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(54) Electric motor for submersible pump.

(57) In a submersible pump, the axial thrust exerted by the impeller of the pump is withstood by the upper bearings (6, 6') of the motor, and the stator (2, 3) of the motor is anchored and centered in the frame (1) by means of a system of projections (15a, 15f) provided in the wall of the frame and engaged in corresponding notches of the supporting system of the bearing and of the stator assembly. This produces a reduction in the dimensions of the motor shaft with a reduction of scrap, an improvement in electromechanical performance, as well as simplifications and economies in construction and in assembly.

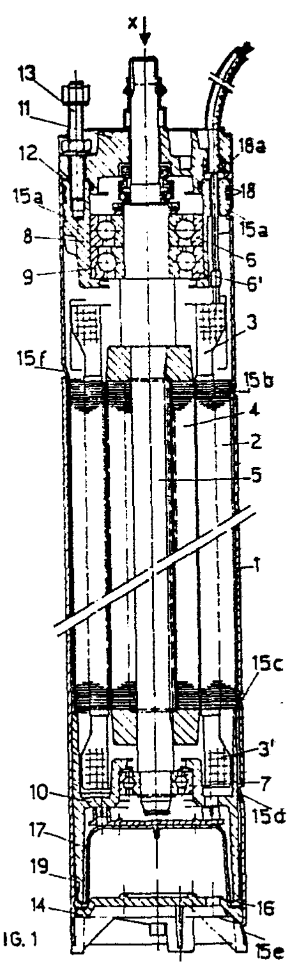

FIG. 1

EP 0 267 444 A2

ELECTRIC MOTOR FOR SUBMERSIBLE PUMP

The present invention relates to an electric motor for submersible pumps with an improved system for the axial anchoring of the motor with regard to the stresses transmitted by the pump, and for the mounting and centering of the stator assembly.

As is known, the impeller of an electric pump transmits an axial thrust through its shaft to the electric motor whereto the pump is directly coupled, the thrust becoming greater as the head of the pump increases. In the case of a submersible pump, intended to lift liquids from relatively great depths and therefore to develop a high head, this thrust is considerable and its absorption by the structural elements of the motor is a mechanical problem affecting the design of the entire electric pump.

In submersible pumps according to the prior art, this axial thrust is transmitted as a compression force by the impeller of the pump to the rotor shaft of the electric motor, and is discharged onto one or more thrust bearings arranged on the opposite side with respect to the coupling to the pump, that is to say at the lower end of the motor shaft, which is mounted with a vertical axis.

This constructive solution forces an oversizing of the diameter of the rotor shaft with respect to the size required by the transmission of the motor torque, in order to make it adapted to withstand the combined bending and compressive stress due to said axial thrust.

This entails, in the first place, a greater scrap for the rotor lamination assembly, due to the greater diameter of the plates which are punched out of the center of the rotor laminations to create the shaft passage in the lamination pack; and in the second place causes greater losses in the iron due to hysteresis and eddy currents, due to the replacement of a part of the rotor's row of magnetic laminations with the steel of the shaft, which is massive and has poorer magnetic properties.

The aim of the present invention is to eliminate the need to oversize the rotor shaft of the submersible electric pump in order to withstand the axial thrust of the impeller, so as to eliminate the above described disadvantages.

Another object of the invention is to improve the simplicity in construction and assembly of the submersible electric pump and to reduce its costs with a simultaneous improvement of its electromechanical performance.

This aim, this object and others are achieved according to the present invention by a motor for submersible electric pumps of the above described type with a tubular frame containing a stator, a rotor torsionally coupled to a shaft rotatably supported within the frame by means of at least one upper bearing and a lower bearing, as well as with elements for supporting the bearings in the frame, axial shaft anchoring elements, elements for the centering and axial and torsional anchoring of the stator, and elements for providing a liquid-tight seal between the interior and the outside of the frame, characterized in that the axial anchoring elements of the shaft are applied to the at least one upper bearing, and in that said at least one upper bearing is a journal thrust bearing.

By virtue of this solution, the shaft of the motor is relieved from the combined bending and compressive stress applied to the shaft of the pump, and can be sized with a smaller diameter with respect to the prior art, with the advantages of less scrap and better electromechanical performance as previously described.

Advantageously, the anchoring elements of said at least one upper bearing consist of an upper support inserted in a liquid-sealing manner within the upper end of the frame and downwardly provided with an axial anchoring abutment for the at least one bearing, of a connecting flange abuttingly fixed into the upper end of the tubular frame and partly protruding therefrom, and of connecting elements for connecting said connecting flange and the upper supporting element.

The containment of the axial thrust within the upper region of the motor obtained by means of the solutions described above advantageously allows to adopt, for the axial and torsional anchoring of the stator and for its centering in the frame, anchoring elements which are considerably simple and economical in manufacture and assembly, consisting of abutment elements or projections, obtained out of the wall of the tubular frame, radially protruding toward the interior thereof and circumferentially spaced from one another along a plurality of circumferences axially spaced along the tubular frame, and engaged in respective peripheral notches of the upper and lower supports and of the stator assembly.

Further advantages and improvements of the present invention will become apparent from the following detailed description of a preferred embodiment, given only by way of non-limitative example and with reference to the accompanying drawings, wherein:

figure 1 is a longitudinal cross section of the preferred embodiment of the electric motor according to the present invention, along the line I-I of figure 2, with a central portion removed for convenience in illustration;

figure 2 is a view of the same from the upper end in the direction X of figure 1;

figure 3 is a detail view of the upper part of the electric motor of figures 1 and 2, in longitudinal cross section, along the line III-III of figure 2;

figures 4, 5, and 6 respectively illustrate the position of the anchoring projections in the frame, and an enlarged detail of a projection in longitudinal and transverse cross section.

For the sake of simplicity in description, only the structural elements significant with regard to the present invention will be pointed out.

With particular reference to figure 1, the electric motor for submersible electric pumps illustrated therein consists of: a tubular frame 1; a stator comprising an assembly of magnetic laminations 2 and a stator winding which is contained in the recesses of the lamination assembly 2, its heads 3, 3' being visible in figure 1; a rotor 4 keyed to a shaft 5 supported in the frame 1 by means of the upper roller bearings 6, 6' and of the lower roller bearings 7; supporting elements for the upper bearings, consisting of an upper support 8 with an axial anchoring abutment 9 and of an upper connecting flange 11, abutting with the abutment 12 against the upper edge of the frame 1, the upper support 8 being connected to the upper flange 11 by means of connecting elements consisting of stud bolts 13 (figures 1 and 2); supporting elements for the lower bearing, consisting of a lower support 10 and of a lower flange or bottom 14.

The axial thrust generated by the impeller of the pump, not illustrated, directly coupled by means of a shaft of the pump and a connecting joint, both not shown, to the upper end of the shaft 5, is absorbed by the guiding thrust bearings 6, 6', and discharged onto the frame 1 by means of the upper support 8 and the upper connecting flange 11; this allows the previously described advantages of reducing the weight of the shaft, of reducing scrap and of improving electromechanical performance.

Advantageously, the containment of the axial thrust by means of elements clustered at the upper end of the motor as described above, without affecting the underlying structure of the electrically and mechanically active elements of the motor itself, also makes it possible to adopt elements for the axial and torsional centering and anchoring of the stator assembly and of the support of the lower bearing which are independent from the abovesaid axial anchoring elements of the shaft, and are extremely simple both in manufacture and in assembly. Said elements for anchoring the stator assembly and the lower support consist of abutment means, or projections (15a ÷ 15f, figures 1 and 4) conveniently provided by punching in the wall of the tubular frame 1, protruding towards its interior and spaced circumferentially with respect to one another along a plurality of circumferences which are in turn axially spaced with respect to one another along the tubular frame, said projections (15a ÷ 15f) being engaged in corresponding notches respectively of the upper support, of the laminations of the stator assembly and of the lower support, as well as against the edge of the lower surface of the bottom 14.

Figures 5 and 6 illustrate, by way of example, respectively a longitudinal and a transverse cross section of the detail of a highly enlarged projection.

The approach of anchoring by means of projections, as described above, allows considerable simplification and economy in construction and in assembly with respect to the more expensive and complex systems of the prior art, which provide the use of hollow pins with an inner thread and/or outer locking tension elements and/or threaded plugs, or the enclosure within synthetic resin. Naturally, this last solution has the disadvantage of not allowing access to the motor for maintenance or repairs. The anchoring by means of projections, according to the present invention, provides the further advantage of allowing the adoption of frames obtained from tubes commonly available on the market which have relatively ample size tolerances and are therefore less expensive, without requiring further machining, since the centering of the motor elements is assigned to said projections.

Conveniently, the motor is intended to operate immersed in oil, and for this purpose liquid sealing elements are provided which consist of gaskets, which in the upper part of the motor (the left side in figure 1) are indicated by 18, 18a.

Said gaskets are interposed respectively between the upper support 8 and the frame 1 and between the upper support 8 and the connecting flange 11. The gasket between the lower support 10 and the bottom 14 is instead provided by the edge 16 of a cup-shaped compensating element 17 in elastomeric material acting as a lung, allowing the thermal expansion of the oil contained in the motor.

Obviously, numerous modifications and variations of the present invention are possible according to the above disclosure. Thus it is assumed that the invention can be embodied in a different manner with respect to what has been specifically described.

Claims

1. Electric motor for submersible electric pumps with a tubular frame (1) containing a stator (2, 3), a rotor (4) torsionally coupled to a shaft (5) rotatably supported within the frame by means of

at least one upper bearing (6, 6') and one lower bearing (7), as well as with elements (8.11: 10, 14) for supporting the bearings within the frame, elements (9) for the axial anchoring of the shaft, elements (15a ÷ 15f) for the centering and the axial and torsional anchoring of the stator and elements (18, 18a; 16) for providing a liquid-tight seal between the interior and the outside of the frame, characterized in that the axial anchoring elements (9) of the shaft (5) are applied to the at least one upper bearing (6, 6') and in that said at least one upper bearing is a journal thrust bearing.

2. Electric motor for submersible electric pump according to claim 1, characterized in that the axial anchoring elements of said at least one upper bearing consist of an upper support (8) inserted in a liquid-tight manner (18, 18a) within the upper end of the frame (1) and downwardly provided with an axial anchoring abutment (9) for the at least one bearing (6, 6'), of a connecting flange (11) abuttingly fixed into the upper end of the tubular frame and partially protruding therefrom, and of connecting elements for connecting said connecting flange (11) and the upper supporting element (8).

3. Electric motor for submersible electric pump according to claim 1 or 2, characterized in that the elements for the centering of the stator and for the axial and torsional anchoring thereof consist of abutment elements (15a ÷ 15f) provided in the wall of the tubular frame (1), radially protruding towards the interior thereof and circumferentially spaced with respect to one another along a plurality of circumferences axially spaced apart along the tubular frame and engaged in respective peripheral notches of the upper support (8) and of the lower support (10) and of the stator assembly (2).

4. Electric motor for submersible electric pump according to claim 3, characterized in that the abutment elements (15a ÷ 15f) consist of projections provided in the tubular frame (1) by punching.

5. Electric motor for a submersible electric pump according to any of claims 1 to 4, characterized in that the lower sealing gasket of the motor consists of a substantially toroidal edge (16) of an elastomeric pressure compensating element (17), said edge (16) being compressed between the lower beveled edge (19) of the lower support and a bottom (14) engaged in the series of bottom projections (15e) of the frame (1).

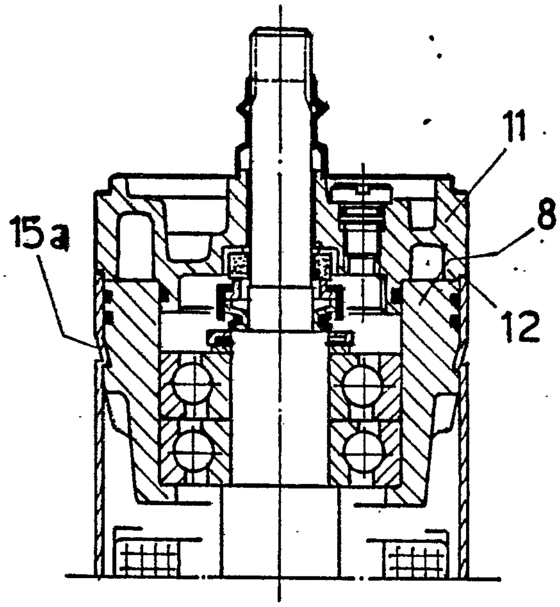

FIG. 3

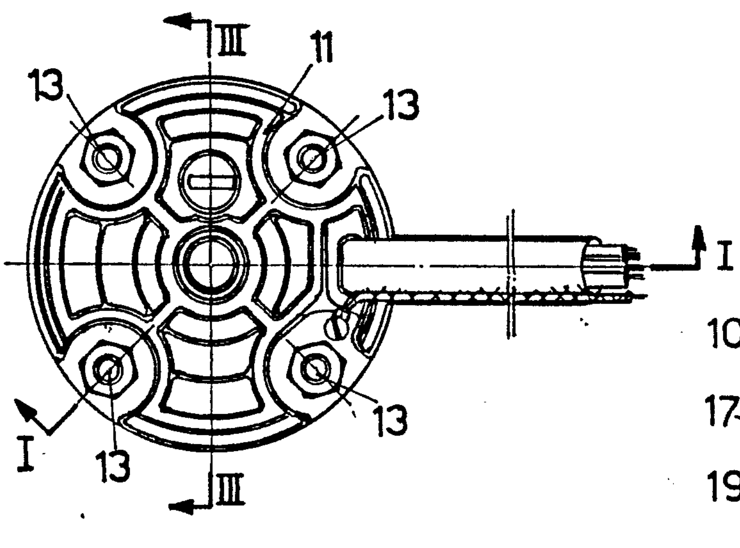

FIG. 2

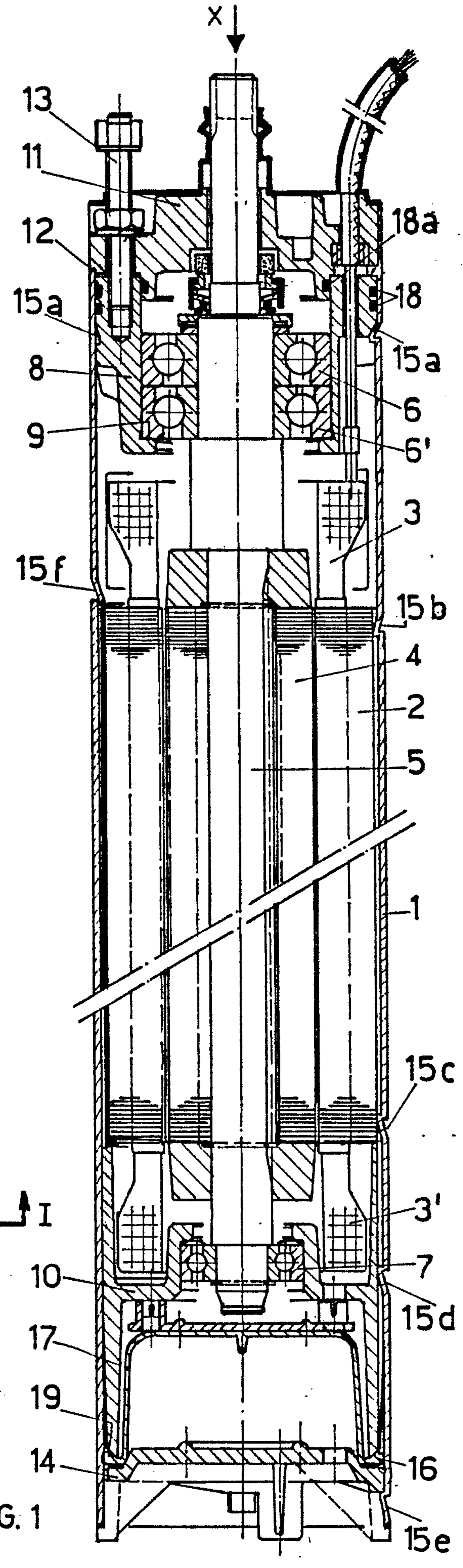

FIG. 1

FIG. 5

FIG. 6

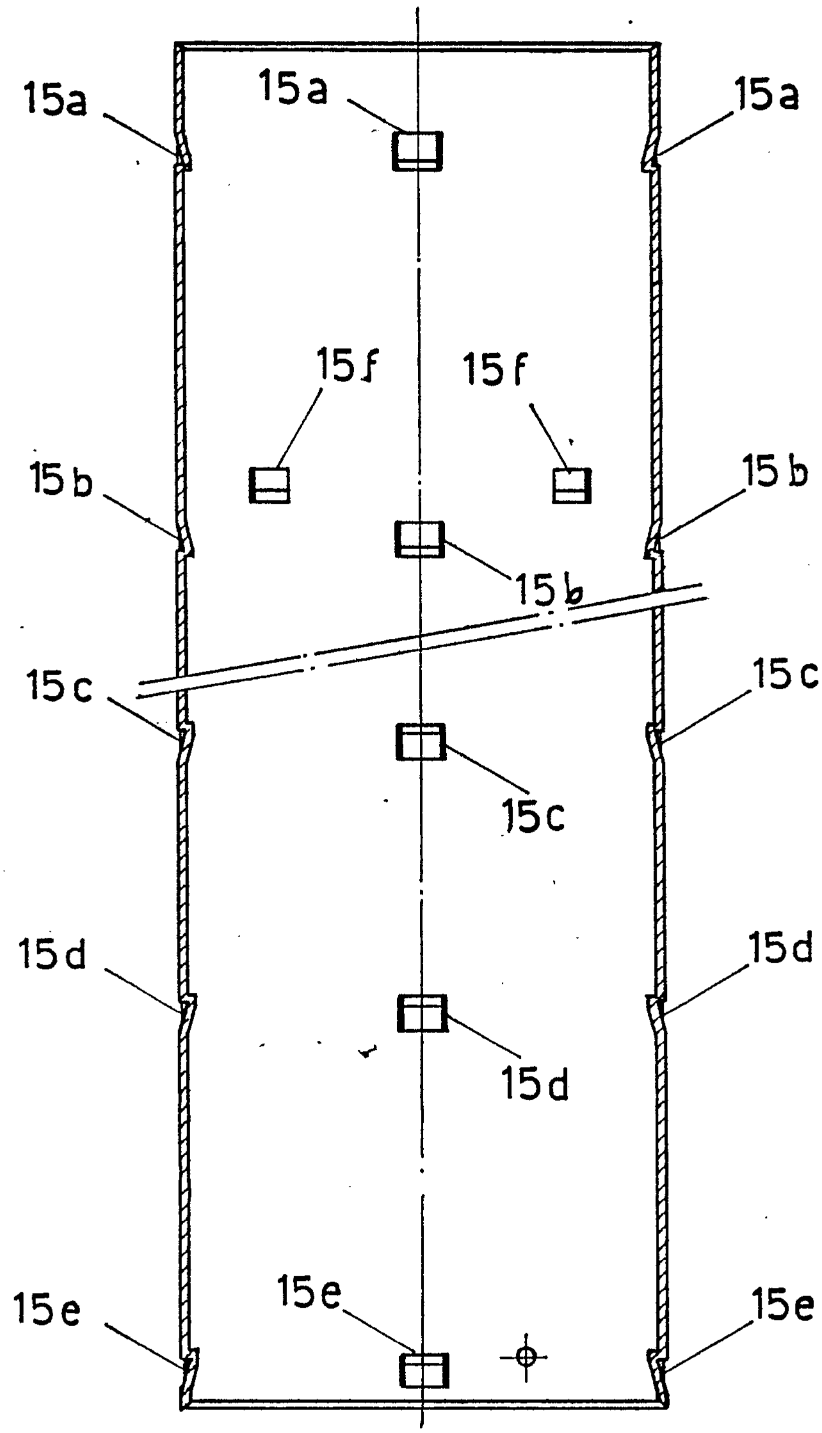

FIG. 4