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(54) LOW-NOISE PUMP COOLED BY THE PUMPED WATER

(76) Inventor: Gianni Ottoboni, Padova (IT)

Correspondence Address:
HARRISON & EGBERT
412 MAIN STREET
7TH FLOOR
HOUSTON, TX 77002 (US)

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(57) ABSTRACT

The invention is a new pump comprising an electric immersion motor (M) and two or more centrifugal impellers (G) enclosed by two concentric cylindrical jackets (Ci, Ce), so as to create an interspace (Ia) between the internal jacket (Ci) and the motor (M) and an interspace (Im) between said two jackets (Ci, Ce). The pumped water flows through the internal interspace (Ia) striking the motor (M), passes through the centrifugal impellers (G) and through the interspace (Im) between the two jackets (Ci, Ce) before being expelled by the pump. The internal jacket (Ci) has a hole (Cio) in its bottom (Cif), through which the volume inside the internal jacket (Ci) communicates with the interspace (Im). The two connections (Oa, Om) are positioned radially to the jackets (Ci, Ce), opposite each other and coaxial. An inverter controls the pump automatically.

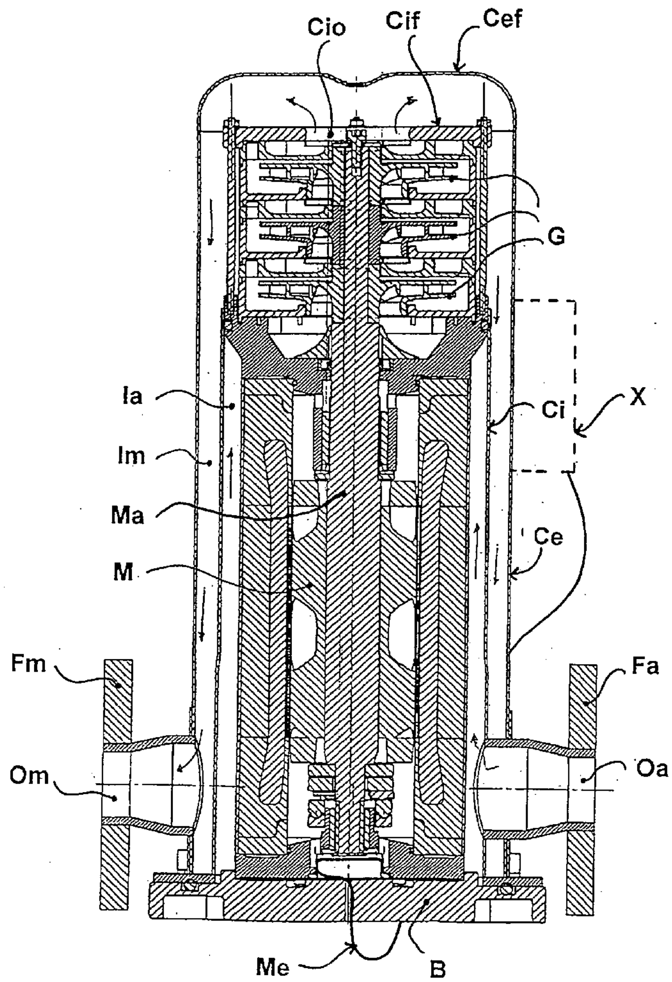
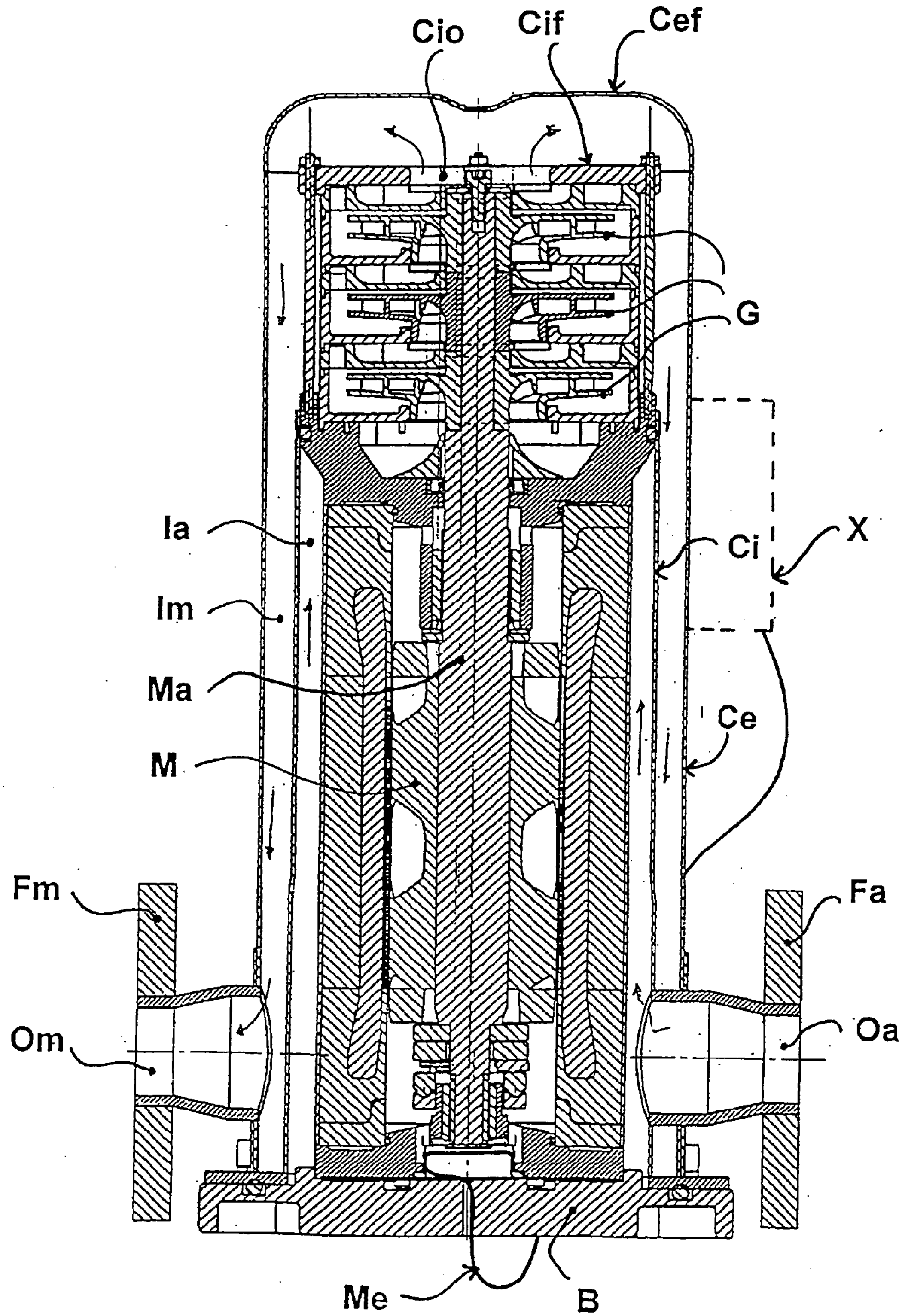


FIGURE 1



LOW-NOISE PUMP COOLED BY THE PUMPED WATER

RELATED U.S. APPLICATIONS

[0001] Not applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

REFERENCE TO MICROFICHE APPENDIX

[0003] Not applicable.

FIELD OF THE INVENTION

[0004] This patent pertains to waterpumps and, in particular, refers to anew, low-noise pump cooled by the same water pumped and conveyed in coaxial jackets wrapped around the motor and the pump impellers.

BACKGROUND OF THE INVENTION

[0005] Surge tank systems or motor pumps installed between the city water supply line and the building water plant are used to maintain constant pressure even at the upper floors of high buildings.

[0006] Surge tank systems are very expensive and bulky and normally are used for large building complexes, such as hospitals, schools and other similar structures.

[0007] The motor pump systems, which are cheaper and not so unwieldy, have some defects, including high noise levels.

[0008] In the attempt to maintain adequate pressure during variations in flow rate, such motor pumps are operated following "on and off" logic.

[0009] Currently, surge tank pumping systems consist of various parts, including a reservoir, a centrifugal pump and a compressor.

[0010] The centrifugal pump introduces water into the reservoir, maintaining the water level.

[0011] The compressor maintains adequate pressure in the reservoir, introducing air into the upper part of said reservoir.

[0012] Additional pressure switches, pressure gauges and control valves are used to start the pump and/or the reservoir when necessary and adjust the pressure of the water being delivered from the reservoir.

[0013] These surge tank pumping systems are not only bulky, but also have significant disadvantages, including: the use of numerous parts which must comply with various standards that also differ for installations in different countries, reliance by pumps and compressors on power supply frequency even with similar voltage, high energy consumption with low efficiency, high noise levels and installation complexity.

BRIEF SUMMARY OF THE INVENTION

[0014] A new type of low-noise pump cooled with the same pumped water has been designed and implemented to eliminate the aforementioned problems.

[0015] One of the purposes the new pump is to limit the intensity and the frequency of the noise emitted.

[0016] Another purpose of the new pump is to ensure that the motor is properly cooled not by using oil or other re-circulated fluids, but by using the same pumped water.

[0017] Another purpose of the new pump is to maintain constant pressure during variations in flow rate of the water needed for the plant being supplied.

[0018] Another purpose of the invention is to allow the new pump to be installed in existing plants, limiting operations and necessary accessories.

[0019] These and other direct and complementary purposes have been achieved through the implementation of the new pump, which comprises two coaxial cylindrical jackets, of which the internal one houses the motor and the centrifugal impellers superimposed and coaxial to the motor. The internal jacket and the external jacket communicate through a hole in the internal jacket, in correspondence with the last impeller. Two opposing and coaxial radial suction and delivery conduits are connected with the internal jacket and with the interspace between the two jackets, respectively. The suctioned water flows from the special conduit, strikes the motor casing, cooling the motor, is suctioned by the impellers and sent into the interspace between the two jackets, from where it exits through the delivery conduit.

[0020] An inverter, consisting of an electric power static converter in two main water input and output sections, controls and manages the operation of the motor and of the whole pump, such as: automatic management of dry operation and relative stop intervals and restart attempts, pump automatic start-up with relative acceleration and deceleration times, insertion of pause times between a start signal and a stop signal with programmable duration, possible high-torque pump start-up.

[0021] The features of the newpump will be more clearly defined in the following description of one among many possible applications of the invention, with reference to the drawing attached.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0022] The FIGURE illustrates a vertical cross-section of the new pump.

DETAILED DESCRIPTION OF THE INVENTION

[0023] The new pump mainly comprises two coaxial cylindrical jackets (Ci, Ce), an electric motor in a water bath (M), several centrifugal impellers (G) and two connecting conduits (Oa, Om).

[0024] The two jackets (Ci, Ce) are shaped like a cup, i.e. they consist of two metallic cylinders with a closing bottom (Cif, Cef) at one end, and one (Ci) is contained in the other (Ce). A base (B) applied to the open ends of the two jackets (Ci, Ce) closes said two jackets (Ci, Ce) and keeps them reciprocally positioned so as to form a cylindrical interspace (Im) between said two jackets (Ci, Ce).

[0025] The internal jacket (Ci), in particular, has a hole (Cio) in its bottom (Cif) so that the volume inside the internal jacket (Ci) communicates with the interspace (Im) between said two jackets (Ci, Ce).

[0026] The two connecting conduits (Oa, Om) are connected to said two jackets (Ci, Ce). In particular, the connecting conduit (Ca) through which the water is suctioned, subsequently called the suction connection (Oa) is connected with the internal jacket (Ci) passing through the side wall of the external jacket (Ce), while the connecting conduit (Cm) through which the water is conveyed, subsequently called the delivery connection (Om), is connected only with the externaljacket (Ce) and the interspace (Im) between the two jackets (Ci, Ce).

[0027] Said two connections (Oa, Om) are connected to the two jackets (Ce, Ci) in proximity to the closing base (B) and are positioned opposite each other and coaxial. Each of the two connections (Oa, Om) has, on its free end, a flange (Fm, Fa) that connects and joins the water drawing and pumped water delivery piping.

[0028] The internal jacket (Ci) houses the electric motor (M) and the centrifugal impellers (G) positioned coaxially to the same internal jacket (Ci).

[0029] The electric motor (M) is housed inside the internal jacket (Ci) so as to rest on the base (B) and so that its rotating shaft (Ma) is facing the hole (Cio) in the bottom (Cif) of the internal jacket (Ci). The power supply cable (Me) of the motor (M) runs through said base (B). The diameter of the motor (M) casing is shorter than the internal diameter of the internal jacket (Ci), so that a cylindrical interspace (Ia) is formed between said motor (M) and said internal jacket (Ci).

[0030] Two or more centrifugal impellers (G), coaxial and in series to each other, are joined on the part of the rotating shaft (Ma) external to the motor (M).

[0031] Both the form of the centrifugal impellers (G) and their layout are such as to draw water from the interspace (Ia) between the motor (M) and the internal jacket (Ci) and to convey it under pressure into the interspace (Im) between the two jackets (Ci, Ce) through the hole (Cio) in the bottom (Cif) of the internal jacket (Ci).

[0032] The new pump built as described above is connected to the water drawing and pumped water delivery piping by means of the flanges (Fa, Fm) of its connections (Oa, Om) and is connected to the electric system.

[0033] The inverter (X) comprises an electric power static converter divided into two main sections: the input section and the output section. The input section consists of a diode rectifier connected to the power mains that con ectric power from AC to DC. The output section consists of an IGBT, three-phase inverter that converts electric power from DC to AC while controlling the frequency and amplitude of the generated AC voltage. The semi-conductor devices that are part of the converter are installed on a cooler that removes the heat dissipated during operation. The power section of the static converter also includes an anti-disturbance filter located on the input of the static converter, between the power mains and the diode rectifier, to meet the equipment electromagnetic compatibility requirements (EMC filter) and a capacitance filter located on the DC side to level the voltage supplied by the rectifier. The electric drive is also equipped with cutouts against overloads, short-circuits and earth faults of the motor (M), missing phase and overheating of the dissipator and power devices.

[0034] The drive control system, which consists of a microprocessor card, performs two functions. The first involves control of the relative hydraulic parameter (flow rate, pressure) and is carried out using a PID regulator. The regulator output supplies the motor (M) with the speed needed to maintain the hydraulic parameter at the set value.

[0035] The second control function is applied to the static converter that must feed the motor (M) so that its speed reaches the required value.

[0036] The control function is carried out by setting the inverter output voltage frequency, i.e. the fundamental (useful) frequency with which the inverter IGBTs are turned on/off. In fact, they are switched to a higher frequency in order to "modulate" the output from the inverter, so that the average value of the voltage that it supplies during the switching period has a sinusoidal pattern in the fundamental (useful) period. With modulation operation, the current that feeds the motor (M) has a sinusoidal waveform and the motor efficiency is not reduced by the electromagnetic losses associated to current harmonics. In addition to setting the motor (M) power supply voltage frequency, the drive control system also modifies voltage amplitude accordingly. The modification is used to regulate the amplitude of the machine flux in order to minimize the leaks in the motor (M) magnetic circuit under all operating conditions.

[0037] The control card has an analog input to acquire the signal supplied by the transducer of the controlled hydraulic parameter and some digital inputs to acquire the motor (M) start, stop and reset controls and the alarm signal supplied by the thermal probe installed on the motor (M).

[0038] The control program implemented on the microprocessor can carry out hydraulic pump management and control operations with operating parameters that can be set by the user through a keyboard interface. The main operations carried out by the control program are the following:

[0039] i) automatic management of dry operation: the time values of the stop intervals and restart attempts can be set for this type of operation;

[0040] ii) pump automatic start-up: the relative operating parameters are the acceleration and deceleration times;

[0041] iii) insertion of pause times between a run control and a stop control with programmable duration;

[0042] iv) possible high-torque pump start-up.

[0043] The water suctioned by the new pump through the suction connection (Oa) flows into the interspace (Ia) between the internal jacket (Ci) and the motor (M), cooling said motor (M). Subsequently, that water is conveyed from the centrifugal impellers (G) into the interspace (Im) between the two jackets (Ci, Ce) through the hole (Cio) on the bottom (Cif) of the internal jacket (Ci). Flowing through said last interspace (Im) between the, two jackets (Ci, Ce), the water transfers the heat previously absorbed by the motor (M) to the external jacket (Ce) and to the external environment.

[0044] In this way, the heat generated by the motor (M) and by the centrifugal impellers (G) during their rotation is first absorbed by the pumped water and then transferred to the external environment (air) through the wall of the external jacket (Ce).

[0045] The noise generated by the motor (M) and by the centrifugal impellers (G) while they are operating is absorbed and dampened by the double layer of water circulating in the two interspaces (Ia, Im).

[0046] Thanks to the coaxial and opposing layout of the two suction (Oa) and delivery (Om) connections, the new pump can be installed in any application.

[0047] If existing pumps are replaced, it is sufficient to remove the previous pump and install the new pump, using connecting conduits if necessary.

[0048] If the new pump is installed for the first time along an existing continuous conduit, said existing conduit need only be cut to a length equal to the distance between the flanges (Fa, Fm) of the new pump, the two union flanges must be welded to the two ends of the existing conduit and the new pump must be joined between said two flanges of said existing conduit.

[0049] Therefore, with reference to the previous description and the attached drawing, the following claims are put forth.

1. Pump, comprising:

an electric immersion motor having an axle connected to at least two centrifugal impellers; and

at least two concentric cylindrical jackets enclosing the motor with the concentric impellers so as to create an a first interspace between an internal jacket and the motor and a second interspace between the jackets; and wherein pumped water flows through the first interspace striking the motor, passes through the centrifugal impellers and flows through the second interspace between the two jackets before being expelled.

2. Pump according to claim 1, further comprising: a suction connection through which water is suctioned, connected to the internal first jacket passing through a side wall of the external second jacket, and wherein, while delivery connection through which the water is conveyed, said suction connection is connected only to the external second jacket and the second interspace between the two jackets, and wherein said two connections are positioned radially to the jackets opposite to each other and coaxial.

3. Pump according to claim 1, wherein the jackets are shaped like a cup, each being comprised of two metallic cylinders with a closing bottom at one respective end, and wherein the internal jacket has a hole in its bottom, through which a volume inside the internal jacket communicates with the second interspace between said two jackets, and wherein a base applied to the open ends of the two jackets closes said two jackets and keeps them the jackets in their reciprocal positions.

4. Pump according to claim 1 wherein the electric motor is housed inside the internal jacket, resting on the base and forming between said motors and said internal jacket a cylindrical interspace, and wherein the centrifugal impellers applied to the rotating shaft of the motor draw the water from the first interspace between the motor and the internal jacket and convey it the water under pressure into the second interspace between the two jackets through the hole in the bottom of the internal jacket.

5. Pump according to claim 1, further comprising: an inverter comprised of an electric power static converter in two main water input and output sections, controlling and managing all motor and all pump operations.

6. Pump according to claim 5, wherein said inverter automatically manages dry operation and relative stop intervals and restart attempts, pump automatic start-up with relative acceleration and deceleration times, insertion of pause times between a start control and a stop control with programmable duration, possible high-torque pump start-up.

7. Pump according to claim 5, wherein said inverter further comprises an electric power static converter divided into two main sections: the input section and the output section, and wherein the input section is comprised of a diode rectifier connected to the mains power supply and converts electric current from AC to DC and wherein the output section consists of an IGBT three-phase inverter and converts the electric current from DC to AC with frequency and amplitude control of the generated AC voltage.

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