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(54) MULTISTAGE CENTRIFUGAL PUMP WITH A COOLED FREQUENCY CONVERTER PLACED BETWEEN THE PUMP AND THE MOTOR

(57) The present invention relates to a multistage centrifugal pump for pumping liquids with a cooled variable frequency drive, said pump being provided with a motor driving the rotation of a shaft which, after going through a leak-tight, rotary mechanical seal, is introduced into a leak-tight chamber in which the rotation of drive reels, attached in successive positions on said shaft, drives a liquid contained in said leak-tight chamber, increasing its pressure, from a liquid inlet to a liquid outlet, at least part of said control assembly being located on at least one part of said partition wall and in thermal contact with same for the cooling thereof, and housed between the partition wall and the motor..

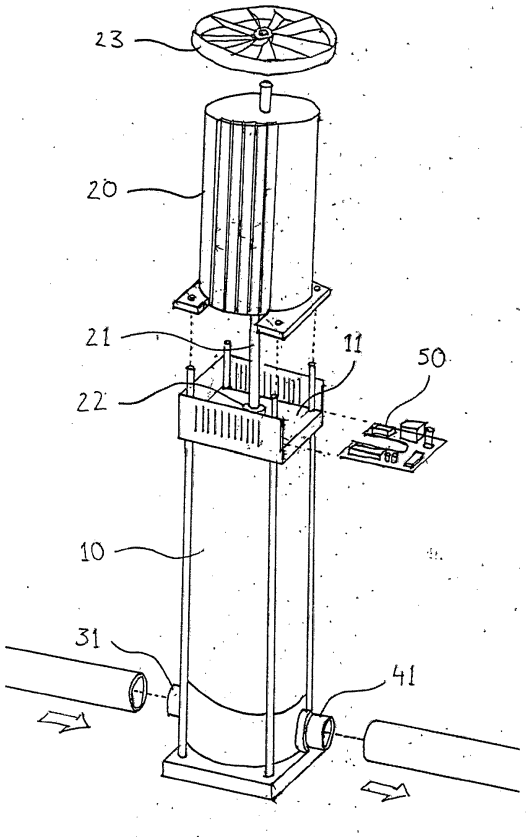

Fig. 1

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Description

Field of the Art

[0001] The present invention relates to the field of multistage centrifugal pumps for pumping liquids with a cooled variable frequency drive, provided with a motor and a leak-tight chamber integrating a cylindrical chamber with one or more liquid inlets, one or more liquid outlets and a plurality of drive reels interposed between said liquid inlets and said liquid outlets and operated by a shaft connected with said motor.

State of the Art

[0002] Multistage centrifugal pumps for pumping liquids are well known in the state of the art, and many of them have an electric motor controlled by means of a control assembly including a variable frequency drive.

[0003] Said control assemblies tend to heat up, so solutions to make the cooling thereof easier have been developed, such as the solution described in patent document EP1511156, for example, in which the air driven by a fan coupled to the shaft of the motor cools said motor and also said control assembly, which is located on one side of the motor, by means of deflectors diverting part of said air against said control assembly. Similarly, patent document JP4983116 also proposes cooling the control assembly using the air driven by the cooling fan of the motor.

[0004] On the other hand, patent document EP1217217 proposes creating a pipe through which water driven by the pump is channeled, part of said pipe being in thermal contact with the control assembly, cooling it. However, said pipe complicates the construction of the pump and does not allow complementing the cooling with air driven by a fan coupled to the shaft of the motor.

Brief Description of the Invention

[0005] The present invention relates to a multistage centrifugal pump for pumping liquids with a cooled variable frequency drive including:

- a leak-tight chamber including a shaft going through it, said shaft projecting from said leak-tight chamber through a partition wall provided with a rotary mechanical seal;
- an electric motor placed outside said leak-tight chamber and facing said partition wall, connected to said shaft for operating same;
- a plurality of drive impellers attached to said shaft for rotating integrally therewith, and inscribed in said leak-tight chamber, said liquid being driven and the liquid pressure successively increased by the rotation of said drive impellers from at least one liquid inlet to at least one liquid outlet, said liquid inlet and said liquid outlet communicating the inside of said leak-tight chamber respectively with a liquid supply pipe and with a liquid discharge pipe;
- a control assembly integrating a variable frequency drive electrically connected to said motor for powering it and for controlling its operating parameters.

[0006] Said motor drives the rotation of a shaft which, after going through a leak-tight, rotary mechanical seal, is introduced into a leak-tight chamber in which the rotation of one or more drive reels, attached in successive positions on said shaft, drives a liquid contained in said leak-tight chamber, increasing its pressure, from a liquid inlet located at one end of the leak-tight chamber to a liquid outlet located at an opposite end of the leak-tight chamber.

[0007] In a novel manner it is proposed that at least part of said control assembly is located on said partition wall and in thermal contact with same for the cooling thereof, and housed between the partition wall and the motor.

[0008] The present invention therefore proposes locating the control assembly regulating the operating parameters of the electric motor between said motor and the leak-tight chamber, in a position adjacent to the rotary mechanical seal, and in thermal contact with the wall of the leak-tight chamber surrounding said rotary mechanical seal. This location of the control assembly allows the heat generated by said control assembly during operation thereof to be conducted through said wall of the leak-tight chamber, and then dissipated into the pumped liquid circulating through the inside of said leak-tight chamber in contact with said wall.

[0009] It will be understood that the control assembly is made up of sensor elements and/or electrical or electronic control and regulation elements, such as, for example, a transformer, a variable frequency drive, a transducer, etc., said elements being able to generate information that can be communicated to a user by means of indicators or signals, and the operating parameters of the pump being able to be modified by means of regulation thereof, the control assembly being able to be manually or automatically regulator by means of actuators, or by means of a PLC (Programmable Logic Controller) or the like.

[0010] According to an additional embodiment, it is proposed that said partition wall includes a heat dissipating relief on at least one of its two opposite faces. Said dissipating relief is a relief on the surface of said wall which increases the surface area for heat exchange.

[0011] Alternatively, it is proposed that said partition wall includes a transducer in contact with the inside of the leak-tight chamber for detecting the pressure of the liquid contained in the leak-tight chamber, and the transducer being connected to the control assembly.

[0012] According to another embodiment, it is proposed that the motor includes a cooling fan coaxial with the mentioned shaft, said fan being located between the

control assembly and the motor to generate a cooling airflow, part of which causes additional cooling of the control assembly.

[0013] Alternatively, it is contemplated that said cooling fan coaxial with the shaft is located at one end of the motor away from the control assembly, and the motor being at least partially enclosed with a casing defining longitudinal pipes around the motor which channel part of the airflow driven by said fan towards the control assembly for the additional cooling thereof.

[0014] It is also proposed that the control assembly partially surrounds the shaft defining a passage with a width greater than the diameter of the shaft, to allow removing the control assembly in a radial direction with respect to said shaft. This construction will allow installing and uninstalling the control assembly without having to separate the motor from the leak-tight chamber, since the shaft is not completely surrounded by the control assembly.

[0015] Additionally, it is proposed that the control assembly has electrical connections complementary with other electrical connections located in the pump, allowing quick removal and disconnection of the control assembly with respect to the rest of the pump. The mentioned electrical connections can optionally be envisaged to allow connection and disconnection thereof with respect to the other electrical connections by means of moving the control assembly in the mentioned radial direction.

[0016] Additionally, the inclusion of a screen is also proposed, said screen separating the control assembly with respect to the rotary mechanical seal and the shaft, which prevents minor water leakages that go through the rotary mechanical seal from being able to damage the control assembly.

[0017] It will be understood that references to geometric positions, such as for example, parallel, perpendicular, tangent, etc., allow deviations of up to $\pm 5°$ with respect to the theoretical position defined by said nomenclature.

[0018] Other features of the invention will be shown in the following detailed description of an embodiment.

Brief Description of the Drawings

[0019] The foregoing and other advantages and features will be more clearly understood based on the following detailed description of an embodiment in reference to the attached drawings which must be interpreted in an illustrative and non-limiting manner, in which:

> Figure 1 shows an exploded perspective view of a multistage centrifugal pump in which the motor, the fan and the control assembly are shown removed from their position.

Detailed Description of an Embodiment

[0020] Figure 1 shows, according to a non-limiting embodiment, a multistage centrifugal pump provided with a control assembly 50 with a variable frequency drive, which allows it to regulate the operating parameters of the pump, particularly pressure or flow rate as well.

[0021] Multistage pumps are made up of an electric motor 20 with a drive shaft 21 projecting therefrom, said drive shaft 21 goes through a rotary mechanical seal 22 and is introduced in a leak-tight chamber 10 in which reels attached to the shaft 21 drive a liquid, increasing its pressure, pumping it by drawing in liquid through a liquid inlet 31 located at one end of the leak-tight chamber 10, and ejecting said liquid through a liquid outlet 41 of the leak-tight chamber 10.

[0022] A control assembly 50 provided with a variable frequency drive regulates the electricity supplied to the motor 20, which allows controlling its speed and rotor torque, thereby regulating pump operating speed and power.

[0023] Said control assemblies 50 tend to heat up, so the cooling thereof is required to prevent early failures or deteriorations. The present invention proposes locating said control assembly 50 between the electric motor 20 and the leak-tight chamber 10, at least one part of the control assembly 50 being in thermal contact with a partition wall 11 which separates the leak-tight chamber 10 from the motor 20 with the rotary mechanical seal 22 going through it preventing liquids from exiting through it. Proper thermal contact can be assured by means of a paste, mass or adhesive with heat conducting properties.

[0024] Optionally, the face of the partition wall 11 in contact with the pumped liquid will have a relief formed on its surface or obtained by means of attaching an element superposed on said partition wall 11 in thermal contact with same. The purpose of this relief is to increase the contact surface existing between the partition wall 11 and the pumped liquid, thereby achieving greater heat exchange, and therefore a more efficient cooling.

[0025] Said control assembly 50 is located around the point in which the shaft 21 goes through the rotary mechanical seal 22, but in order to make the installation and maintenance thereof easier, it has been envisaged that the control assembly 50 does not completely surround said shaft 21, rather only partially, thereby freeing up a passage which allows removing or installing the control assembly 50 by means of a radial movement thereof with respect to said shaft 21. In this case, the control assembly adopts a U shape, shown in Figure 1, removed in the mentioned radial direction.

[0026] It is also contemplated that the electrical connections between said control assembly 50 and the rest of the pump are made by means of connectors having an axial connection which allow a quick and simple connection and disconnection of both elements, making the mounting replacement, and maintenance thereof easier. Said connectors will preferably be located such that the connection and disconnection thereof is done in the same radial direction in which the insertion or removal of the control assembly 50 of the body of the pump takes place,

allowing the insertion and connection to be performed simultaneously. An example of this embodiment would consist of a quick connection of the control assembly 50, formed by pins parallel to the direction of insertion of the control assembly 50 in the pump, located on the front side of the control assembly 50, said pins coinciding with complementary connectors located in an inner wall of the pump, facing said pins, the pins being connected to said connector once the control assembly 50 is mounted on the wall of the dissipator.

[0027] Additionally, is contemplated that the motor 20 includes a fan 23 coaxial to the shaft 21 connected thereto at one of its two ends, such that the rotation of said fan 23 causes an air circulation around the motor 20, cooling it. Said air circulation also cools the control assembly 50, preferably by means of deflectors directing part of said airflow against the exposed surface of the control assembly 50.

[0028] In one embodiment that is not shown, said fan 23 is located between the control assembly 50 and the motor 20, whereas in another embodiment illustrated in Figure 1, the fan 23 is at the end of the motor 20 furthest away from the control assembly 50. In both cases, there is preferably a casing defining pipes or channels around the motor 20 for channeling the airflow along the entire length of the motor 20, thereby achieving a better and more homogeneous cooling thereof. Air outlets or inlets will be located in a perimetral position adjacent to the control assembly 50, thereby getting the airflow to come into contact with said control assembly 50, cooling it.

[0029] A screen is arranged surrounding the rotary mechanical seal 22 and the shaft 21 going through it, physically separating them from the control assembly 50, thereby protecting said control assembly 50 from possible leakage of pumped liquid that may accidentally go through the rotary mechanical seal 22.

Claims

1. A multistage centrifugal pump for pumping liquids with a cooled variable frequency drive including:

   • a leak-tight chamber (10) including a shaft (21) going through it, said shaft projecting from said leak-tight chamber through a partition wall (11) provided with a rotary mechanical seal (22);
   • an electric motor (20) placed outside said leak-tight chamber (10) and facing said partition wall, connected to said shaft (21) for operating same;
   • one or more drive impellers attached to said shaft (21) for rotating integrally therewith, and inscribed in said leak-tight chamber (10), said liquid being driven and the liquid pressure successively increased by the rotation of said drive impellers from at least one liquid inlet (31) to at least one liquid outlet (41), said liquid inlet (31) and said liquid outlet (41) communicating the inside of said leak-tight chamber respectively with a liquid supply pipe and with a liquid discharge pipe;
   • a control assembly (50) integrating a variable frequency drive electrically connected to said motor (20) for powering it and for controlling its operating parameters;
   characterized in that
   said control assembly is at least partially located on said partition wall (11) and in thermal contact with same for the cooling thereof, and housed between the partition wall (11) and the motor (20).

2. The centrifugal pump according to claim 1, **characterized in that** said partition wall (11) includes a heat dissipating relief on at least one of its two opposite faces.

3. The centrifugal pump according to claim 1 or 2, **characterized in that** said partition wall (11) includes a transducer in contact with the inside of the leak-tight chamber (10) for detecting liquid pressure, and connected to said control assembly (50).

4. The centrifugal pump according to claim 1, 2 or 3, **characterized in that** the motor (20) includes a cooling fan (23) coaxial with the mentioned shaft (21), said fan (23) being located between the control assembly (50) and the motor (20) to generate an airflow part of which causes additional cooling of the control assembly (50).

5. The centrifugal pump according to claim 1, 2 or 3, **characterized in that** the motor (20) includes a cooling fan (23) coaxial with the mentioned shaft (21), said fan (23) being located at one end of the motor (20) away from the control assembly (50), and the motor (20) being at least partially enclosed with a casing defining longitudinal pipes along the motor (20) which channel part of the airflow driven by said fan (23) towards the control assembly (50) for the additional cooling thereof.

6. The centrifugal pump according to any one of the preceding claims, **characterized in that** the control assembly (50) partially surrounds the shaft (21) defining a passage with a width greater than the diameter of the shaft (21), to allow removing the control assembly (50) in a radial direction with respect to said shaft (21).

7. The centrifugal pump according to any one of the preceding claims, **characterized in that** the control assembly (50) has electrical connections complementary with other electrical connections located in the pump, allowing removal and disconnection.

8. The centrifugal pump according to claims 6 and 7, **characterized in that** the mentioned electrical connections are envisaged to allow connection and disconnection thereof with respect to the other electrical connections by means of moving the control assembly (50) in the mentioned radial direction.

9. The centrifugal pump according to any one of the preceding claims 6 to 8, **characterized in that** a screen separates the control assembly (50) from the rotary mechanical seal (22) and the shaft (21).

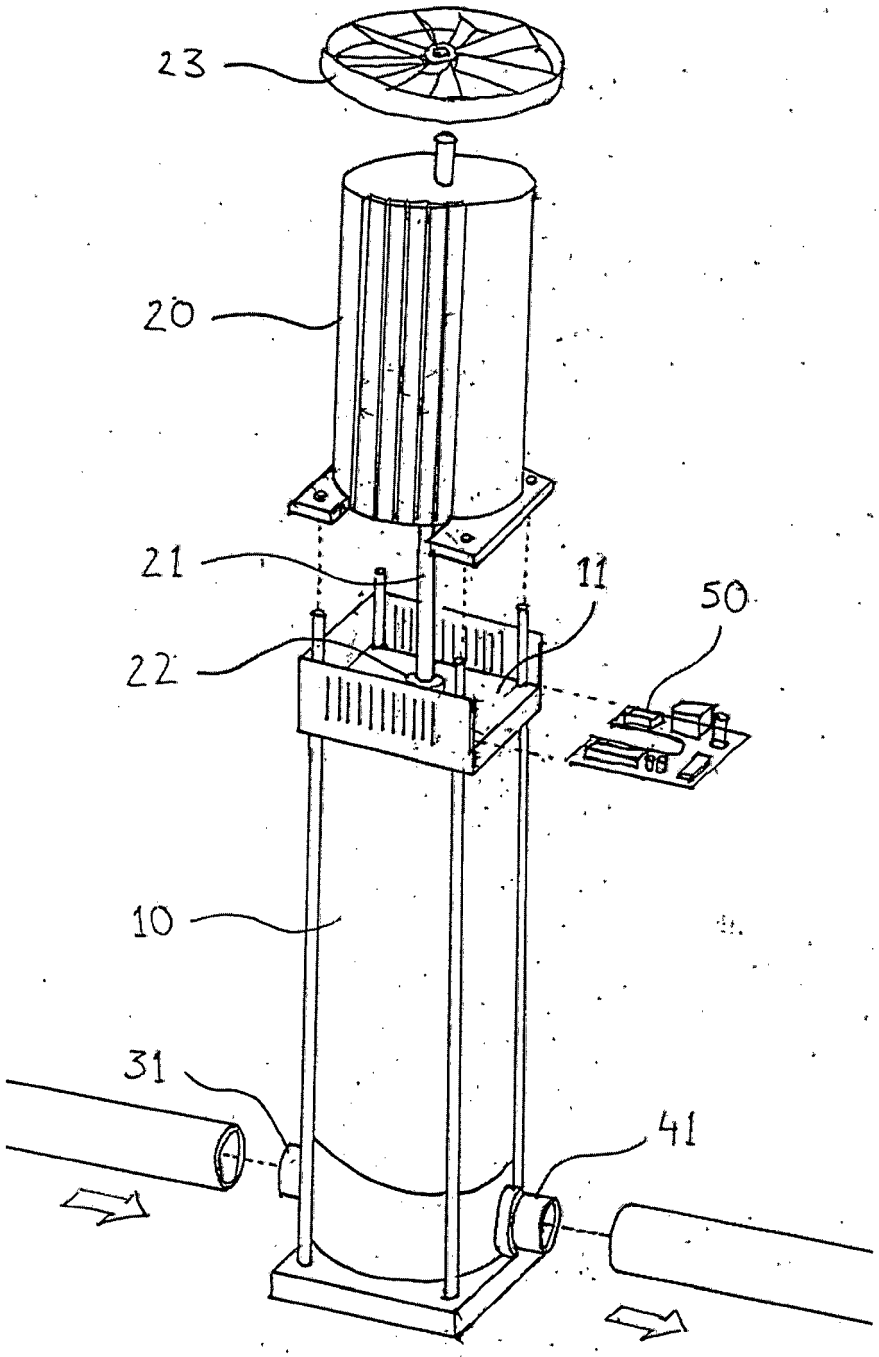

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 15 38 0040

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y A	DE 36 42 726 A1 (GRUNDFOS INT [DK]) 23 June 1988 (1988-06-23) * claim 1; figures 1,3 * -----	1,2,4,5, 7,9 3 6,8	INV. F04D13/06 F04D29/58 F04D1/06 F04D13/02
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A	DE 199 27 741 A1 (DENSO CORP [JP]; ASMO CO LTD [JP]) 23 December 1999 (1999-12-23) * figures 1,2 * -----	6	

TECHNICAL FIELDS SEARCHED (IPC)
F04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 March 2016	Brouillet, Bernard

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 38 0040

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21-03-2016

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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