United States Patent [19] [11] **3,771,910**

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[54] **AXIAL THRUST COMPENSATION FOR CENTRIFUGAL PUMPS**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **417/420,** 415/104, 415/106
[51] **Int. Cl.** **F04b 35/04**
[58] **Field of Search** 415/104, 105, 106; 417/410, 420

[56] **References Cited**

UNITED STATES PATENTS

2,810,349	10/1957	Zozulin	417/420
3,107,310	10/1963	Carriere et al.	417/420
3,354,833	11/1967	Laing	417/420
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Attorney—Pennie, Edmonds, Morton, Taylor & Adams

[57] **ABSTRACT**

An inductive driven centrifugal pump having an impeller mounted in a bearing for limited universal movement and including a seal between the impeller and a portion of the pump casing and fluid passage means connecting opposite sides of the impeller whereby fluid pressure acting on opposite sides of the impeller is equalized.

6 Claims, 4 Drawing Figures

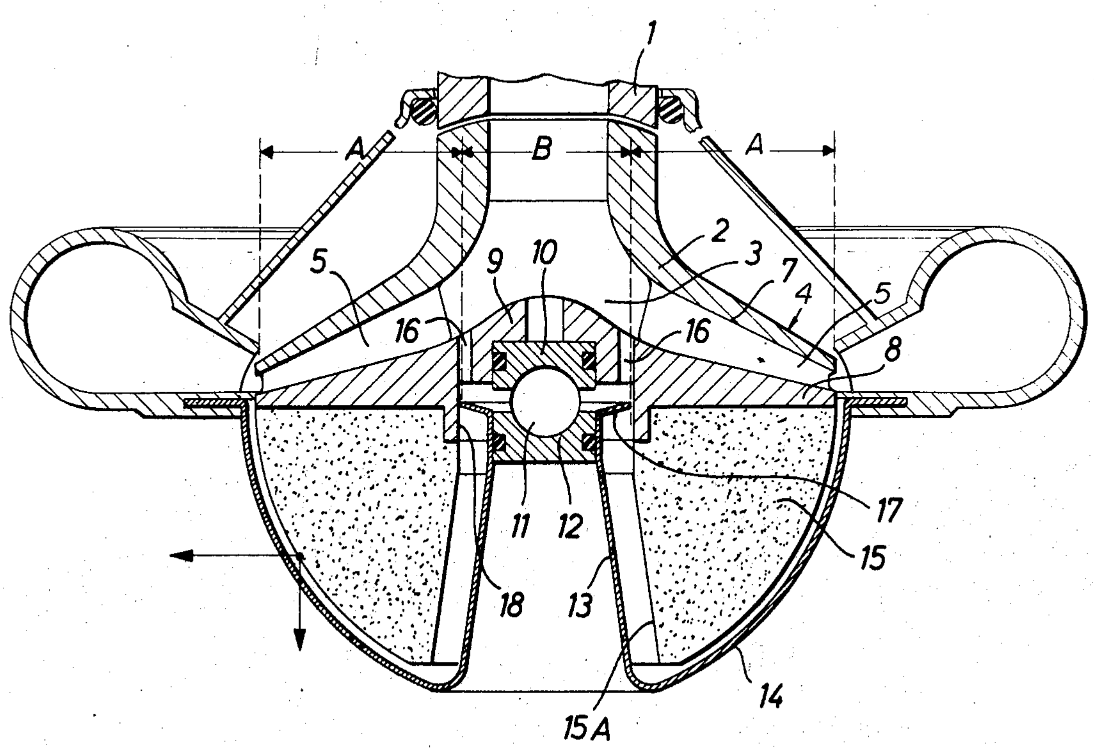

FIG. 1

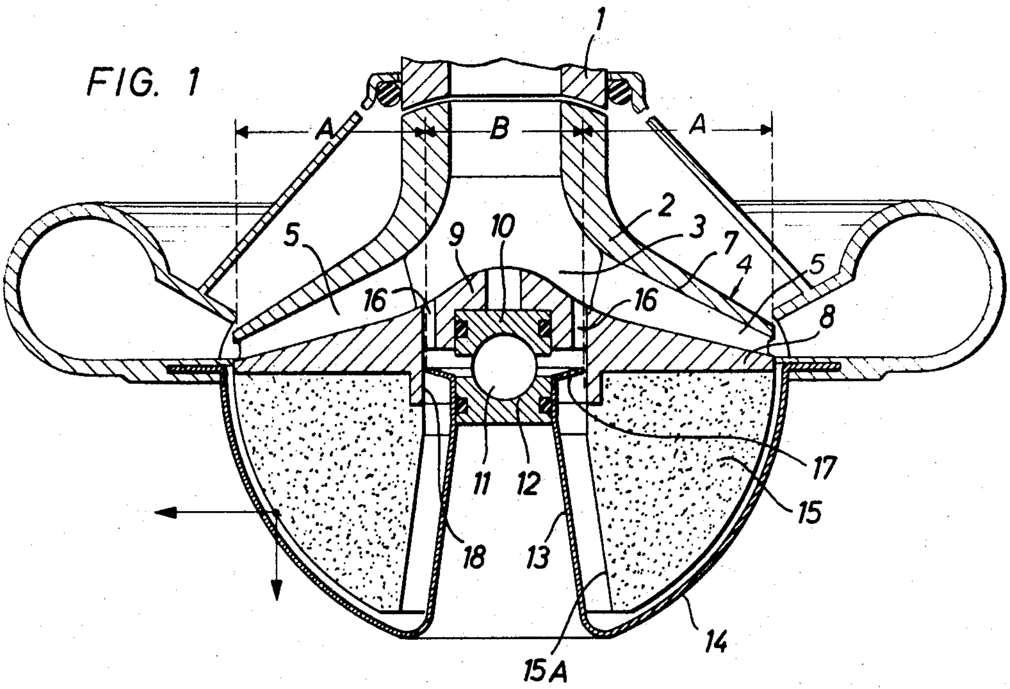

FIG. 2

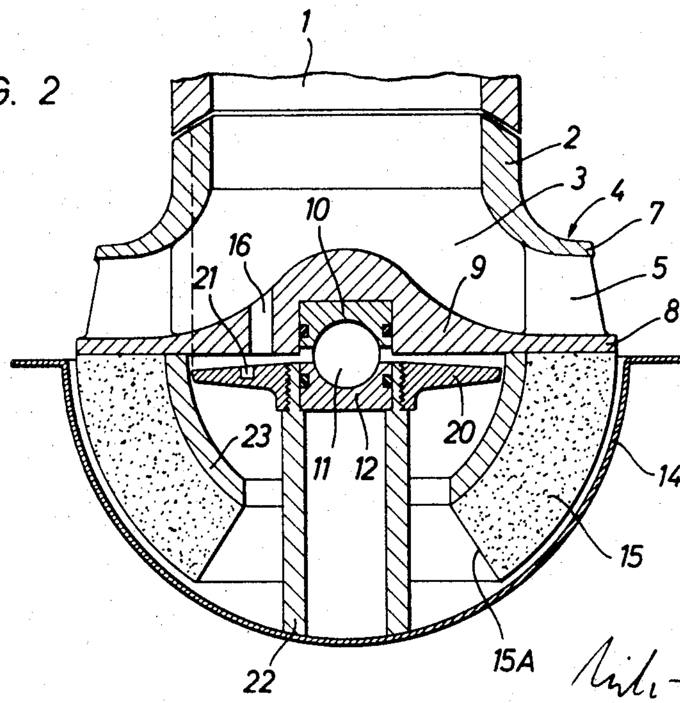

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FIG. 3

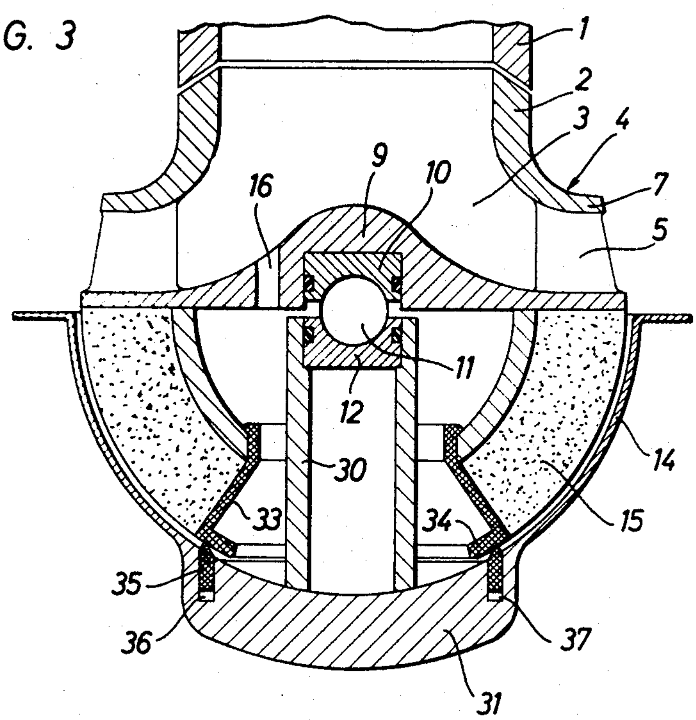
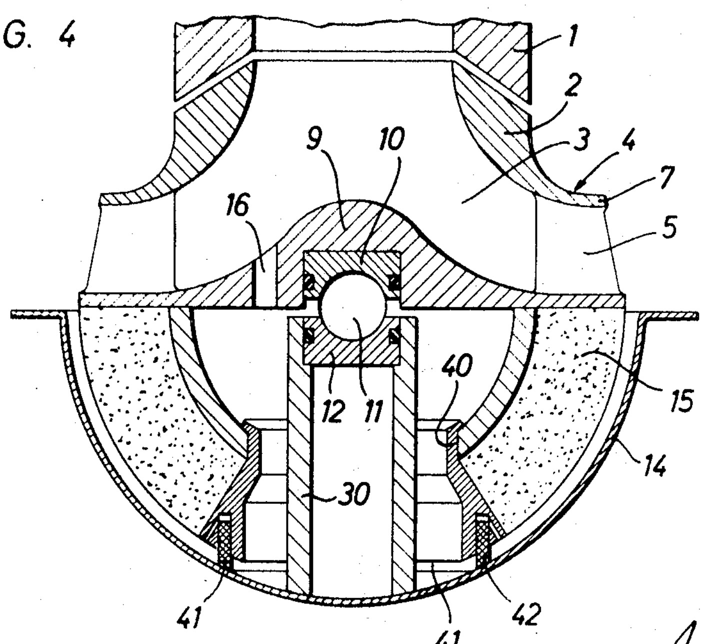


FIG. 4



INVENTOR

AXIAL THRUST COMPENSATION FOR CENTRIFUGAL PUMPS

BACKGROUND OF THE INVENTION

This invention relates to centrifugal pumps of the kind having a shrouded impeller and a single entry eye, the impeller being rotatable in a casing the interior of which is subjected to wholly or partially to the pressure generated by the pump. In such a pump, the impeller is subject to an axial thrust because of the following. The effective front axially-projected area of the intake eye is unbalanced as to the fluid pressure upon it, namely the mean intake pressure (or "suction"), which acts on the upstream or front side of the impeller only; whilst the fluid pressure within the casing acts on the axially projected area of the shroud to result in an axial thrust on the front of the impeller in one sense of direction and in the opposite sense of direction this fluid pressure acts on the back of the impeller over the whole of its projected area. Such pumps are known (and are the particular kind to which the invention applies) in which the impeller rotor unit embodies a magnetic mass having a spherical convex contour corresponding to the spherical concave contour of a thin non-magnetic wall of the casing, there being a small gap between such contours, the rotor unit then being driven as an induction motor by the electromagnetic field of coil windings external to the said wall. For example, centrifugal pumps of this type are described in U.S. Pat. No. 3,354,833. The magnetic forces tend to thrust the rotor unit axially and rearwardly but such thrust is not always sufficient to exceed the net axial thrust due to the fluid pressures above referred to.

When the impeller of such a pump is allowed some universal angular freedom to tilt by running on a spherical-type bearing, the combined effect of the fluid pressure and magnetic thrusts may be such — especially when running in a throttled condtion — as to lift the impeller rotor unit away from such bearing, which is a circumstance which must be avoided.

The main aim of the invention is to ensure, in such a pump, that in all circumstances of running the impeller rotor is held in engagement with the bearing.

SUMMARY OF THE INVENTION

The invention therefore resides primarily in a centrifugal pump of the kind having a single sided shrouded impeller, a casing in which the pump-generated fluid pressure exists or at least a partial pump pressure exists which greater than that in the intake eye, and a spherical bearing and induction a electromagnetic drive where the pump is provided a seal between the impeller rotor unit and the casing at an effective radius such as to define an axially-projected area approximately equal to the effective axially-projected area of the entry eye of the impeller, the bearing being on the low pressure side of the seal, and fluid communication being provided between the entry eye and the front side of the seal.

By this means, the fluid entry pressure normally exerted on one side of the impeller resulting in net forces tending to lift the impeller from the bearing is relieved.

DESCRIPTION OF THE DRAWINGS

The invention includes various embodiments of the foregoing characterising features; four of these are illustrated in the accompanying drawings in which each of

FIG. 1 is a schematic sectional view in the plane of the median axis of rotation and of a diameter of the impeller of a centrifugal pump constructed according to the invention;

FIG. 2 is a view similar to FIG. 1 of a second embodiment of a pump constructed according to the invention;

FIG. 3 is a view similar to FIG. 1 of a third embodment of a pump constructed according to the invention; and

FIG. 4 is a view similar to FIG. 1 of a still fourth embodiment of a pump constructed according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 there is illustrated a fixed intake duct **1** of a centrifugal type pump aligned with a hollow stubshaft **2** leading fluid in to the eye region **3** of the an impeller which is generally indicated at **4.** The impeller has radially-disposed vanes **5** which interattach a front shroud **7** and the impeller disc **8.** The disc **8** is somewhat domed to form a central boss **9,** in which on the rear side of the disc is fixed the rotating cup **10** of a spherical bearing having ball **11** and non-rotating cup **12.** The cup **12** is sealedly secured in a frustoconical axial extension **13** of a thin, nonmagnetic, concavely spherically contoured casing wall **14** which is joined to the pump casing.

The impeller **4** is part of an impeller rotor unit, comprising the impeller itself and a magnetic mass **15** which is convexly spherically contoured to correspond with the wall **14**; the spherical centres of the casing, mass **15**, cups **9** and **12**, are all common with that of the ball **11**, so that the rotor unit as a whole is able to tilt universally as well as to rotate.

External to the wall **14** and not shown, there is provided in known manner as for example as shown in U.S. Pat. No. 3,354,833 electromagnetic winding to drive the rotor unit in the manner of an induction motor. For that reason the gap between the surfaces of **14** and **15** is made minimal. This gap is, however, in effect a chamber charged at the pump-generated pressure. This pressure is operative therefore on the rearwardly axially-projected area of the rotor unit to tend to thrust the rotor off the bearing; and the same pressure acts on the forwardly axially-projected area of the shroud **7**, to thrust the rotor towards the bearing. The two effective areas being substantially equal (as will be explained) the opposed thrusts balance out. The magnetic force between the mass **15** and exterior inductive winding (not shown) still however, produces a rearward thrust on the rotor unit tending to keep the elements **9, 10** and **11** properly engaged.

Holes **16** are bored through the impeller disc **8** so as to form fluid passages connecting the front side of the impeller containing the eye area **3** with the rear or back side of the impeller.

The extension **13** has at its inner end a seal element **17** in the form of an annular lip whose margin is in a plane in which the spherical centre lies. The element **17** has a close clearance from a cylindrical bore **18** which is coaxial in the impeller disc **8** and which the holes **16** connect with the eye region **3.** The pressure on the forward side of the seal element **17** is, therefore, the intake or eye pressure of the pump and the bearing is within this low-pressure ambience. The seal element in effect results in relieving the impeller of the axial thrust otherwise caused by the eye pressure. It is true that when the rotor unit tilts, a slight increase of the seal clearance will occur but this is not important if the dimensions are fairly small. The internal hollow **15**A of the mass **15** is frustoconical like the extension **13,** so as to afford clearance for rotor tilt. The ends of the duct **1** and stub **2** are complementarily spherical — again on the ball-centre — to permit the universal tilting required.

Indicated at A is the annular axial projected area of the shroud **7** (which is the same as that of the mass **15**) and at B, the like area of the eye (which is the same as that of the seal element **17**).

In FIG. **2,** so far as they apply the same references are used. In this embodiment of the invention the seal element **20** is relatively much larger in effective area, corresponding to the larger projected area of the eye **3;** the area of the shroud is proportionately less. In this case the seal element **20** is screwed on to the tubular axial extension **22** of the wall **14.** In order to facilitate assembly the element **20** is notched as at **21** for the engagement of a tool for which access is provided by the hole **16.** The size of the element **20** is now such that it could not effectively seal in a cylinder as in FIG. **1,** so the mass **15** is provided with a spherically formed liner **23** with which the margin of the element **20** forms a small but constant clearance. The function of the design is the same as in the FIG. **1** example.

In FIG. **3** again like parts have the same references. In this embodiment however the seal is considerably changed. The cup **12** is again mounted on a casing extension **30** and this is itself fixed with a boss **31** forming an axial extension of the casing wall **14.** The magnetic mass **15** is provided with a frustoconical internal lining **33** which has an inward flange or lip **34** with a spherically concentric external surface. Against this surface bears a seal ring **35** which is a short cylinder slidable axially in a cylindrical annular recess **36** formed in the boss **31.** The ring **35** is urged axially, for example by a resilient corrugated washer at **37,** so that its edge at **35**A bears lightly but positively against the surface of the lip **34.** This seal defines substantially the same axially-projected area as that of the eye **3.** The hole (or holes) **16** connect the eye with the interior of the mass **15** as before.

Lastly turning to FIG. **4,** there is shown a variant of the FIG. **3** embodiment (again the references, where common, are retained) in which the seal is like that of FIG. **3** but mounted in the rotor unit. In this construction the magnetic mass **15** has a skirt-like liner **40** surrounding and well clear of the support extension **30** of the casing wall **14.** The liner **40** has a cylindrical axial channel or recess **41** in which is axially slidable a seal ring **42,** again urged axially by a resilient washer (not shown). The edge of the ring **42** is fashioned spherically to bear against the concave interior surface of the wall **14.** The function is as in the previous embodiments.

I claim:

1. A centrifugal pump of the type having a casing, an axial fluid inlet in said casing, a rotatable impeller in said casing having an eye area on the front surface thereof opposite said inlet subjected to the fluid pressure in said inlet and a shrouded area on the front surface extending radially outwardly from said eye area subjected to increased fluid pressure imparted by said impeller when said pump is operating, bearing means mounting said impeller for rotation and adjacent the rear surface thereof, magnetic means on said impeller for effecting a magnetic couple with an inductive drive means, and a separating wall forming a part of said casing sealing said impeller from the inductive drive means; the improvement which comprises including a circular sealing means between said separating wall and said impeller where the axially projected area defined by the sealing means along the outer diameter thereof is approximately equal to the axially projected area of said eye area, and including fluid passage means in the impeller extending from the eye area on the front side thereof to a rear side thereof axially opposite said eye area whereby the fluid pressure acting on the rear side will be the same as the fluid pressure acting on the eye area.

2. A centrifugal pump according to claim **1** wherein said impeller has a convex spherical surface, said separating wall has a concave spherical surface closely spaced with respect to said convex surface, and wherein said sealing means comprises an annular element fixed to said separating wall, said element being closely spaced from a circular surface on said impeller.

3. A centrifugal pump according to claim **2** wherein said bearing is a spherical bearing and wherein said annular element lies in a plane passing through the center of said bearing.

4. A centrifugal pump according to claim **2** wherein said bearing is a spherical bearing, were said impeller has a concave spherical surface, and where said annular element is closely spaced to the concave surface of said impeller.

5. A centrifugal pump according to claim **1** wherein said sealing means comprises an annular element on said separating wall moveable axially with respect thereto and engaging said impeller.

6. A centrifugal pump according to claim **1** wherein said sealing means comprises an annular element on said impeller moveable axially with respect thereto and engaging said separating wall.

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