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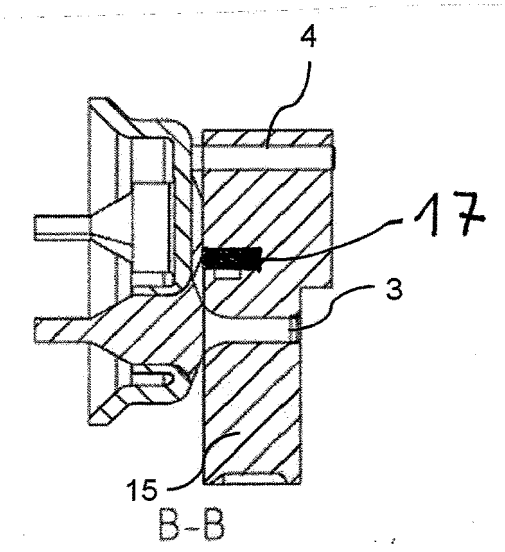
(54) ELECTRICAL DEVICE INCLUDING AN INTEGRATED TEMPERATURE SENSOR

(57) Electrical device (2) comprising a housing (1), a plurality of power contact elements (3) and a ground contact element (4) disposed on the housing (1), the power contact elements (3) and the ground contact element (4) configured for connecting the electrical device (2) to a power supply device (5) and the power contact elements (3) forming a terminal (6) for being connected to the power supply device (5) by a single connector (15). The terminal (6) also includes the ground contact element (4) for contacting the power contact elements (3) and the ground contact element (4) by the single connector (15), and the power contact elements (3) and the ground contact element (4) are formed as respective pins, wherein the power contact elements (3) have equal lengths and the ground contact element (4) is longer than each power contact elements (3); and wherein the single connector (15) contains moreover a temperature sensor (17).

Fig. 7



EP 4 343 151 A1

Description

[0001] The invention relates to an electrical device including an integrated temperature sensor, i.e. a sensor for the measurement of temperature. The invention relates in particular to an electrical device including an integrated temperature sensor which furthermore comprises a housing, a plurality of power contact elements and a ground contact element disposed on the housing, the power contact elements and the ground contact element configured for connecting the electrical device to a power supply device and the power contact elements forming a terminal for being connected to the power supply device by a single connector.

[0002] Common regulations pertaining to electrical installations in any appliance including any household appliance require that a ground potential common to all electrical components be established in the appliance. Accordingly additional cabling is required besides dedicated to power or signal distribution to properly connect each component to the common ground potential. This implies in particular that any conductive housing, particularly any metal housing, be provided with a ground contact element to be attached to ground potential. It is customary practice to provide such ground contact element as a tab of a lug placed between the housing and a screw fixed to the conductive housing, for attaching a suitable ground connector at a cable bearing ground potential.

[0003] The common solution for establishing a common ground potential in an appliance is easy to implement by the manufacturer of an electrical motor to be built into an appliance by merely requiring some tabbed lug to be included in the construction as a point of contact. However, the common solution provides difficulties for the manufacturer that finally integrates all components into an appliance. In particular, the common solution requires at least two different types of connection to be made to an electrical motor of the type defined in the initial paragraph above, namely one type of connection to the power contact elements, and another to the ground contact element. This requires at least two steps in a manufacturing process. Also, the proper contacting of all present power contact elements may be prone to errors by juxtaposing connectors.

[0004] The publication DE 27 25 796 A1 discloses a high-vacuum-tight electrical socket with pin contacts anchored in a housing, the housing consisting of a high-vacuum-resistant thermoplastic, for example polycarbonate, and the pin contacts being guided through the housing and each having a labyrinth in the housing lead-through region. In preferred embodiments, the socket with a sealing flange forms a single molded part, is sleeve-shaped, and has at least two longitudinal slots for receiving engagement cams of an associated connector. Preferably, snap recesses are provided in the longitudinal slots into which the cams of the plug engage in the end position. A longitudinal guide groove or tab may be provided in the sleeve-like receptacle. Moreover, it is disclosed that the pin contact for connection to ground is preferably longer than the other contact pins. Finally, an electrically conductive element may be provided which is connected to the pin contact for connection to ground and may be brought into contact with fastening means of the socket.

[0005] As regards the electrical motor used in household appliances it is noted that current BLDC electrical motors have electrical terminals having 3 or 4 pins for power supply. These BLDC motors are often used for instance in compressors like refrigeration compressors used in air conditioning, heat pump dryers and heat pump washer dryers. In this respect, these BLDC motors require the use of a thermosensor (or another temperature measurement sensor as for example an NTC or thermocouple) in order to measure the discharge temperature of the compressor and send this temperature information to the inverter hardware. This temperature value can be used for instance in order to stop the compressor in case the value exceeds a certain set upper temperature or other control actions.

[0006] The most common thermosensor installation options include for example the placement of the thermosensor or temperature sensor in the discharge pipe in the outlet of the compressor. In this case an additional tube is in general used that is often to the pipe as encapsulation, or a clapping system to the discharge pipe is used. Another known possibility is the placement of the thermosensor or temperature sensor inside a plastic cover in the compressor top cap next to the compressor power supply.

[0007] The publication US 5,509,786 discloses a thermal protector mounting structure for a hermetic refrigeration compressor having a housing in which an electric motor, a compressing means and a volume of refrigerant gas are provided, the compressor housing having at least one through hole formed therein, the thermal protector mounting structure comprising:

an airtight terminal assembly secured in the through hole formed in the compressor housing so that the through hole is airtightly closed by the terminal assembly, the terminal assembly including a metal base an a plurality of electrically conductive terminal pins secured to the metal base by an electrically insulative material with small thermal conductivity; a thermal protector comprising a hermetic metal casing having a withstanding pressure required in the compressor housing, a thermally responsive element disposed in the casing to be approximately parallel to an inner wall of the casing and to be in direct contact with the inner wall so that the thermally responsive element is responsive with a snap action, only to heat transferred thereto from the inner wall of the casing, a switch element disposed in the casing to be responsive to a thermal deformation of the thermally responsive element. The thermal protector is mounted in the compressor housing to a plurality of connection terminals connected to respective ends of the terminal pins so that the casing thereof is exposed to the refrigerant in the compressor housing, a part of the refrigerant being in contact with the compressing

means.

[0008] The publication EP 3 952 032 A1 discloses an electrical machine comprising a housing, a plurality of power contact elements and a ground contact element disposed on the housing, the power contact elements and the ground contact element configured for connecting the electrical machine to a power supply device and the power contact elements forming a terminal for being connected to the power supply device by a single connector, wherein the terminal also includes the ground contact element for contacting the power contact elements and the ground contact element by the single connector, and the power contact elements and the ground contact element are formed as respective pins, wherein the power contact elements have equal lengths and the ground contact element is longer than each power contact elements.

[0009] Accordingly there is a need for providing error-proof and conveniently installed contacts both to power contact elements and to a ground contact element and that provide a convenient measurement of the temperature.

[0010] The object underlying the present invention is therefor the provision of an electrical device as defined in the initial paragraph above which allows for error-proof and convenient contacting to power contact elements and ground contact element, as well as an improved temperature measurement upon integration into an appliance, in particular a household appliance. Preferably a separate temperature sensor, for example to control the temperature of a compressor, should be dispensible.

[0011] This object is achieved according to the present invention by the electrical device pursuant to the independent claim. Preferred embodiments of the electrical device according to the invention are indicated especially in the dependent claims. Preferred embodiments may also be applied in combinations to any extent unless they are impossible under technical considerations, even if not specified herein explicitly.

[0012] The present invention is thus directed to an electrical device comprising a housing, a plurality of power contact elements and a ground contact element disposed on the housing, the power contact elements and the ground contact element configured for connecting the electrical device to a power supply device and the power contact elements forming a terminal for being connected to the power supply device by a single connector, wherein the terminal also includes the ground contact element for contacting the power contact elements and the ground contact element by the single connector, and the power contact elements and the ground contact element are formed as respective pins, wherein the power contact elements have equal lengths and the ground contact element is longer than each power contact elements; and wherein the single connector furthermore contains a temperature sensor.

[0013] The temperature sensor may be for example a thermosensor, an NTC of a thermocouple.

[0014] The present invention thus involves the integration of the temperature measurement sensor together with the electrical connector which may be connected to a compressor of a heat pump or other target device. The compressor or other target device could have for instance 3 pins or 4 pins for electrical connection.

[0015] In a preferred embodiment of the invention, the plurality of power contact elements is three power contact elements. Thereby the invention is qualified for application to an electrical device that is operated by supplying three-phase alternating current.

[0016] The temperature sensor will be in general in contact with the base of the electrical terminal of the compressor or other target device. Some system will be set up in general in order to ensure proper contact between the metal surfaces, for instance, one spring making pressure against piston sensor element. The measurement is in general effected by measuring the conductivity between for example a compressor metal base and the temperature sensor.

[0017] Moreover the in general required cable harness can be integrated as well together with the power supply cable harness.

[0018] In another preferred embodiment of the invention the housing includes a sheet metal section, the sheet metal section includes the terminal, each power contact element is isolated against the sheet metal section by an isolator, and the ground contact element is electrically connected to the sheet metal section. Thereby the terminal is easily manufactured, and easily accessed for attaching the connector.

[0019] In an additional preferred embodiment of the invention the terminal is a flat region on the housing. Thereby the housing may be formed in accordance with present needs, reserving any specific provision for the terminal to a suitably selected part of the housing.

[0020] By having the ground contact element longer than the power contact elements it is assured in accordance with the present invention that upon mounting the connector the ground contact element is connected first, thereby attaching the housing to common ground and ascertaining that, should any connection to the power contact elements within the housing be faulty by making an undesirable contact to the housing, prevention from power potential being attached to the housing is avoided. Instead the ensuing short to common ground gives a clear and easily diagnosed error signature. In addition it is assured that the ground contact element is the last to be released from the connector as the connector is removed from the terminal.

[0021] In a preferred embodiment of the invention, the ground contact element is in the range of from 0,5 mm to 30 mm, preferably about 6 mm, longer than the length of each power contact element.

[0022] In a further preferred embodiment of the invention each of the power contact elements and the ground contact

element is formed as a cylinder.

[0023] Moreover, the relatively large ground contact element is readily applied to verify proper attachment of the connector to the terminal.

[0024] The electrical device implementing the invention can be applied to any household appliance. In particular the household appliance may be a laundry care machine such as a laundry dryer or a dishwasher, all equipped with a heat pump for drying purposes and the electrical device applied to drive a gas compressor in the heat pump.

[0025] In yet an additional preferred embodiment of the invention the electrical device is connected to a gas compressor for driving it, particularly a gas compressor that is used in a heat pump. More preferably, the electrical device and the gas compressor are enclosed by the housing. Even more preferably the gas compressor is configured for compressing a gaseous working medium circulating in a heat pump. The gas compressor is then preferably one of a reciprocating piston compressor and a rotary piston compressor.

[0026] The electrical device of the present invention is preferably configured for operation in a household appliance where it is applied for driving a compressor in a heat pump as explained above. The household appliance is preferably a laundry dryer.

[0027] The invention has numerous advantages. The invention allows to use an electrical connector with an integrated temperature sensor, in particular a thermosensor, such that only one connection step to the target device, for instance a compressor of a heat pump, is required. One of the main advantages of this invention is thus a cost decrease, because a separate temperature sensor is not needed. The production costs are reduced because the step for assembling separately the temperature sensor in any of the above described most common options is not necessary. Moreover, a better temperature measurement of the discharge temperature of a compressor having already the encapsulation of the electrical connector protecting against external influences like for instance an air effect of cooling fans is possible.

[0028] Advantages of the invention include moreover that all contact elements including the power contact elements and the ground contact element are combined into a single terminal, thereby made accessible via a single connector that contains in addition a temperature measurement sensor. Thus all required connections to the electrical device may be attached by mounting a single connector which provides all necessary contacts to the power supply and to common ground.

[0029] Preferred embodiments of the invention are explained in the following in detail with reference to the attached figures which show the following:

Fig. 1	a schematic view of an embodiment including an electrical device with an integrated temperature sensor which drives a gas compressor in a heat pump;
Figs. 2, 3, and 4	views of an upper part of an embodiment including a housing enclosing an electrical device; and
Figs. 5, 6, and 7	views of the upper part as in Figs. 2, 3, and 4, showing in particular a connector placed on the housing.

[0030] As shown in Fig. 1, an electrical device 2 comprises a housing 1, a plurality of power contact elements 3 and a ground contact element 4 disposed on the housing 1. The power contact elements 3 and the ground contact element 4 are configured for connecting the electrical device 2 to a power supply device 5, and the power contact elements 3 form a terminal 6 for being connected to the power supply device 5 by single connector 15 which is shown just schematically above the power contact elements 3 and the ground contact element 4 although the temperature sensor 17 can be seen. Connector 15 communicates with power supply device 5 via external electrical leads 16.

[0031] Terminal 6 provided as a flat region or structure on housing 1 also includes ground contact element 4, thereby enabling contacting power contact elements 3 and ground contact element 4 by the single connector 15. Power contact elements 3 and ground contact element 4 are formed as respective pins, wherein the power contact elements 3 have equal lengths and the ground contact element 4 is longer than each power contact elements 3. Thus all required connections to electrical device 2 may be attached by mounting single connector 15 which provides all necessary contacts to power supply 5 and to common ground.

[0032] Each of power contact elements 3 and ground contact element 4 is formed as a cylinder, and is preferably made from a suitably conductive metal such as copper or copper alloy. Ground contact element 4 is in the range of from 0,5 mm to 30 mm, preferably about 6 mm, longer than the length of each power contact element 3. Internal electrical leads 7 shown as dotted lines connect power contact elements 3 to electrical device 2, and also ground contact element 4 to housing 1 for protection.

[0033] By having ground contact element 4 longer than each of power contact elements 3 it is assured that upon mounting connector 15 ground contact element 4 is connected first, thereby attaching the housing to common ground and ascertaining that, should any connection to power contact elements 3 within housing 2 be faulty by making an undesirable contact to housing 2, prevention from power potential being attached to housing 2 is avoided. Instead the ensuing short to common ground gives a clear and easily diagnosed error signature. Further it is assured that ground

contact element 4 is the last to be released from connector 15 as connector 15 is removed from terminal 6, which retains the connection to common ground as long as possible and provides safety against exposure to undesirable power potential on removing connector 15.

[0034] Still further, the relatively large ground contact element is readily applied to verify proper attachment of the connector to the terminal.

[0035] The plurality of power contact elements 3 is here three power contact elements 3, implying that the electrical device 2 is to be powered by three-phase alternating current that is provided by power supply 5.

[0036] Housing 1 fully encloses electrical device 2 and a gas compressor 8 driven by it, and includes a sheet metal section, the sheet metal section including terminal 6, each power contact element 3 isolated against the sheet metal section by an isolator 14 not shown in Fig. 1 but in Figs. 2 to 4. Ground contact element 4 is electrically connected to the sheet metal section, as symbolized in Fig. 1 by a respective internal electrical lead 7. In practice however, housing 1 being made from metal, ground connect pin 4 may be connected directly to the housing, for example by soldering, brazing, or welding. The enclosure of electrical device 2 and gas compressor 8 provides both machines immersed in gas that gas compressor 8 is to compress, thereby applying such gas as a cooling medium both for gas compressor 8 and electrical device 2. Heat generated during operation may be carried away by such gas as it leaves gas compressor 8 in a compressed state, or transferred to housing 1 for dissipation into the environment, or both.

[0037] In the embodiment of Fig. 1 gas compressor 8 is configured for compressing a gaseous working medium circulating in a heat pump 8, 9, 10, 11, 12 comprising gas compressor 8, working medium circuit 9 guiding the working medium either in gas phase or liquid phase as the inverse Rankine cycle applied in the heat pump provides, heat source 10 which is a heat exchanger transferring heat to a process air flow by condensing the working medium, heat sink 11 which is a heat exchanger extracting heat from the air flow by evaporating the working medium, and restrictor 12 which may be a valve or capillary that decompresses the working medium as it passes through by flowing from heat source 10 to heat sink 11. Heat sink 11 is also applied for condensing humidity in the air flow passing through and separating condensed humidity from the air flow, thereby effecting a drying process wherein the air flow is applied to dry a humid ware such as pieces of laundry. The temperature sensor 17 allows the control of the compressor. In particular, a surpassing of a critical temperature can be observed to stop for example the working of the compressor.

[0038] A condensate collector 13 is provided for collecting such condensate, and storing it for disposal. Gas compressor 8 maybe of the type reciprocating piston compressor, or of the type rotary piston compressor. In the exemplary embodiment of Fig. 1 electrical device 2 is configured for operation in a household appliance which is here a laundry dryer.

[0039] Figures 2, 3, and 4, exhibit various views of an upper part of housing 1 including terminal 6, and on terminal 6 placed three power contact elements 3 which are formed as cylinders and which are isolated from housing 1 by isolators 14. The isolators 14 may be made from glass or plastic. Likewise ground contact element 4 is placed on terminal 6, without continuing the symmetry in the arrangement of the three power contact elements 3. All power contact elements 3 are of equal lengths and a length of ground contact element 4 is about 6 mm longer than the length of each power contact element 3. The temperature sensor is not present here.

[0040] Figures 5, 6, and 7, exhibit the same upper part of housing 1 with terminal 6, power contact elements 3 and ground contact element 4, and connector 15 in which a temperature sensor 17 is provided attached to terminal 6.

[0041] Fig. 7 exhibits a section through the configuration of Fig. 6, cut along line B-B. Isolator 14 appears as integral part of the power contact element 3 in the section without being pointed out in detail in Fig. 7.

[0042] Advantages of the embodiments shown in the Figures include that all contact elements including power contact elements 3 and ground contact element 4 are combined into single terminal 6, thereby made accessible via single connector 15. Thus all required connections to electrical device 2 may be attached by mounting single connector 15 which provides all necessary contacts to power supply 5 and to common ground.

[0043] By having ground contact element 4 longer than power contact elements 3 it is further assured that upon mounting connector 15 ground contact element 4 is connected first, thereby attaching housing 2 to common ground and ascertaining that, should any connection to power contact elements 3 within housing 2 be faulty by making an undesirable contact to housing 2, prevention from power potential being attached to housing 2 is avoided. Instead the ensuing short to common ground gives a clear and easily diagnosed error signature. In addition it is assured that ground contact element 4 is the last to be released from connector 15 as connector 15 is removed from terminal 6. Still further, relatively large ground contact element 4 is readily applied to verify proper attachment of connector 15 to terminal 6.

List of Reference Numerals

[0044]

1 Housing
2 Electrical device
3 Power contact

4 Ground contact
5 Power supply device
6 Terminal
7 Internal electrical lead
8 Gas compressor
9 Working medium circuit
10 Heat source
11 Heat sink
12 Restrictor
13 Condensate collector
14 Isolator
15 Connector
16 External electrical leads
17 Temperature (measurement) sensor, thermosensor

Claims

1. An electrical device (2) comprising a housing (1), a plurality of power contact elements (3) and a ground contact element (4) disposed on the housing (1), the power contact elements (3) and the ground contact element (4) configured for connecting the electrical device (2) to a power supply device (5) and the power contact elements (3) forming a terminal (6) for being connected to the power supply device (5) by a single connector (15), wherein the terminal (6) also includes the ground contact element (4) for contacting the power contact elements (3) and the ground contact element (4) by the single connector (15), and the power contact elements (3) and the ground contact element (4) are formed as respective pins, wherein the power contact elements (3) have equal lengths and the ground contact element (4) is longer than each power contact elements (3); and wherein the single connector (15) contains moreover a temperature sensor (17).

2. The electrical device (2) according to claim 1, wherein the plurality of power contact elements (3) is three power contact elements (3).

3. The electrical device (2) according to one of claims 1 and 2, wherein the housing (1) includes a sheet metal section, the sheet metal section includes the terminal (6), each power contact element (3) being isolated against the sheet metal section by an isolator (14), and the ground contact element (4) being electrically connected to the sheet metal section.

4. The electrical device (2) according to any preceding claim, wherein the terminal (6) is a flat region on the housing (1).

5. The electrical device (2) according to any preceding claim, wherein a length of the ground contact element (4) is in a range of from 0,5 mm to 30 mm, preferably about 6 mm, and longer than the length of each power contact element (3).

6. The electrical device (2) according to any preceding claim, wherein each of the power contact elements (3) and the ground contact element (4) is shaped as a cylinder.

7. The electrical device (2) according to any preceding claim, which is adapted to be connected to a gas compressor (8) for driving it.

8. The electrical device (2) according to claim 7, wherein the electrical device (2) and the gas compressor (8) are enclosed by the housing (1).

9. The electrical device (2) according to one of claims 7 and 8, wherein the gas compressor (8) is configured for compressing a gaseous working medium circulating in a heat pump (8, 9, 10, 11, 12).

10. The electrical device (2) according to one of claims 7 to 9, wherein the gas compressor (8) is one of a reciprocating piston compressor and a rotary piston compressor.

11. The electrical device (2) according to any preceding claim, which is configured for operation in a household appliance.

12. The electrical device (2) according to claim 11, wherein the household appliance is a laundry dryer.

Fig. 1

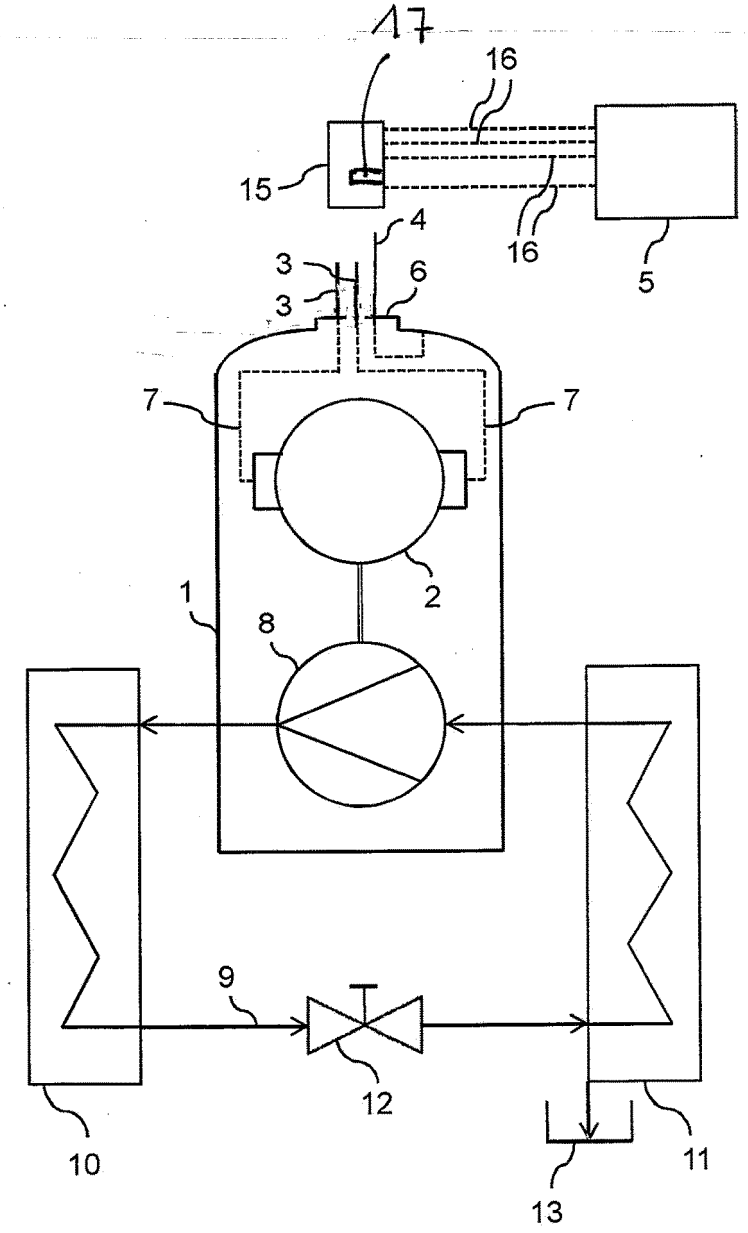


Fig. 2

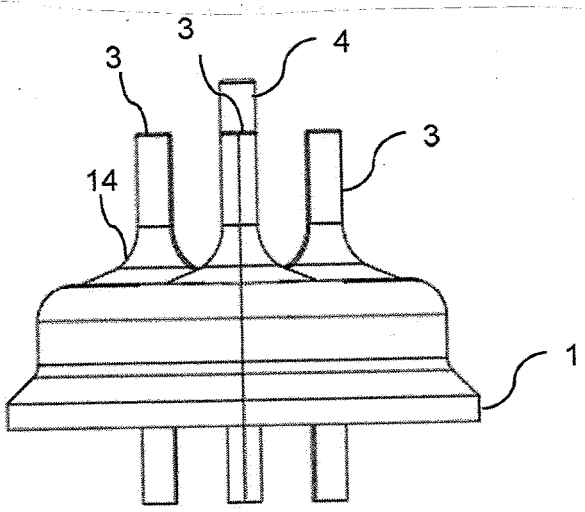


Fig. 3

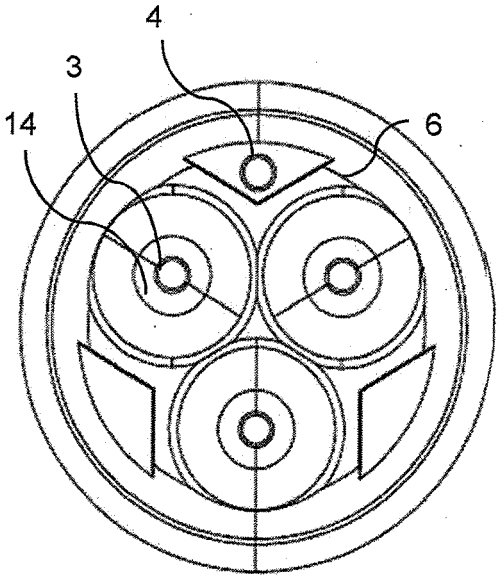


Fig. 4

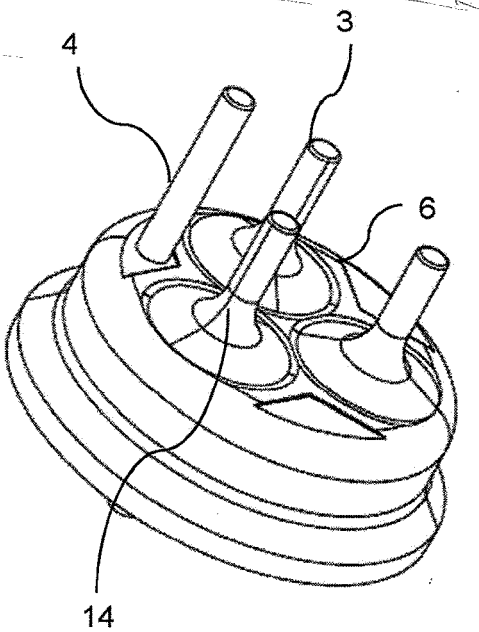


Fig. 5

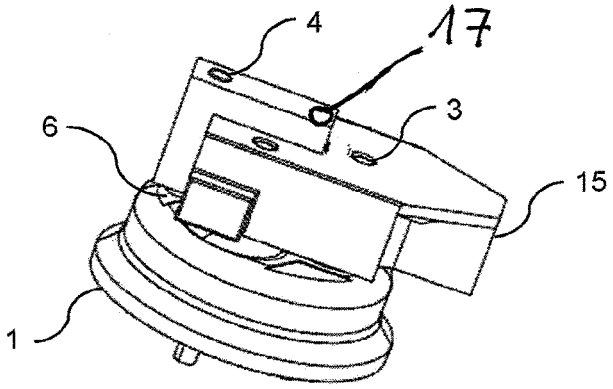


Fig. 6

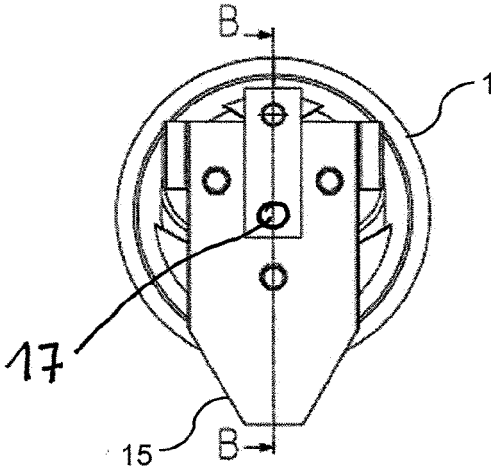
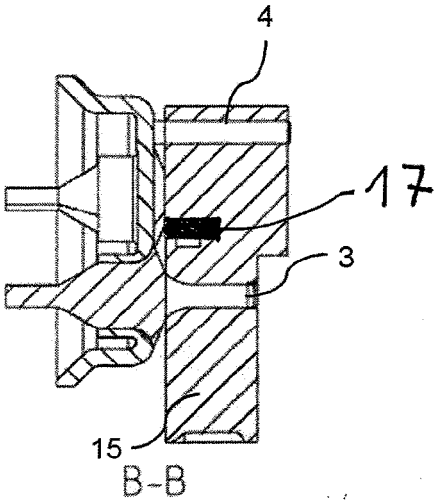


Fig. 7



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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 4195

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
			F04C H01R H02K F04B F04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 January 2024	Descoubes, Pierre

CATEGORY OF CITED DOCUMENTS

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