

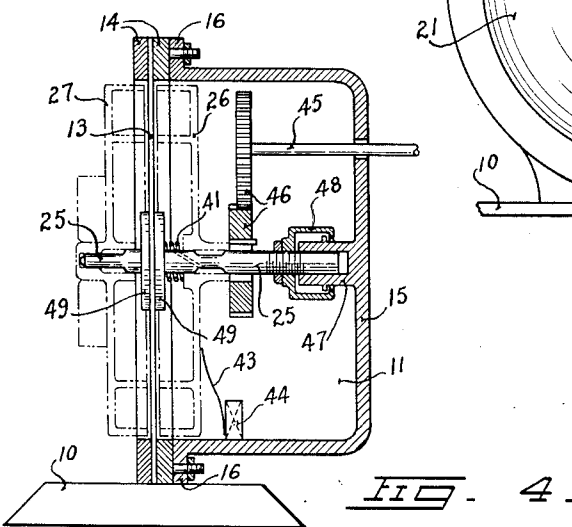
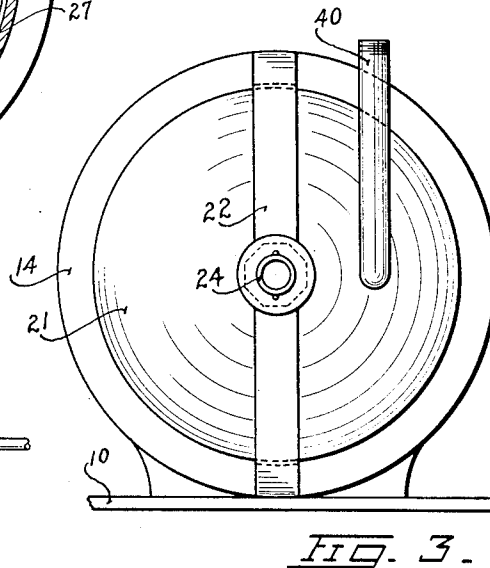
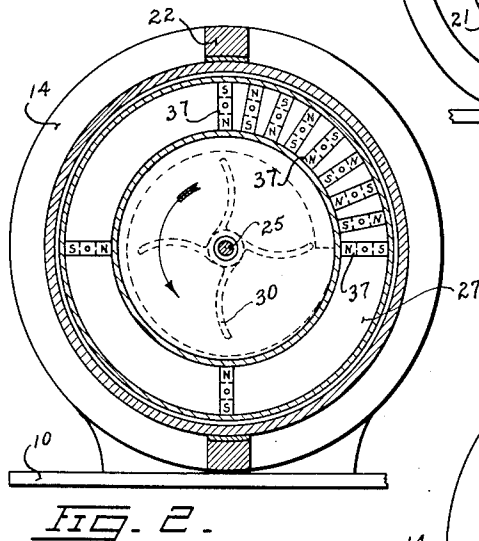
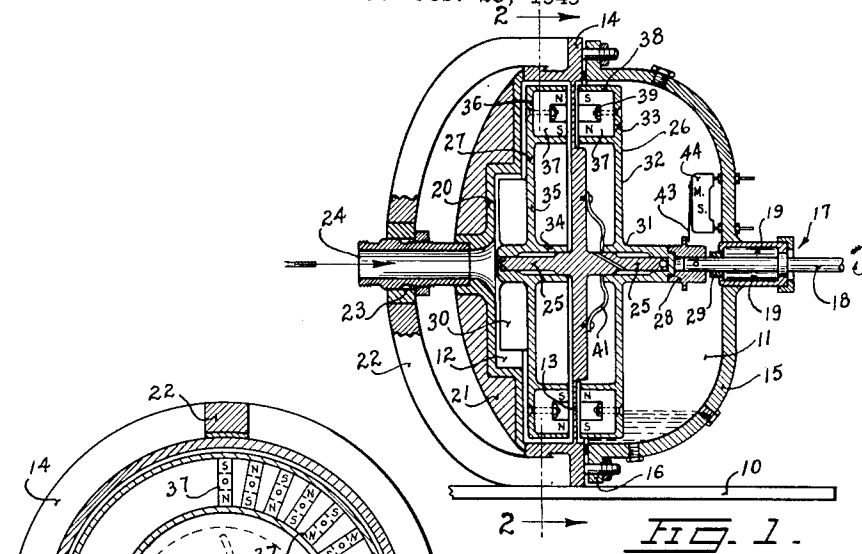
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MAGNETICALLY DRIVEN CENTRIFUGAL PUMP

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MAGNETICALLY DRIVEN CENTRIFUGAL PUMP

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3 Claims. (Cl. 310—104)

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This invention pertains to centrifugal pumps of a type useful to the chemical and dairy industry.

In both the chemical and dairy industries, there are many installations where it is desired to pump liquids in which the liquids are either extremely corrosive or easily contaminated by foreign matter. Such foreign material may be trapped in the pump or enter from outside sources. Consequently, it is advantageous to these industries and to others to utilize a pump in which the functional portion of the pump may be hermetically sealed to prevent entry of foreign materials or, on the other hand leakage of the material from the pump. To accomplish this in the past, it has always been extremely difficult, due to the necessity of providing openings in the functional portion of the pump for the entrance of the shafts essential to drive the operating parts. In order to adequately seal these functional openings, it has been necessary to resort to packing glands involving many different structural shapes and incorporating materials of construction of an expandable nature to retard leakage through the gland.

Furthermore in the dairy industry in particular, where a large quantity of perishable liquids such as milk must be handled, it has been extremely difficult to maintain material handling equipment sufficiently clean in order to avoid contamination from bacteria. The normal cleaning operations seldom remove all traces of the milk from the operating parts and consequently there is the constant danger of bacterial growth occurring in the uncleaned portion of the equipment. In addition, the conventional sealing glands used in pumps must be lubricated which introduces the possibility of contamination of the milk by the lubricating materials and also portions of the packing gland which may become separated and flow into the milk, or other liquid being pumped.

The present invention is designed to overcome the disadvantages discussed above by providing a centrifugal pump with a pumping chamber which may be hermetically sealed to prevent the undesired flow of liquid either into or out of the chamber. Another distinctive feature of the pump of this invention is the elimination of any mechanical connection between the pumping rotor and the means for rotating the rotor. The elimination of any mechanical coupling between the operating parts of the pump removes all the disadvantages encountered in conventional pumps where a mechanical drive shaft enters the pumping chamber.

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The novel pump embodying the advantages set out above consists of two chambers, one of which may be hermetically sealed with the exception of an inlet and outlet for the fluid to be pumped, and a rotor carrying pumping vanes. The other chamber contains a rotor driven by an external means of the rotor. As stated above, there is no mechanical coupling between the two rotors and the rotation of the functional or pumping rotor by the mechanical driven rotor is accomplished by magnetic attraction between magnets disposed circumferentially around the face of each rotor. A wall of non-magnetic material forms the dividing line between the two chambers and carries stub axles which act as supports for the two rotating members, which are arranged to rotate freely in a parallel relationship to each other.

With these and incidental objects in view, the invention includes certain novel features of construction and combination of parts, the essential elements of which are set forth in the appended claims and a preferred form and embodiment of which is hereinafter described with reference to the drawings which accompany and form part of this specification. In the drawings:

Figure 1 is a side elevation in section showing the invention.

Figure 2 is a sectional view along the line 2—2 of Figure 1.

Figure 3 is an end elevation showing the discharge conduit leading from the pump.

Figure 4 is a side elevation in section of an alternate form of the invention.

Referring now to Figure 1 a base 10 of any suitable size and shape supports the novel pump. The pump is divided into two main portions, a compartment 11 on the right hand side of Figure 1 containing the positively driven rotor and a functional or operating compartment 12 shown on the left hand side of Figure 1. The two compartments 11 and 12 are separated by a plate 13. The plate 13 is circular in section and is joined at its periphery by a flanged ring 14. The method of joining the circular plate 13 on the flange ring 14 is not pertinent to the invention and any conventional construction may be followed and in some cases the plate 13 and the flange 14 could be made integrally. The plate 13 should be constructed from a material which will not act as a shield to magnetic flux. For this reason iron or mild steel should not be used and it is preferable to use non-ferrous metals or stainless steel. In cases where liquids are being handled which are corrosive or where the liquid might be contaminated by specific metals it

would be advisable to use materials which would neither be attacked by the liquid nor be contaminating in nature.

The compartment 11 is formed on one side by the wall 13 and on the other side by a housing 15 which is of generally hemispherical shape and has a peripheral flange 16. An opening 17 is provided in the housing 15 for the passage of the driving shaft 18 which is supplied with suitable bearings 19.

The compartment 12 shown on the left hand side of Figure 1 is bounded on one side by the wall plate 13 and has two outer housings or casings the internal of which is shown at 20 and an external housing at 21. The internal housing 20 is of stepped cross section and is circular in nature the peripheral edges contacting the plate 14. A spider of relatively heavy construction shown at 22 is provided with an opening 23 in the centre thereof through which passes a conduit 24 leading through the external and internal casings 21 and 20 of the compartment 12. The function of the pipe 24 is to lead fluid to be pumped directly into the vortex of the pump. The spider and pipe 24 function to hold the two casings securely in place and prevent leakage from the compartment 12.

The plate 13 carries two coaxial stub shafts shown at 25 extending normally from approximately the centre of the plate into each compartment. The shafts 25 may be welded or secured by any other conventional means to the plate 13. Disposed for rotation on the shafts 25 are a pair of disc-shaped rotors 26 and 27. The rotors are mounted for free rotation on the shafts which are of sufficient length to accommodate the rotors.

The rotor 26 is located in the chamber 11 and is connected by a coupling 28 to a drive shaft 18. The rotor 26 and the coupling are constructed in such a manner that a certain amount of longitudinal movement on the shaft 18 is permitted. A bushing 29 in the aperture 17 functions to hold the shaft 18 in place and to limit the longitudinal movement of the rotor 26 and the coupling 28.

The rotor 27 is located in the chamber 12 and is mounted in a similar manner to the rotor 26. Both rotors are of the same structural shape, with the exception that the rotor 27 carries with it vanes 30, which act on the fluid contained in the chamber 12. The rotor 26 has a hub 31 and a web portion 32 communicating with a peripheral portion 33 of considerable width. The rotor 27 likewise has a hub 34, a web portion 35 and a peripheral portion 36. It will be noticed that the rotor 27 is mounted in a reverse manner to the rotor 26, otherwise the construction is similar.

The rotor 26 is coupled to the shaft 18 and is rotated by the application of force transmitted through the shafting 18 from any outside agency, such as an electric motor. For convenience in describing the operation of the pump, the rotor 26 will hereinafter be called the driving rotor. The other rotor 27 which carries the vanes 30 is not mechanically connected to the driving rotor but is rotated by magnetic attraction with the first mentioned or driving rotor. Hereinafter, the rotor 27 will be referred to as the driven rotor.

Mounted in the peripheral portions 33 and 36 of the driving and driven rotors, are a series of horseshoe or U-shaped magnets arranged as in the form of an annulus as at 37. These magnets are fitted into pockets or openings 38 in the peripheral portions and secured in place by any conventional means such as studs and bolts shown

generally at 39 in Figure 1. Both the driving and driven rotors are made of non-magnetic and preferably corrosion resistant materials, and the permanent magnets are arranged symmetrically around the peripheral portions. The spacing between adjacent magnets is made approximately equal to the spacing between the poles of a single magnet. The magnets are arranged in such a manner that the north pole of one magnet is adjacent to the south pole of the magnet lying beside it and similarly around the peripheral portion. The arrangement of the magnets in both rotors is identical. Consequently the two rotors being mounted parallel to each other with the poles of the magnets in each rotor facing each other, the attractive forces between the north pole of a magnet in one rotor and the south pole of the magnet in the other rotor will be extremely high and positive rotation of one rotor will therefore cause rotation of the other. The mutual magnetic attraction of the magnets is at its maximum when the north poles of one rotor are in juxtaposition to the south poles of the other rotor. Should a displacement occur, so that for example the north pole of one rotor is beginning to approach the north pole of the other rotor, a repulsion will develop between the like poles which will tend to push the pole back to its original advantageous position opposite the south pole. This is obviously the natural position which the two rotors will assume, unless forcibly held in a different position. Therefore, not only the mutual magnetic attraction between opposite poles of the magnet is utilized in this device, but the repulsion between like poles is used as well. This arrangement of the magnets considerably increases the effectiveness of the couplings.

The vanes 30 being secured to the driven rotor will rotate with the rotor and fluid entering through the conduits 24 into the centre vortex created by the rotating vanes, will be increased in velocity and pressure and leaves the compartment through the conduit 40 which extends through the outer casing 21 and the inner casing 20 of the compartment 12.

It will be obvious from the foregoing description that by means of this apparatus, fluid may be conveniently pumped without danger from corrosive action from the fluid or contamination of the fluid due to dirt entering the pumping chamber. The pumping chamber 12 is, for practical purposes, hermetically sealed, but may be easily disassembled for cleaning.

If for any reason the rotor of the driven rotor meets temporarily with excessive resistance, and a complete stoppage of the driven rotor or a relative slipping between the two magnet assemblies occur, then the time average of the force of attraction between the driven and the driving rotors will diminish. When this condition occurs, it is desirable to slow down or stop the rotation of the driving rotor until the most advantageous, natural position between the magnet assemblies is reestablished. In the present device, the diminution of the time average of the force of attraction is utilized to automatically stop the rotation of the driving rotor until such time as the attractive force will again increase and the rotation of both rotors will again be in step.

As previously described, the driving rotor 26 is loosely mounted on the step shaft for longitudinal movement with the coupling 28 along the driving shaft 18. As the magnetic coupling is lost, a spring 41 mounted upon the plate 13 tends to overcome the diminished magnetic attraction and

forces the driving rotor 26 outwardly along the shaft. A flange 42 on the coupling 23 engages spring arm 43 co-operating with a micro-switch 44. Consequently when the magnetic attraction decreases and the driving rotor tends to move longitudinally on the shaft 13 as a result of the action of the spring 41, the micro-switch 44 is actuated and disconnects the source of power turning the shaft 13. Immediately that the magnetic attraction between the driving and driven rotors is resumed and the magnetic attraction is sufficient to overcome the effect of the spring 41, the driving rotor moves inwardly and the micro-switch again makes contact with the source of energy turning the shaft 13 and the normal mechanical force is again applied to the driving rotor. This device is suitable for overload conditions which might cause damage to the machine.

An alternative construction is illustrated in Figure 4 which provides greater rigidity of the stub shafts and thus makes the pump more suitable for larger capacity and by permitting the use of a thinner separating wall or membrane considerably increases the mutual magnetic attraction of the magnets in the driving rotors which results in greater mechanical efficiency of the driven rotor.

For sake of clearness in description, Figure 4 illustrates only the essential features of the invention. It will be observed that the plate 13 is secured and functions in a similar manner to that disclosed in the previous embodiment of the invention. The rotors 26 and 27 are also constructed in a practically similar manner to the previously described rotors. The principal difference between this embodiment and that previously described, is that the driving rotor 26 which is supported on the stub shaft 25 is rotated by a longitudinal shaft 45 operating through a set of gears of suitable design 46 rather than by attachment to the prolongation of the central longitudinal axis. The stub shaft 25 is extended and is supported by a thrust bearing 47 and adjusting means 48. The adjusting means 48 are provided in order to provide for longitudinal adjustment of the stub shaft 25. Discs 49 are affixed rigidly to plate 13 and stub shafts 25 are in turn secured to the discs 49. The stub shaft 25 and the discs may be constructed as a unit and fixed rigidly to the plate 13.

Although the pump has been described without reference to any specific capacity, it will be obvious to those skilled in the art that it is merely a matter of arrangement of structural dimensions to produce any desired capacity.

The most outstanding advantage accruing from the operation of the pump described above is that the operating chamber may be made from corrosive resistant materials or materials which will not contaminate the fluid and may be easily cleaned. In addition, of course, to the structural materials which may be employed in the pump, the fact that there is no mechanical shaft extending into the pumping chamber itself is of material advantage. All packing glands are eliminated and any contamination which might occur through the entry of oil or packing material into the fluid is avoided. In addition of course, the quite common problem in pumping

corrosive fluids is avoided where the fluid attacks the packing gland and causes leakage.

We claim:

1. A magnetic coupling comprising a wall of non-magnetic material, rotors disposed on each side of said wall in substantially fixed spaced relationship and each mounted for free coaxial rotation about a stationary stub shaft extending normally from the dividing wall and integral therewith, an annulus of permanent magnets disposed on the adjacent faces of each rotor at equal distances from the axis of rotation, means to rotate positively one of the rotors, magnetic attraction between the rotors causing synchronous rotation of the other rotor by said positively driven rotor, said magnets having axially extending, radially aligned poles and alternate magnets being oppositely directed.

2. In the device disclosed in claim 1 wherein the permanent magnets are U-shaped and are spaced apart a distance equal to the distance between the poles.

3. A magnetic coupling comprising a wall of non-magnetic material, a centrally disposed shaft integral with and extending from both sides of said wall, disc-shaped rotors in substantially fixed spaced relationship on each side of said wall and mounted for coaxial rotational motion on said shaft, an annulus of permanent magnets located on adjacent faces of said rotors near the peripheral edges thereof at equal distances from the shaft axis, means to positively rotate one of said rotors, magnetic attraction between the rotors causing synchronous rotation of the other rotor, and means responsive to asynchronism between said rotors to control the driving means so as to maintain the rotors in synchronous rotation, said means comprising a spring normally urging one of said rotors away from the other, the magnetic attraction between the two discs preventing the spring from moving the one rotor away from the other but allowing the spring to move one rotor away from the other when the magnetic attraction is disturbed, said motion opening a switch in an electric circuit to stop the means supplying power to positively rotate said one rotor.

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