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(71) Applicant: **BSH Hausgeräte GmbH**
81739 München (DE)

(72) Inventors:
• **Baryla, Marcin**
Zgierz (PL)
• **Motyka, Michal**
95-070 Aleksandrów Łódzki (PL)
• **Ruiz Bermejo, Jose Antonio**
26540 Alfaro (La Rioja) (ES)

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(54) **ELECTRICAL MACHINE INCLUDING CONTACT ELEMENTS FORMING A TERMINAL**

(57) The invention relates to an electrical machine 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 machine 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.

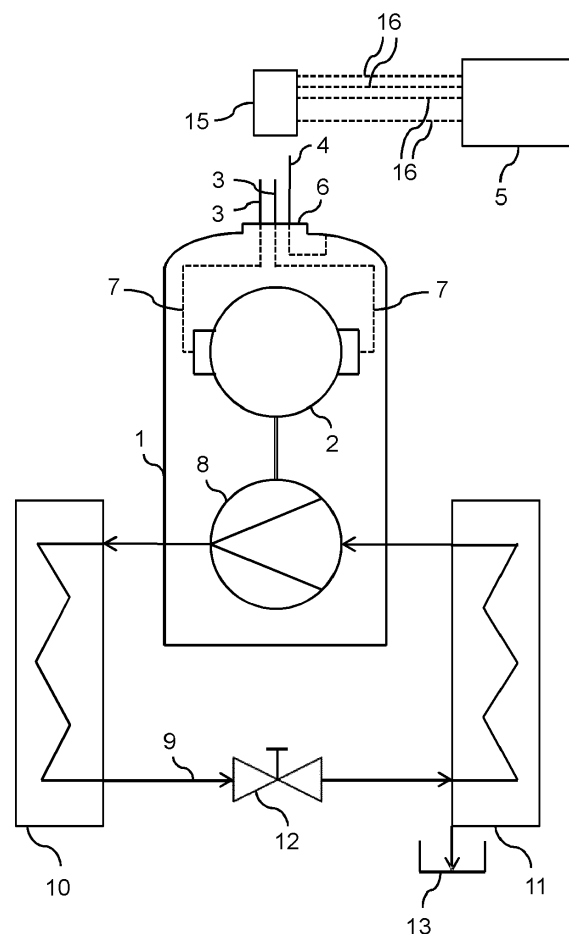


Fig. 1

Description

[0001] The invention relates to 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.

[0002] Document EP 2 559 804 A1 discloses an electrical machine as defined above. The electrical machine is combined with a gas compressor driven by the electrical machine, the electrical machine and the gas compressor hermetically enclosed in a housing. The gas compressor serves for driving a working medium in a heat pump adapting the inverse Rankine cycle and established in a household appliance that is a laundry dryer, the heat pump provided for cyclically heating and cooling an air flow circulating for drying laundry. The electrical machine is designed to be powered by three-phase alternating current, and consequentially has three power terminals combined into a terminal placed on the housing for connecting to a power supply device.

[0003] Document EP 2 513 368 B1 discloses a household appliance embodied as a laundry dryer and including a heat pump with a gas compressor and an expansion device, the heat pump operating in the inverse Rankine cycle for pumping heat from a heat sink to a heat source. In the inverse Rankine cycle a working medium that is conventionally also termed "refrigerant" circulating between the heat source and the heat sink is cyclically evaporated and condensed. Drying of humid ware in the household appliance is effected by an air flow passing along the drying ware and guided in an essentially closed circuit. Therein the air flow is heated by the heat source prior to passing the humid ware, and cooled by the heat sink after passing the humid ware and loading itself with humidity. The cooling provides for the humidity in the air flow to condense and precipitate from the air flow. Precipitated humidity is separated and collected for later disposal.

[0004] Document EP 2 640 885 B1 also discloses a household appliance embodied as a laundry dryer including a heat pump operating in the reverse Rankine cycle. The heat pump includes a gas compressor for compressing and driving a working medium, and a control device configured for providing electrical power to the gas compressor and controlling operation of the gas compressor. Several sensors are also provided in the household appliance and associated to the control device to take measurements during drying operation, and forward related measured data to the control device for use in controlling drying operation.

[0005] Document EP 2 732 090 B1 also discloses a household appliance particularly embodied as a laundry dryer and including a heat pump. The air flow applied for drying is guided in an open circuit, taken in from the household appliance's environment by a suitable blower. This air flow is first heated by the heat pump's heat source, then passed along humid ware to be dried, and then cooled and stripped from entrained humidity in the heat sink. Finally the air flow is exhausted back to the environment.

[0006] Document EP 2 985 466 A1 discloses various embodiments of a gas compressor for application in a heat pump in a household appliance, the gas compressor embodied as a rotary piston gas compressor or a reciprocating piston gas compressor.

[0007] Document EP 1 902 496 B1 discloses an electric power terminal feed-through adapted to be installed in a housing, comprising a metallic body with a cylindrical sidewall, at least one current conducting pin extending through the body and a seal sealing the at least one current conducting pin to the body. The seal may be a preformed insert including glass.

[0008] In the present context a household appliance is an appliance determined for use in operating a private household to effect a specific and predetermined material purpose.

[0009] 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 cabling 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.

[0010] While 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 including some tabbed lug in the construction as a point of contact, 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.

[0011] Accordingly there is a need for providing error-proof and conveniently installed contacts both to power contact

elements and to a ground contact element.

[0012] Therefore it is an object of the invention to provide an electrical machine as defined in the initial paragraph above which allows for error-proof and convenient contacting to power contact elements and ground contact element upon integration into an appliance.

[0013] On purpose of solving this object the present invention provides an electrical machine of the generic type as defined in the generic part of the independent claim attached which also includes the features of the characterizing part of said independent claim.

[0014] Preferred embodiments of the invention are defined in dependent claims attached as well as in the subsequent disclosure. Such preferred embodiments may also be applied in mutual combinations insofar as possible under technical considerations to any extent, even if not specified herein explicitly.

[0015] Accordingly the present invention provides, as a solution to the problem as defined above, 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.

[0016] Advantages of the invention include 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. Thus all required connections to the electrical machine may be attached by mounting a single connector which provides all necessary contacts to the power supply and to common ground.

[0017] By having the ground contact element longer than the power contact elements it is further assured 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.

[0018] Still further, the relatively large ground contact element is readily applied to verify proper attachment of the connector to the terminal.

[0019] Principally the invention may be applied to any electrical machine, and the electrical machine implementing the invention be applied to any household appliance. In particular the household appliance may be a laundry care machine such as a laundry dryer or a washer-dryer, or a dishwasher, or a cooling appliance such as a refrigerator or a freezer, or a heating appliance such as a water heater or a climatization device, all equipped with a heat pump for drying, cooling, or heating purposes and the electrical machine applied to drive a gas compressor in the heat pump.

[0020] 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 machine that is operated by supplying three-phase alternating current.

[0021] 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.

[0022] In an additional preferred embodiment of the invention the terminal is a flat region on the housing. Thereby the shape of the housing may be shaped in accordance with present needs, reserving any specific provision for the terminal to a suitably selected part of the housing. With more preference the power contact elements may be included in a hermetic feed-through that includes the terminal. Thereby commercially available hermetic feed-throughs may be applied in the invention.

[0023] In a further preferred embodiment of the invention each of the power contact elements and the ground contact element is shaped as a cylinder.

[0024] In yet another preferred embodiment of the invention a length of the ground contact element is between 0,5 mm and 30 mm, preferably about 6 mm, longer than the length of each power contact element.

[0025] In yet an additional preferred embodiment of the invention the electrical machine is connected to a gas compressor for driving the gas compressor, qualifying the invention for application to a gas compressor, particularly a gas compressor for application in a heat pump. With even more preference the electrical machine and the gas compressor are enclosed by the housing. With still more preference the housing encloses the electrical machine and the gas compressor hermetically. With still more preference the gas compressor is configured for compressing a gaseous working medium circulating in a heat pump. With further preference the gas compressor is one of a reciprocating piston compressor, a rolling piston compressor, and a scroll compressor.

[0026] In yet a further preferred embodiment of the invention the electrical machine is configured for operation in a household appliance. In such context the electrical machine is applied for driving a compressor in a heat pump as explained precedingly. With more preference the household appliance is one of a laundry care machine, particularly a laundry dryer or a washer-dryer, or a dishwasher, or a cooling appliance such as a refrigerator or a freezer, or a heating appliance such as a water heater or a climate control device.

[0027] Preferred embodiments of the invention are now explained in detail with reference to the Figures of the attached drawing. These Figures show and exhibit as follows:

Fig. 1 shows a schematic view of an embodiment including an electrical machine 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 machine; and

Figs. 5, 6, and 7 views of the upper part as in Figs. 3, 4, and 5, a connector placed on the housing.

[0028] As shown in detail in Fig. 1 an electrical machine 2 comprises a hermetically closed housing 1, a plurality of power contact elements 3, the plurality being two in the example of Fig. 1, 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 machine 2 to a power supply device 5, and the power contact elements 3 form a terminal 6 for being connected to power supply device 5 by a single connector 15 which is shown just schematically above the power contact elements 3 and the ground contact element 4. Connector 15 communicates with power supply device 5 via external electrical leads 16.

[0029] 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 machine 2 may be attached by mounting single connector 15 which provides all necessary contacts to power supply 5 and to common ground.

[0030] Each of power contact elements 3 and ground contact element 4 is shaped as a cylinder, and is preferably made from a suitably conductive metal such as copper or copper alloy. A length of ground contact element 4 is between 0,5 mm and 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 machine 2, and also ground contact element 4 to housing 1 for protection.

[0031] By having ground contact element 4 longer than each of power contact elements 3 it is further 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.

[0032] Still further, the relatively large ground contact element is readily applied to verify proper attachment of the connector to the terminal.

[0033] The plurality of power contact elements 3 is three power contact elements 3, implying that the electrical machine 2 is to be powered by three-phase alternating current that is provided by power supply 5.

[0034] Housing 1 fully and hermetically encloses electrical machine 2 and gas compressor 8 driven by electrical machine 2, with connector terminals not exhibited explicitly provided for gas inlet and gas outlet in addition to power contact elements 3 and ground contact element 4. Housing 1 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 apparent from Fig. 1 but apparent from Figs. 2 to 4. Terminal 6 may include a commercially available feed-through for guiding power contact elements 3. 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, at or near terminal 6. The enclosure of electrical machine 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 machine 2. Heat generated during operation may be carried off 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.

[0035] 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, such as described in principle in the prior art documents cited hereinabove. 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, as also mentioned in the prior art documents cited hereinabove.

[0036] In the embodiment of Fig. 1 electrical machine 2 is configured for operation in a household appliance which is a laundry dryer. Electrical machine 2 therein serves for operating gas compressor 8 of the heat pump 8, 9, 10, 11, 12 as explained in the preceding paragraph.

[0037] An application for the heat pump 8, 9, 10, 11, 12 shown in Fig. 1 may be provided in a household appliance such as a laundry care machine, particularly a laundry dryer or a washer-dryer, or a dishwasher, or a cooling appliance, particularly a refrigerator or a freezer, or a heating appliance, particularly a water heater or a climate control device.

[0038] Figures 2 3, and 4, exhibit various views of an upper part of housing 1 including terminal 6, an on terminal 6 placed three power contact elements 3 shaped as cylinders and isolated from housing 1 by isolators 14 which may be made from glass or plastic. Isolators 14 may hermetically seal housing 1 against its environment, and may be provided in a commercially available feed-through that is included in terminal 6, or even forms terminal 6. Likewise ground contact element 4 is placed on terminal 6, without continuing the symmetry in the arrangement of the three power contact elements 3. Again, all power contact elements 3 are of mutually equal lengths and a length of ground contact element 4 is about 6 mm longer than the length of each power contact element 3.

[0039] 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 attached to terminal 6. 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.

[0040] Advantages of the embodiments shown in the drawing include that all contact elements 3, 4 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 machine 2 may be attached by mounting single connector 15 which provides all necessary contacts to power supply 5 and to common ground.

[0041] 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

[0042]

- 1 Housing
- 2 Electrical machine
- 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

5 Claims

1. An electrical machine (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 machine (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), **characterized in that** 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).
2. The electrical machine (2) according to claim 1, wherein the plurality of power contact elements (3) is three power contact elements (3).
3. The electrical machine (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) is isolated against the sheet metal section by an isolator (14), and the ground contact element (4) is electrically connected to the sheet metal section.
4. The electrical machine (2) according to any preceding claim, wherein the terminal (6) is a flat region on the housing (1).
5. The electrical machine according to claim 4, wherein the power contact elements (3) are included in a hermetic feed-through that includes the terminal (6).
6. The electrical machine (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 machine (2) according to any preceding claim, wherein a length of the ground contact element (4) is between 0,5 mm and 30 mm, preferably about 6 mm, longer than the length of each power contact element (3).
8. The electrical machine (2) according to any preceding claim, which is connected to a gas compressor (8) for driving the gas compressor (8).
9. The electrical machine (2) according to claim 8, wherein the electrical machine (2) and the gas compressor (8) are enclosed by the housing (1).
10. The electrical machine (2) according to claim 9, wherein the housing (1) encloses the electrical machine (2) and the gas compressor (8) hermetically.
11. The electrical machine (2) according to one of claims 8 to 10, wherein the gas compressor (8) is configured for compressing a gaseous working medium circulating in a heat pump (8, 9, 10, 11, 12).
12. The electrical machine (2) according to one of claims 8 to 11, wherein the gas compressor (8) is one of a reciprocating piston compressor, a rolling piston compressor, and a scroll compressor.
13. The electrical machine (2) according to any preceding claim, which is configured for operation in a household appliance.
14. The electrical machine (2) according to claim 13, wherein the household appliance is one of a laundry care machine, particularly a laundry dryer or a washer-dryer, or a dishwasher, or a cooling appliance, particularly a refrigerator or a freezer, or a heating appliance, particularly a water heater or a climate control device.

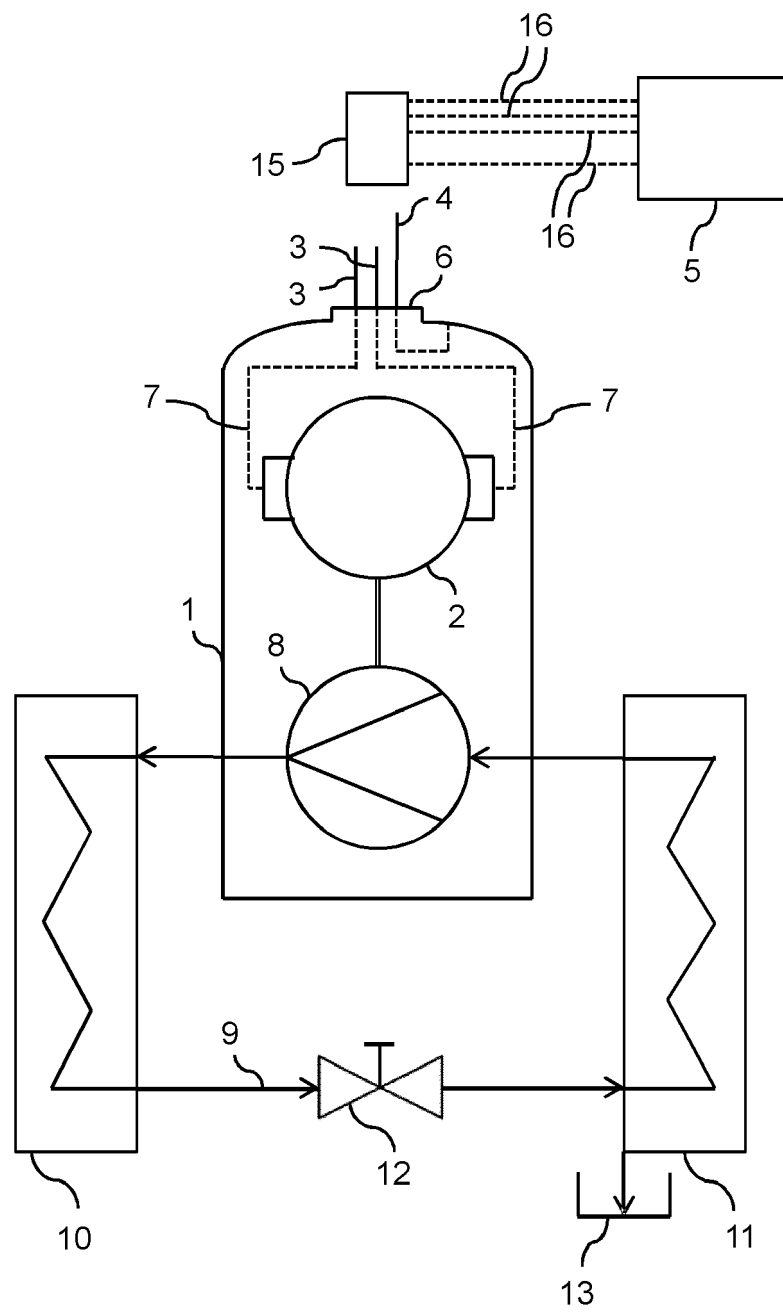
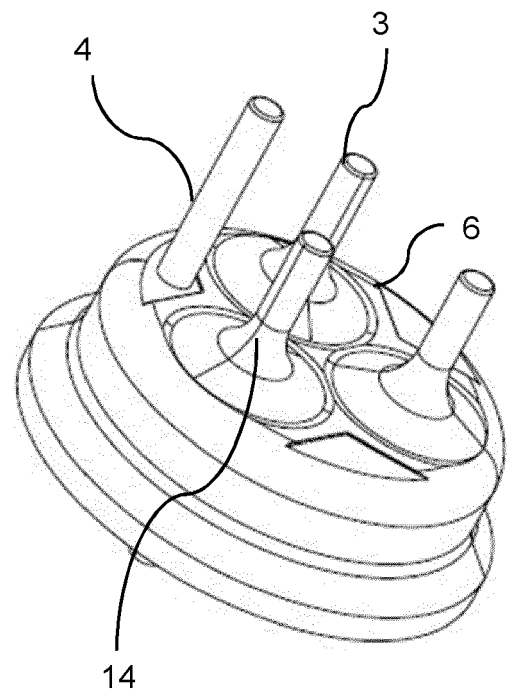
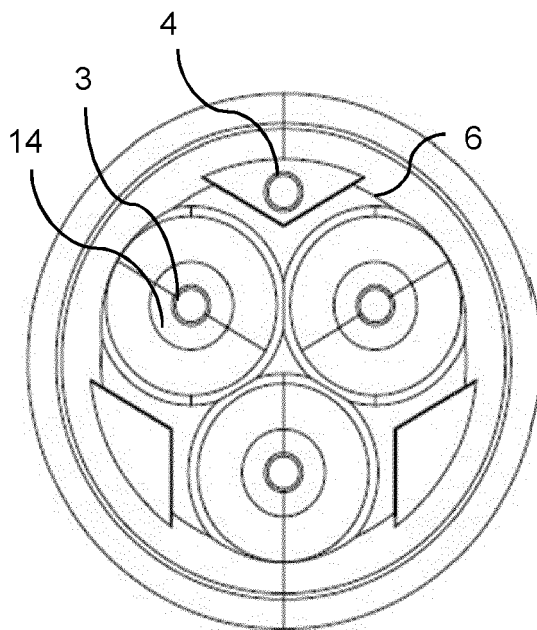
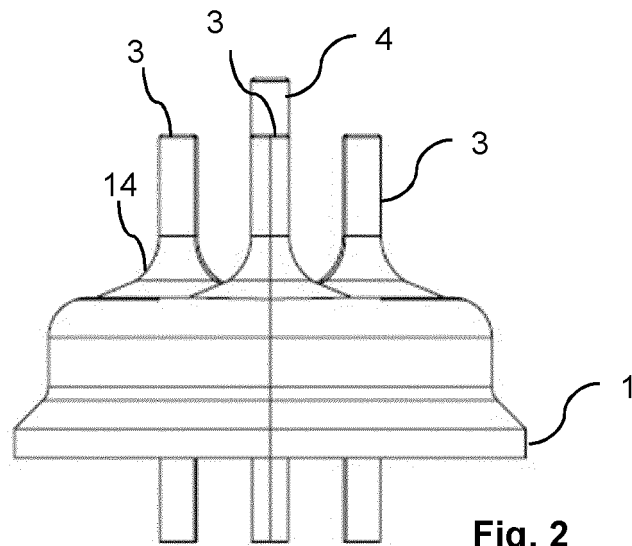


Fig. 1



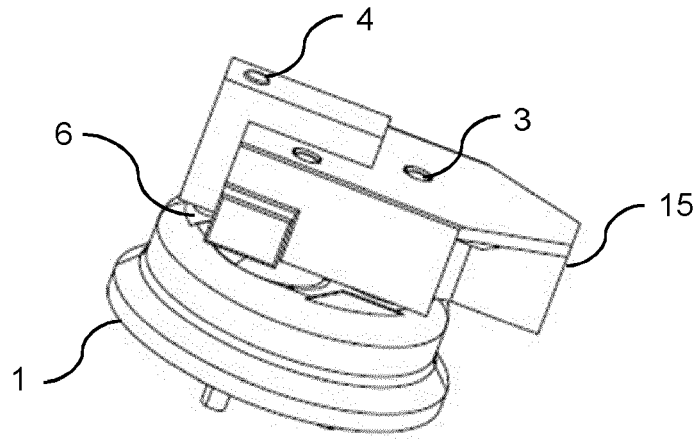


Fig. 5

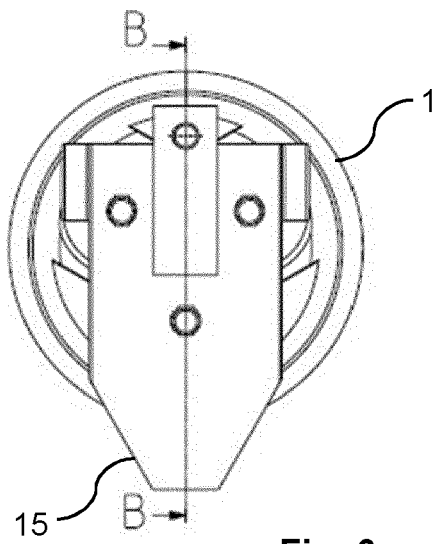


Fig. 6

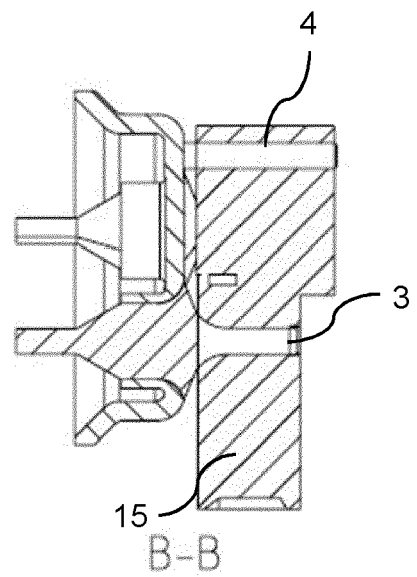


Fig. 7



EUROPEAN SEARCH REPORT

Application Number

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 13 December 2021	Examiner Corrales, Daniel
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

**ANNEX TO THE EUROPEAN SEARCH REPORT
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