0020] The base has a lateral hole 10 that houses a sealing ring (not shown in the drawings) of an electric wire bundle (not shown in the drawings) forming an appropriately insulated electric cable penetrating into the base, so that the various electric wires, also appropriately insulated, can be connected to the respective switches. The opposite end of the electric cable, which has a suitable length, is connected to the apparatus to be controlled.

[0021] The board 6 is fastened to the bottom of the base 1 by means of long screws 16, so that it can be easily inserted, lifted or removed. The length of said screws is such that they protrude past the top edge of the switches.

[0022] The base 1 has a cavity 11 under the board 6, so that it can house an anti-condensate resistor (also known as heater), i.e. a heating resistor (not shown in the drawings) to which power is supplied by electric wires of the bundle in order to keep the entire push-button panel at a controlled temperature, e.g. for better operator comfort in a cold outside environment. It is also useful to prevent freezing or condensate formation inside the push-button panel, which might even become filled with water, e.g. due to a wide temperature range (day/night).

[0023] The hollow base and the cover are advantageously made from die-cast aluminium, whereas the piston is made of 316 stainless steel (marine-grade steel), and the cylinder and the bushing are made of brass. Any other rigid metallic material can nevertheless be used.

[0024] Advantageously, the hollow base has a rounded outline 12 for better and more comfortable handling and gripping.

[0025] External coverings 14 for the switches are also provided, e.g. made of plastic material, which are applied, e.g. by means of screws, onto the outer surface of the cover.

[0026] The length of the cover, of the base and of the board may be such as to allow accommodating one or two sets of electric switches.

[0027] The above-described non-limiting example of embodiment may be subject to variations without departing from the protection scope of the present invention, including all equivalent designs known to a man skilled in the art.

[0028] For example, one variant (Figure 9) includes a so-called lamination joint 20, i.e. a perpendicular extension on the perimetric inner edge of the cover 2 that fits into a corresponding recess 21 on the perimetric inner

edge of the hollow base 1, for the purpose of preventing flames from coming out in the event of an explosion, thus improving the explosion-proof characteristics of the push-button panel.

[0029] The elements and features shown in the various preferred embodiments may be combined together without however departing from the protection scope of the present invention.

[0030] The advantages deriving from the application of the present invention are apparent.

[0031] Common switches can be used, since they are completely protected by the explosion-proof enclosure.

[0032] Conversely, prior-art push-button panels make use of non-explosion-proof enclosures and explosion-proof switches.

[0033] This provides a higher level of protection, thus covering protection classes so far left uncovered, in compliance with current regulations for potentially explosive areas such as the ATEX, IECEx and UL standards. In particular, for the ATEX standard: Ex II 2G Ex d IIC T6 Gb; Ex II 2D Ex tb IIIC T85°C Db IP6X; Tamb: -20°C;+60°C. For the IECEx standard: Ex d IIC T6 Gb; Ex tb IIIC T90°C Db IP6X; Tamb: -20°C;+60°C. For the ULus standard: Class I Division 1 Group A, B, C&D T6; Tamb: - 25°C;+60°C. For the cUL standard: Class I Division 1 Group A, B, C&D T6; Tamb: - 25°C;+60°C.

[0034] The explosion-proof characteristic is thus transferred from the switch to the enclosure.

[0035] From the above description, those skilled in the art will be able to produce the object of the invention without introducing any further construction details.

Claims

1. Explosion-proof push-button panel for remote electric control via cable, **characterized in that** it comprises:
 - a hollow base (1) and a cover (2);
 - a board (6), internal to said hollow base (1);
 - one or more electric switches having non-explosion-proof characteristics (3), secured to said board inside said hollow base (1);
 - one or more movable cylinders (4), for each one of said electric switches (3), inside said hollow base (1), said movable cylinders (4) being adapted to control the opening and closing of corresponding switches to which they are secured;
 - one or more pistons (5) capable of sliding through corresponding holes (7) in said cover (2), said pistons being adapted to engage against corresponding cylinders (4) and to be actuated from the outside of the push-button panel, when the latter is closed, for causing said cylinders to move;
 - one or more elastic silicone bands (9) secured

to the inner surface of the cover, in correspondence with said holes (7), so as to elastically adhere to the base of said one or more pistons (5) and ensure that the latter will elastically return into the idle position following actuation;

- said hollow base (1) and said cover (2) being adapted to form an operationally closed metal enclosure having explosion-proof characteristics.

2. Explosion-proof push-button panel for remote electric control via cable according to claim 1, comprising one or more bushings (13), one for each of said holes (7), acting as supports for said pistons, said bushings having a hollow T-shape, within which a corresponding piston can slide.
3. Explosion-proof push-button panel for remote electric control via cable according to claim 1, wherein said base (1) has a cavity (11) under said board (6) for housing at least one anti-condensate resistor.
4. Explosion-proof push-button panel for remote electric control via cable according to claim 1, wherein said board (6) is fastened by means of long screws (16) to the bottom of the base (1), so that it can be easily inserted, lifted or removed, the length of said screws being such that they protrude past the top edge of the switches.
5. Explosion-proof push-button panel for remote electric control via cable according to claim 1, wherein the base (1) comprises a lateral hole (10) that houses a sealing ring of an electric cable penetrating into the base, so that the electric wires of the cable can be connected to the respective electric switches.
6. Explosion-proof push-button panel for remote electric control via cable according to claim 1, comprising external coverings (14) for said one or more switches (7), applied to the outer surface of said cover (2).
7. Explosion-proof push-button panel for remote electric control via cable according to claim 1, wherein said base (1) has a rounded outline (12).
8. Explosion-proof push-button panel for remote electric control via cable according to claim 2, wherein the hollow base, the cover, the pistons, the bushings are made of metallic material.
9. Explosion-proof push-button panel for remote electric control via cable according to claim 1, wherein said cover comprises, on its perimetric inner edge, a lamination joint (20) adapted to fit into a corresponding recess (21) on the perimetric inner edge of said hollow base (1).

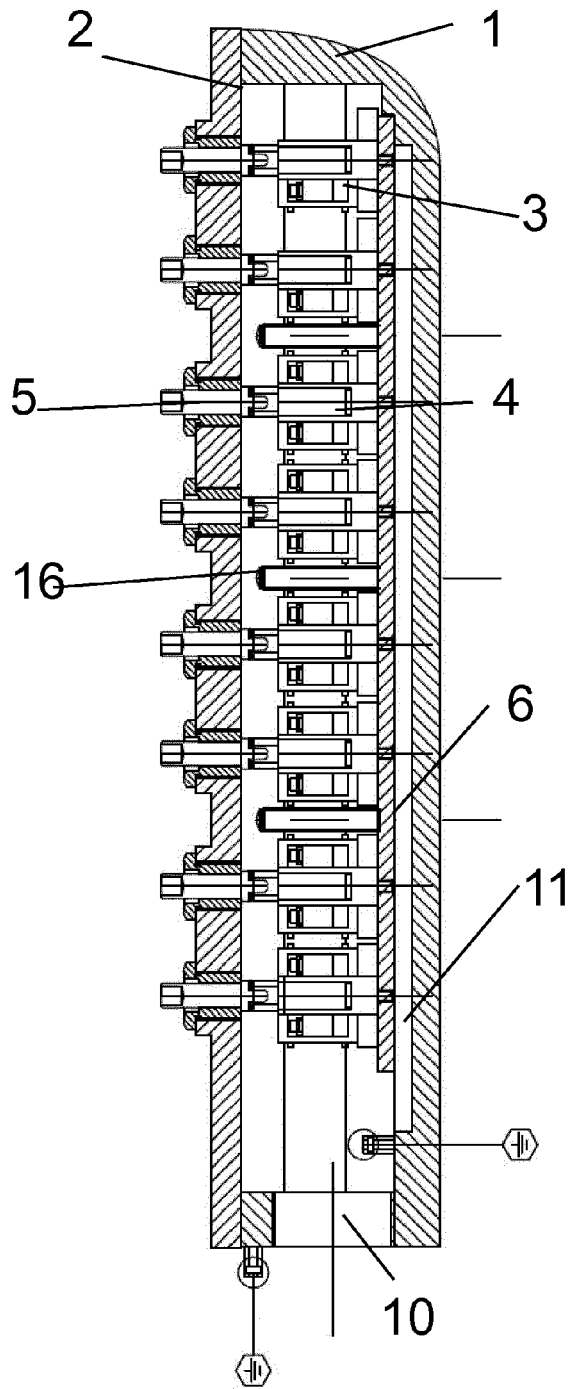


FIG. 1

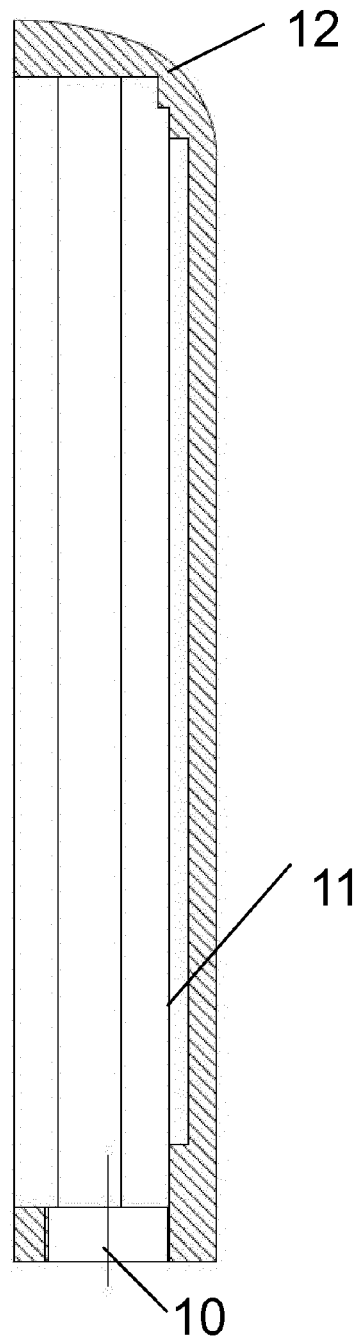


FIG. 2

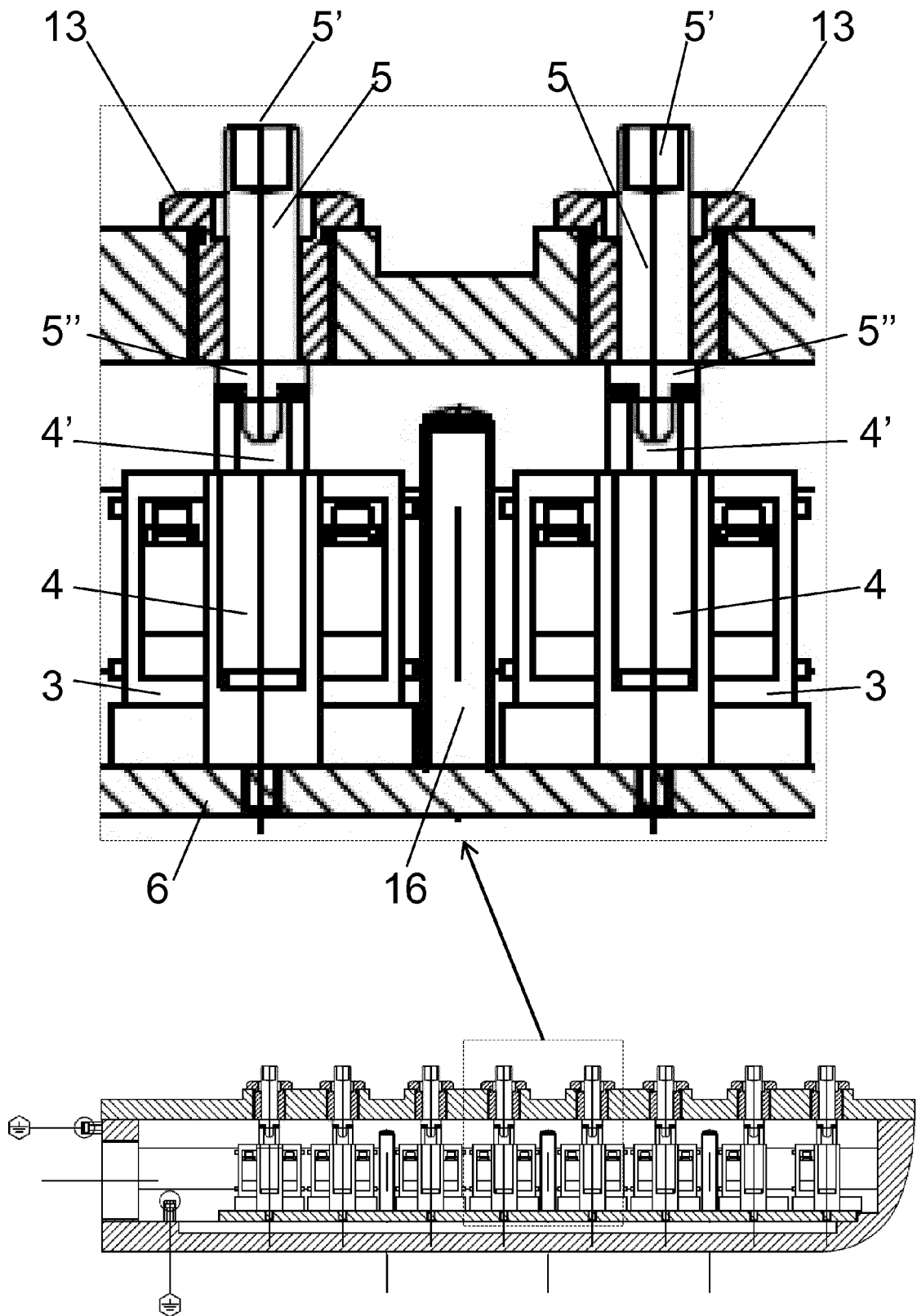


FIG. 3

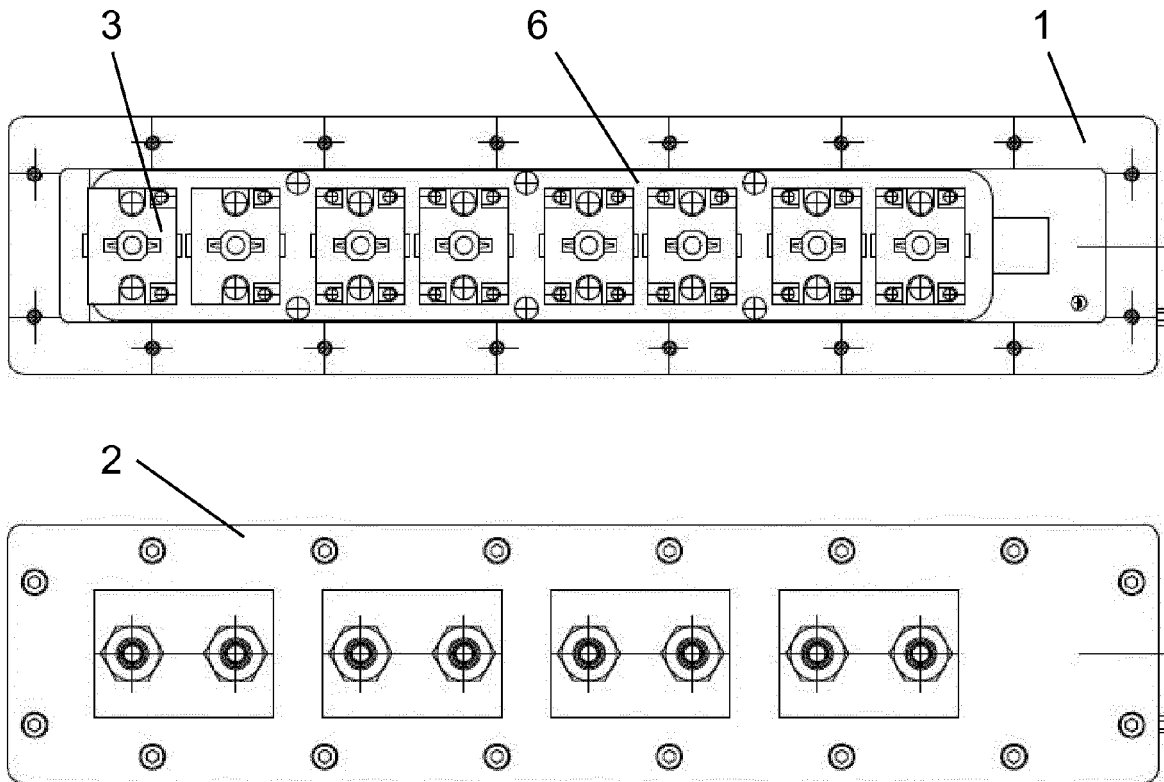


FIG. 4

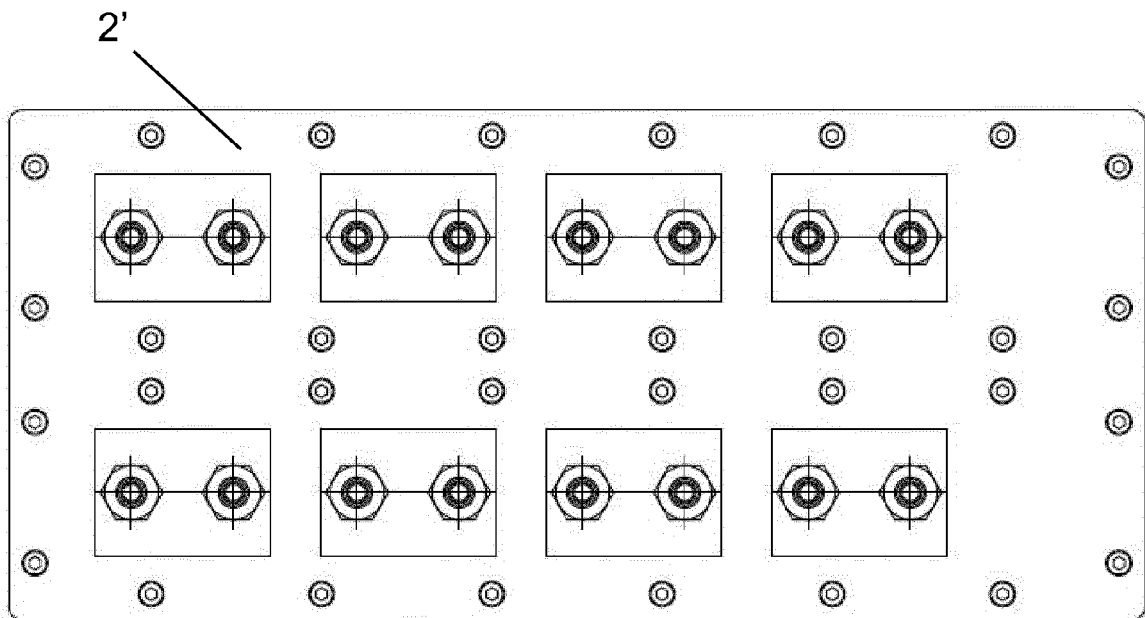


FIG. 5

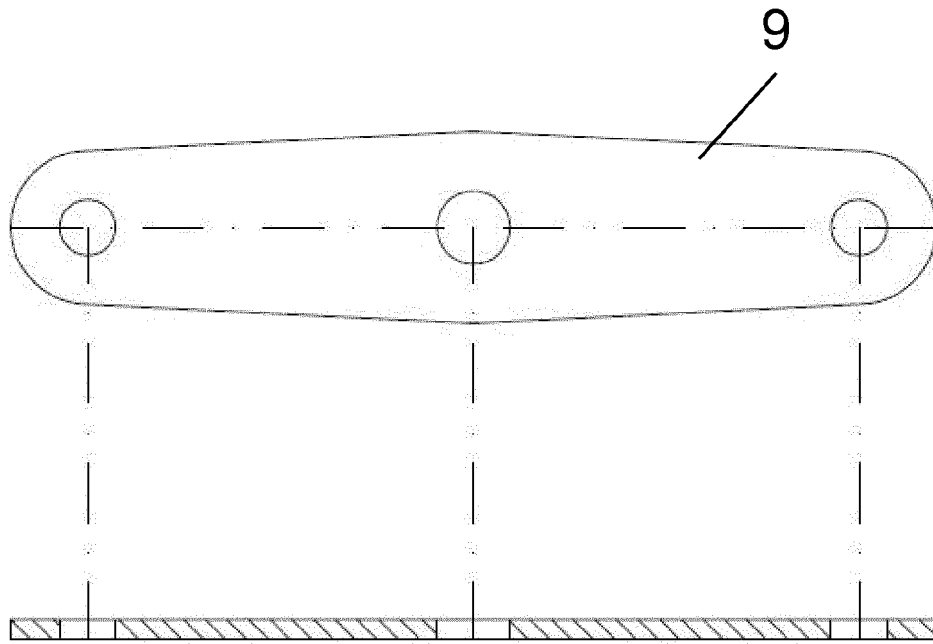


FIG. 6

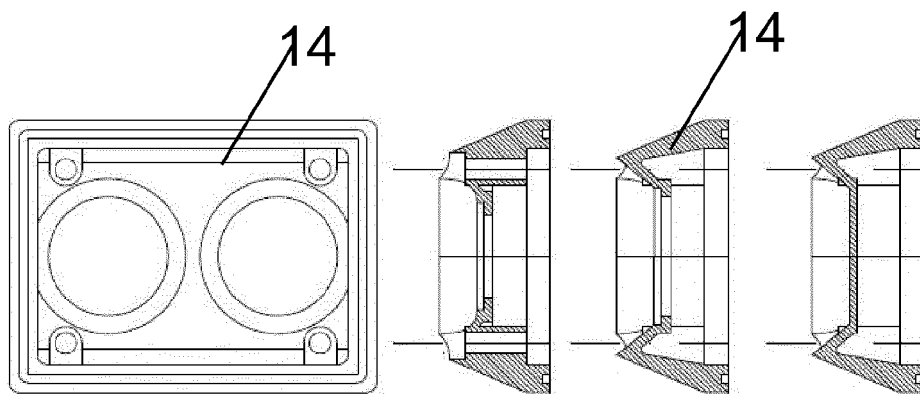


FIG. 7

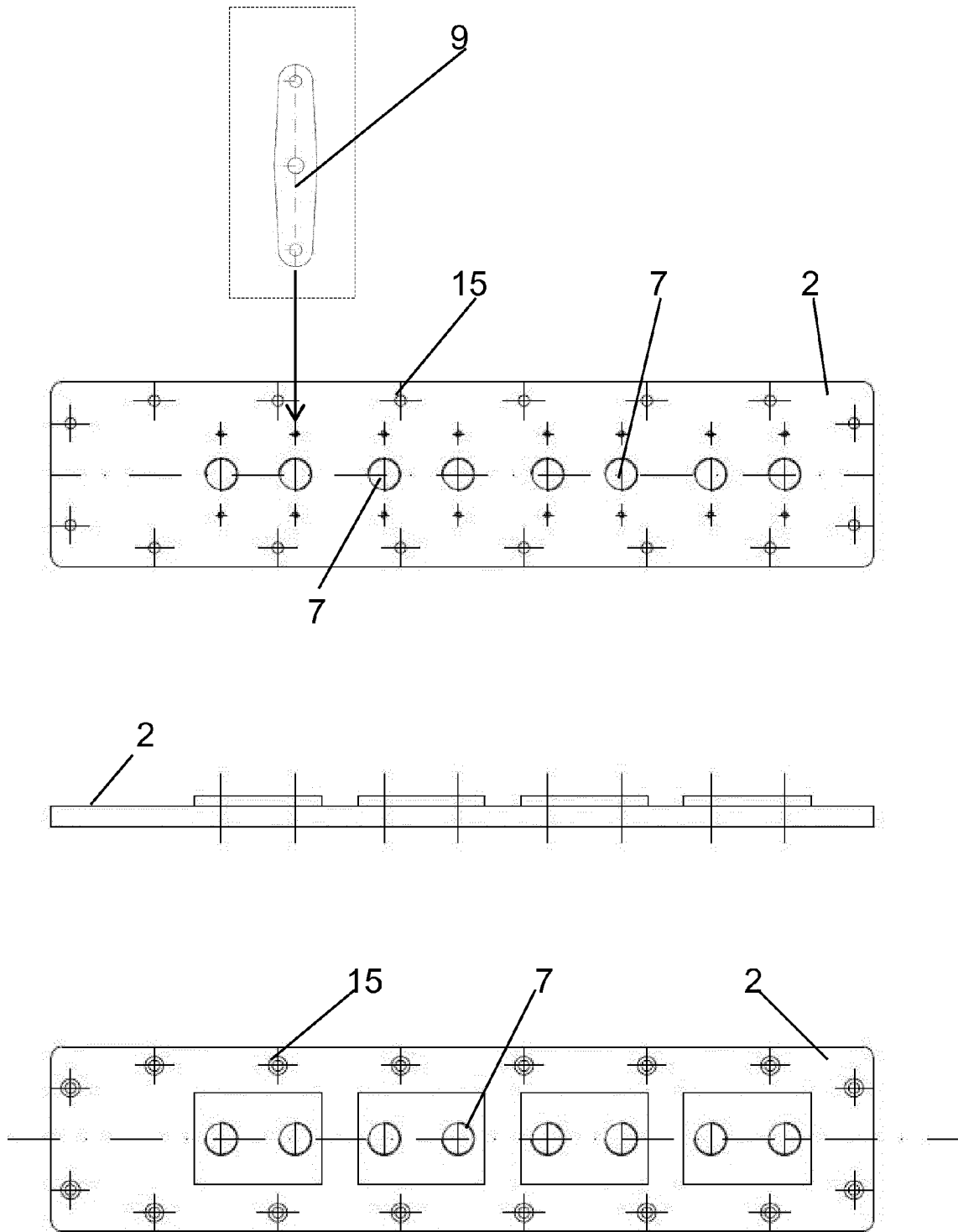


FIG. 8

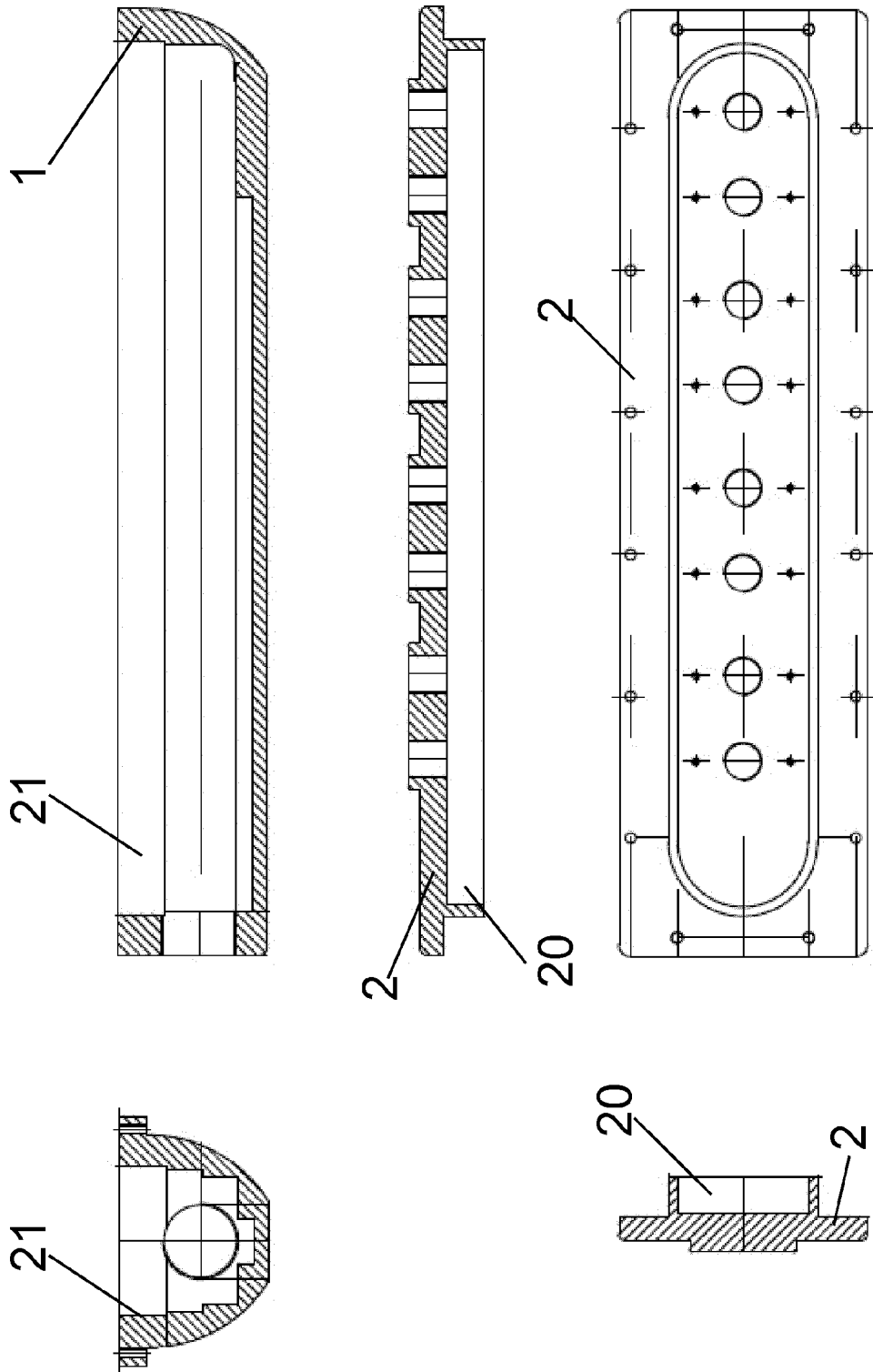


FIG. 9



EUROPEAN SEARCH REPORT

Application Number
EP 17 17 2877

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 3 236 989 A (ZAVERTNIK MARSHALL G ET AL) 22 February 1966 (1966-02-22) * column 2, lines 13-17; figures 1,2,3,6 * * column 2, line 39 - column 4, line 63 * -----	1-9	INV. H01H9/04 H01H13/86
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			H01H
Place of search		Date of completion of the search	Examiner
Munich		22 September 2017	Bräckelmann, Gregor
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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