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[54] **PUMP AND FILTER UNIT**

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[51] **Int. Cl.**.....**F04b 35/04**

[58] **Field of Search**.....417/370, 420, 313, 417/369, 366; 415/121 G

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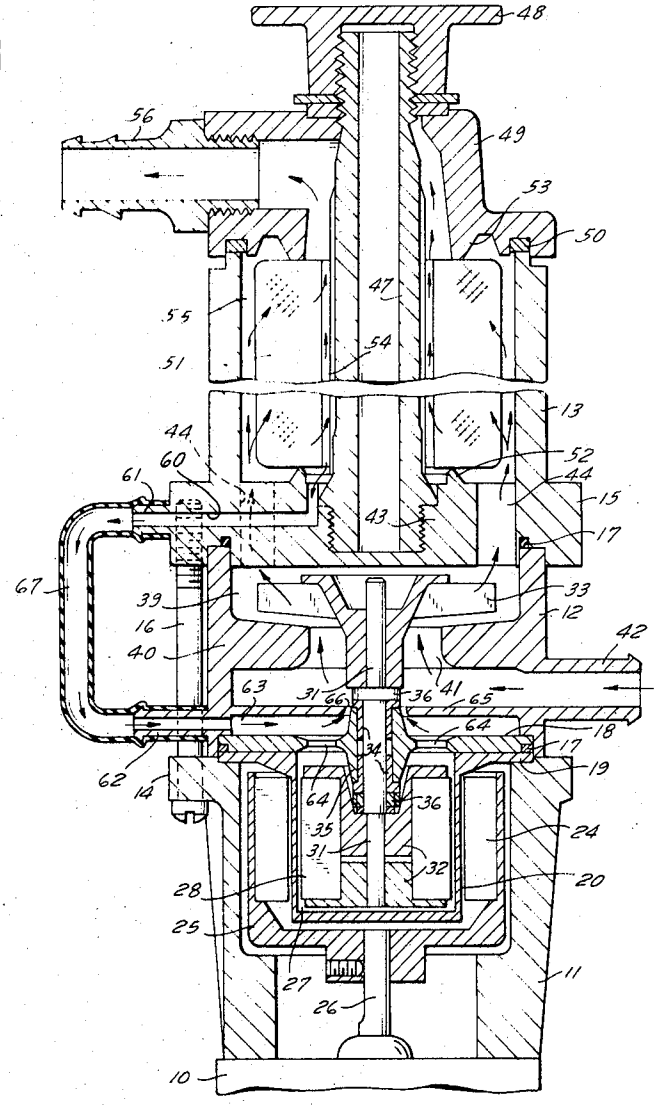
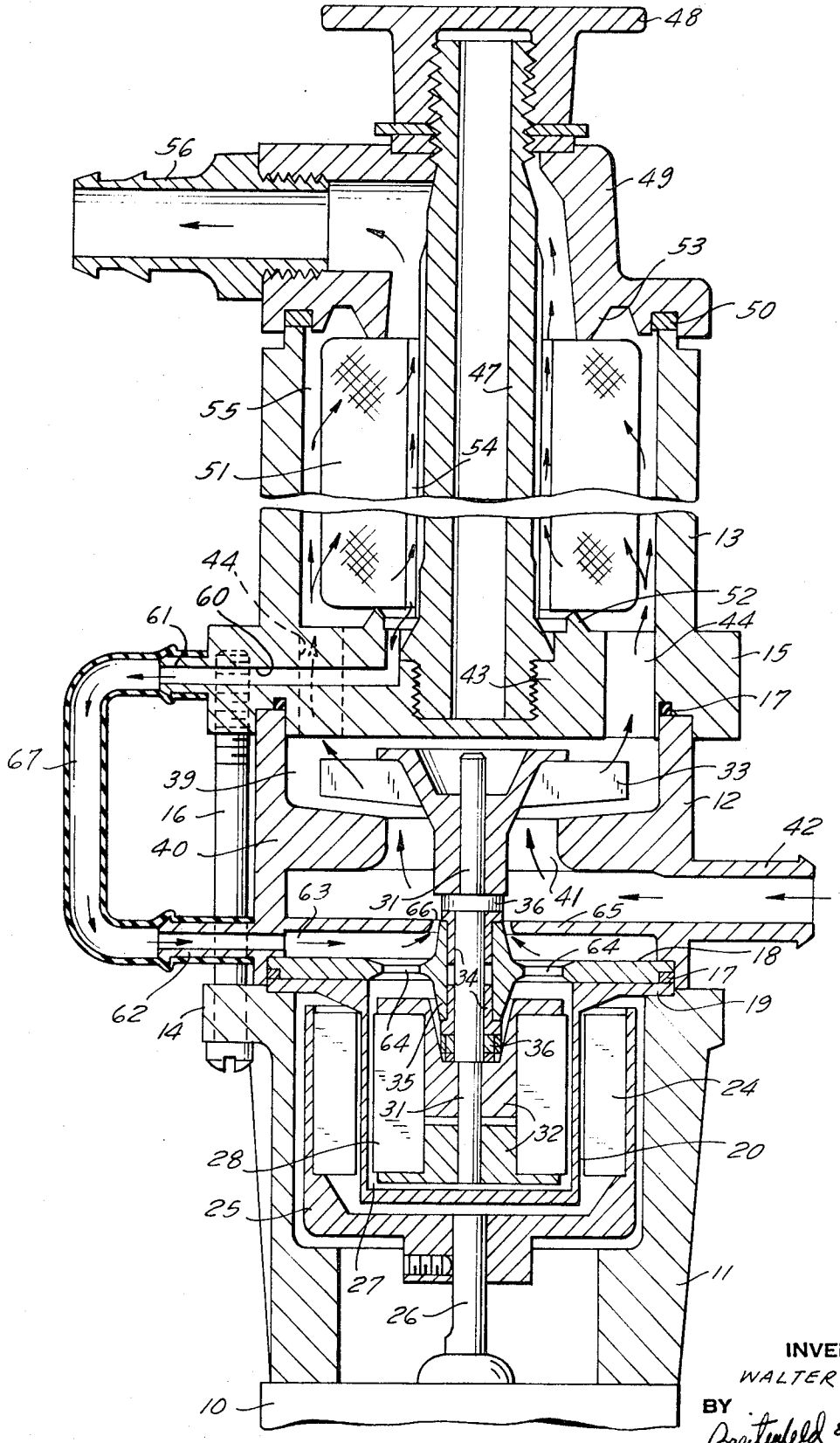
[57] **ABSTRACT**

A pump impeller is rotated by a motor through magnetically coupled driving and driven magnets. The driven magnet rotates with the impeller and is located in a chamber defined by a cup-shaped partition interposed between the two magnets. The impeller draws dirty liquid through the pump inlet and delivers it to a filter housing in which the liquid is filtered. Through a passageway located between the driven magnet chamber and the pump inlet, filtered liquid is introduced into the driven magnet chamber; the filtered liquid also flows through the passageway to the pump inlet through a restricted opening surrounding the shaft on which the impeller and driven magnet are mounted. The pump drive motor, pump body, and filter housing are all axially aligned.

6 Claims, 1 Drawing Figure





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PUMP AND FILTER UNIT

This invention relates to combined centrifugal pump and filter units, and more particularly to such units wherein the impeller of the pump is rotated via two magnetically coupled magnets.

Centrifugal pumps in which a magnetic coupling is used to transmit rotation of a motor shaft to the pump impeller are known. In such pumps, a driving magnet rotates with the motor shaft and a driven magnet rotates with the impeller, the magnets being separated by a thin non-magnetic stationary partition. The partition forms part of a liquid-tight sealing means which prevents any of the liquid being pumped from reaching the motor, thereby saving the motor from possible damage, although of course the liquid does come into contact with the driven magnet.

The strength of attraction between the two magnets of the coupling, and hence the strength of the coupling, depends to a great extent upon the distance between the magnets; the closer the magnets, the stronger the attraction between them. For this reason, the partition is made as thin as possible, and the magnets are arranged as close as possible to the opposite sides of the partition. This critical minimum spacing requirement must be dealt with regardless of what type of liquid is being pumped. However, a particular problem is presented when the liquid contains solid particles, and the pump is used to force such a liquid through a filter to filter out the particles from the liquid. As mentioned above, the liquid being pumped ordinarily comes into contact with the driven magnet, and when this liquid carries solid particles, the particles become lodged between the driven magnet and the partition. As the particles build up in this very narrow space, they apply a braking force to the driven magnet which can slow the latter enough to break the magnetic coupling, thereby allowing the driving magnet to rotate freely while the impeller comes to a halt. If the magnetic coupling is strong enough, jamming of the driven magnet by the particles can cause the motor to stall and be damaged.

It is an object of the present invention to overcome this problem by providing a centrifugal pump and filter unit employing a magnetic coupling wherein particles in the liquid to be filtered are kept out of engagement with the driven magnet.

It is a more specific object of the invention to provide such a pump and filter unit in which the driven magnet is kept immersed in particle-free liquid which has passed through the filter of the unit.

It is another object of the invention to provide such a pump and filter unit wherein particle-free filtered liquid continuously circulates in a direction from the driven magnet toward the pump inlet, thereby preventing flow of particle-containing liquid toward the driven magnet.

It is a further object of the invention to provide such a pump wherein the drive motor, pump body, and filter housing are all axially aligned.

Additional objects and features of the invention will be apparent from the following description in which reference is made to the accompanying drawing, in which the figure is a vertical cross-sectional view through a pump and filter unit incorporating the present invention.

The unit chosen to illustrate this invention includes an electric drive motor **10**, a ring-like pump support **11**, a pump body **12**, and a cylindrical filter housing **13**, all of which are axially aligned. Three ears **14** project outwardly from the upper end of support **11** and a flange **15** projects outwardly from the lower end of filter housing **13**. Three bolts **16** (only one being visible in the drawing) extend through ears **14** and into flange **15** to hold together the assembly of support **11**, pump body **12** and filter housing **13**. Suitable seals **17** are provided to make the connections liquid tight. The upper end of support **11** and the lower end of pump body **12** are formed with interior recesses which together snugly accommodate the peripheral edge of a circular plate **18** and the peripheral edge of a flange **19** projecting outwardly from the top of a cup-shaped partition **20**, the latter being formed of non-magnetic material, such as a suitable metal.

Surrounding partition **20** is an annular driving magnet **24** carried by an annular bracket **25** fixed to the shaft **26** of motor **10**. The interior of cup-shaped partition **20** defines a driven magnet chamber **27** within which an annular driven magnet **28** is located coaxial with driving magnet **24**. Magnets **24** and **28** are spaced as closely as possible to their respective sides of the annular wall of partition **20**, so that the radial spacing between them is a minimum, and hence the radial force of attraction between them is a maximum.

Driven magnet **28** is fixed to the lower end of a shaft **31** by means of a pair of brackets **32**. A pump impeller **33** is fixed to the upper end of shaft **31**. The central portion of shaft **31** is accommodated within bearings **34** held within a hub **35** of plate **18**. Axial movement of shaft **31** is prevented by collars **36** fixed to it and slidably engaging the ends of bearings **34**. It will be seen that when motor shaft **26** rotates, driving magnet **24** rotates with it and due to the force of magnetic attraction driven magnet **28** also rotates, whereupon shaft **31** and impeller **33** also rotate.

Impeller **33** rotates within an impeller chamber **39** formed in pump body **12**, the lower wall **40** of chamber **39** having a central opening defining the pump inlet **41**. Inlet **41** communicates with an inlet connection tube **42** adapted to be connected to a conduit through which liquid to be filtered flows to the pump. The top wall of impeller chamber **39** is defined by the bottom wall **43** of filter housing **13**, holes **44** in wall **43** forming the pump outlet.

A rod **47** extends axially through filter housing **13**, its lower end being threaded into bottom wall **43** and its upper end threadably accommodating a knob **48**. The latter tightly presses a cover **49** on to the upper end of housing **13**, a seal **50** providing a liquid-tight connection between the two. Surrounding rod **47** is a filter tube **51**, the lower end of the filter tube being seated upon an annular ridge **52** projecting upwardly from bottom wall **43**, and the upper end seating against an annular ridge **53** projecting downwardly from cover **49**. Filter tube **51** is radially spaced from rod **47** and housing **13** to define, respectively, an inner filter chamber **54** and an outer filter chamber **55**. At its upper end, inner filter chamber **54** communicates with a discharge connection tube **56** adapted to be connected to a conduit through which filtered liquid flows from the unit. Holes **44** in bottom wall **43** of filter housing **13** communicate with outer filter chamber **55**.

It will be appreciated, therefore, that as impeller **33** rotates, liquid to be filtered flows in the direction of the arrows through tube **42** into inlet **41**, and through holes

44 into outer filter chamber 55. The liquid is then forced radially through filter tube 51, so that only filtered liquid reaches inner filter chamber 54, from which it flows out through tube 56.

The pump and filter unit thus far described has the advantage of compactness and efficiency since motor 10, magnetic coupling 24, 28, pump body 12, and filter housing 13 are all axially aligned. However, a problem is presented due to the tendency of solid particles in the liquid flowing through inlet connection tube 42 and inlet 41 to drop into driven magnet chamber 27 and become lodged between driven magnet 28 and the surrounding wall of partition 20. The present invention avoids this in the following way.

Bottom wall 43 of filter housing 13 is formed with an internal bore 60 which communicates at its inner end with inner filter chamber 54 and terminates at its outer end in a connection tube 61. Pump body 12 presents a connection tube 62 communicating at its inner end with an auxiliary chamber 63 within the pump body. The bottom wall of chamber 63 is defined by plate 18, chamber 63 communicating with driven magnet chamber 27 through holes 64 in plate 18. Chamber 63 has an annular top wall 65 furnished with a central hole slightly larger than the diameter of hub 35 of plate 18 so as to define an annular restricted flow passage 66 between wall 65 and hub 35. A length of tubing 67 interconnects connection tubes 61 and 62.

As a result of this construction, a portion of the filtered liquid entering inner filter chamber 54 through filter 51 flows through bore 60, tube 61, tubing 67, and tube 62, into auxiliary chamber 63. This filtered liquid will initially flow through holes 64 to fill driven magnet chamber 27. During continued operation of the pump, the pressure within driven magnet chamber 27 is, as a practical matter, zero or slightly positive. On the other hand, a partial vacuum or negative pressure exists at inlet 41. Consequently, filtered liquid entering chamber 63 flows through restricted passage 66 to inlet 41. This continuous flow of filtered liquid from auxiliary chamber 63, at the upper end of driven magnet chamber 27, toward pump inlet 41 eliminates any possibility of liquid to be filtered, and the particles it may contain, from entering driven magnet chamber 27, during operation of the pump. Furthermore, the very limited width of restricted passage 66, while sufficient for allowing filtered liquid under pressure to flow through it, makes it very difficult, if not impossible, for solid particles to move downwardly through it toward the driven magnet chamber during periods when operation of the pump is terminated. Thus, driven magnet chamber 27 remains filled with only particle-free filtered liquid.

The invention has been shown and described in preferred form only, and by way of example, and many variations may be made in the invention which will still be comprised within its spirit. It is understood, therefore, that the invention is not limited to any specific form or embodiment except insofar as such limitations are included in the appended claims.

What is claimed is:

1. A centrifugal pump and filter unit, comprising:
   a. a pump body having an inlet and an outlet;
   b. a rotatable impeller within said body between said inlet and outlet;
   c. filter means for receiving and filtering liquid from said outlet;
   d. means for rotating said impeller including a driven magnet rotatable with said impeller and a driving magnet magnetically coupled to said driven magnet;
   e. a partition separating said magnets and defining a chamber within which said driven magnet rotates;
   f. an auxiliary chamber between said driven magnet chamber and said inlet;
   g. means for introducing into said auxiliary chamber filtered liquid from said filter means;
   h. means establishing communication between said auxiliary chamber and said driven magnet chamber, filtered liquid flowing through said means to fill said driven magnet chamber; and
   i. passageway means establishing communication between said auxiliary chamber and said inlet, filtered liquid flowing through said passageway means from said auxiliary chamber to said inlet in a direction away from said driven magnet chamber, so as to prevent unfiltered liquid flowing to said inlet from flowing through said passageway means to said driven magnet chamber.

2. A pump and filter unit as defined in claim 1 wherein said filter means includes a hollow cylindrical filter element, liquid to be filtered flowing from outside said filter element to its hollow interior, and said means (g) includes a liquid passageway communicating with the interior of said filter element.

3. A pump and filter unit as defined in claim 1 wherein said means (d) for rotating said impeller includes a motor having a shaft, said driving magnet being rotatable with said motor shaft, and wherein said filter means includes a filter housing accommodating a filter element, said motor, pump body, and filter housing all being axially aligned.

4. A pump and filter unit as defined in claim 1 wherein said filter means filters all the liquid leaving said outlet.

5. A pump and filter unit as defined in claim 1 wherein said means (d) for rotating said impeller includes a shaft upon which said impeller and driven magnet are mounted, said passageway means includes a restricted opening surrounding said shaft.

6. A pump and filter unit as defined in claim 1 wherein said magnets are annular and concentrically arranged, and said partition is cup shaped, the wall of said partition being interposed between said magnets.

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