

Jan. 1, 1963

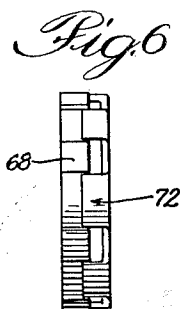
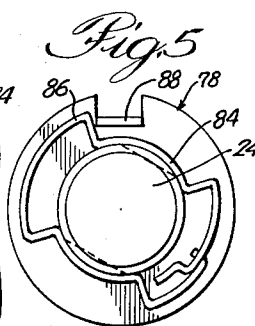
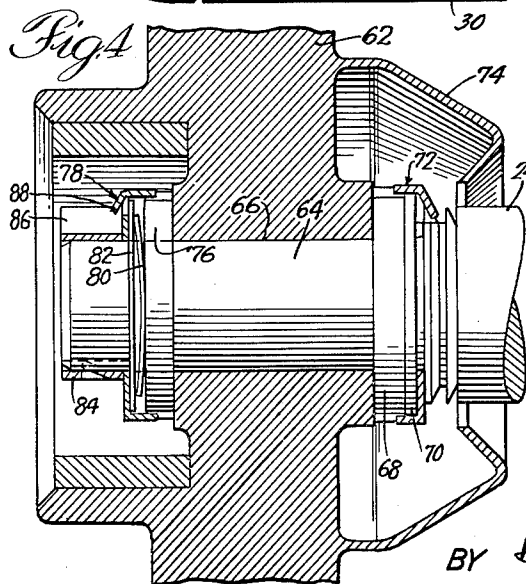
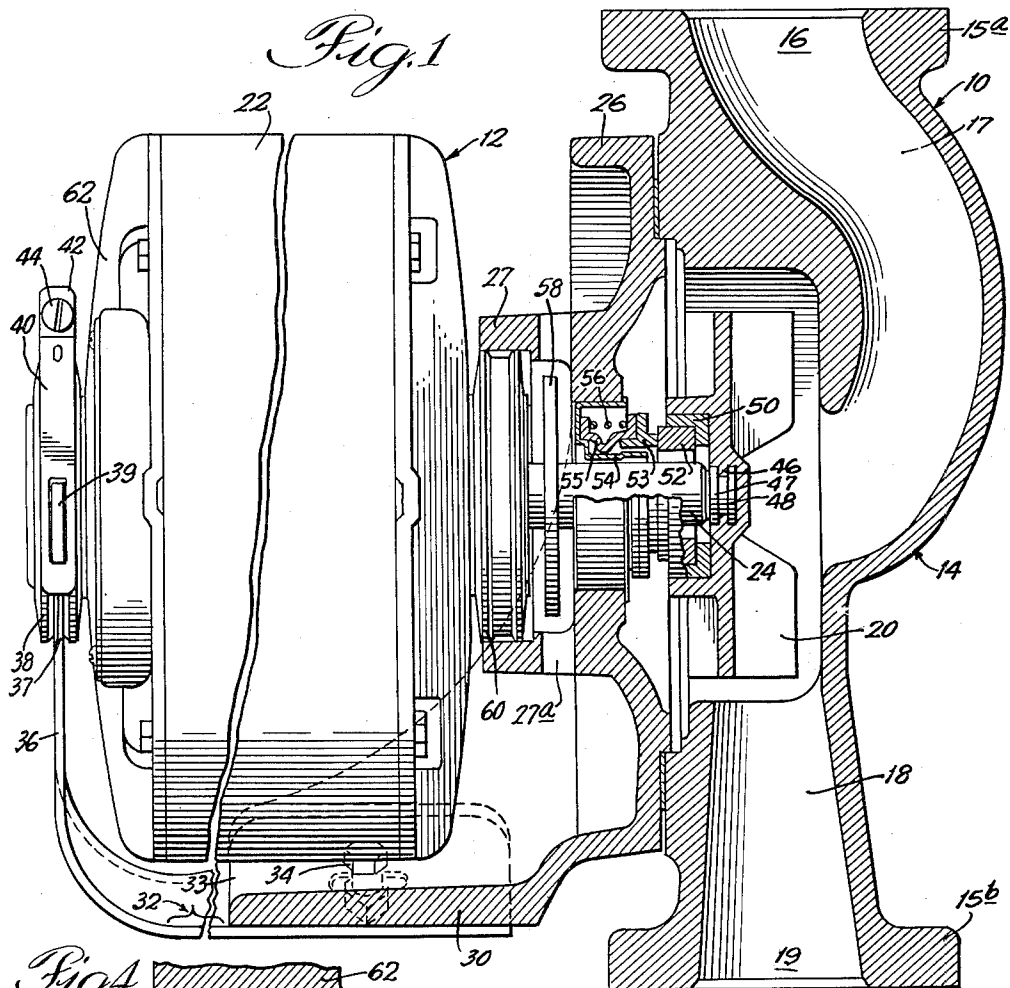
H. SPRING

3,071,075

LIQUID CIRCULATOR

Filed July 25, 1960

2 Sheets-Sheet 1



INVENTOR:

Hans Spring

BY *Bois, Freeman & Molinare*
ATTORNEYS.

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Fig. 2

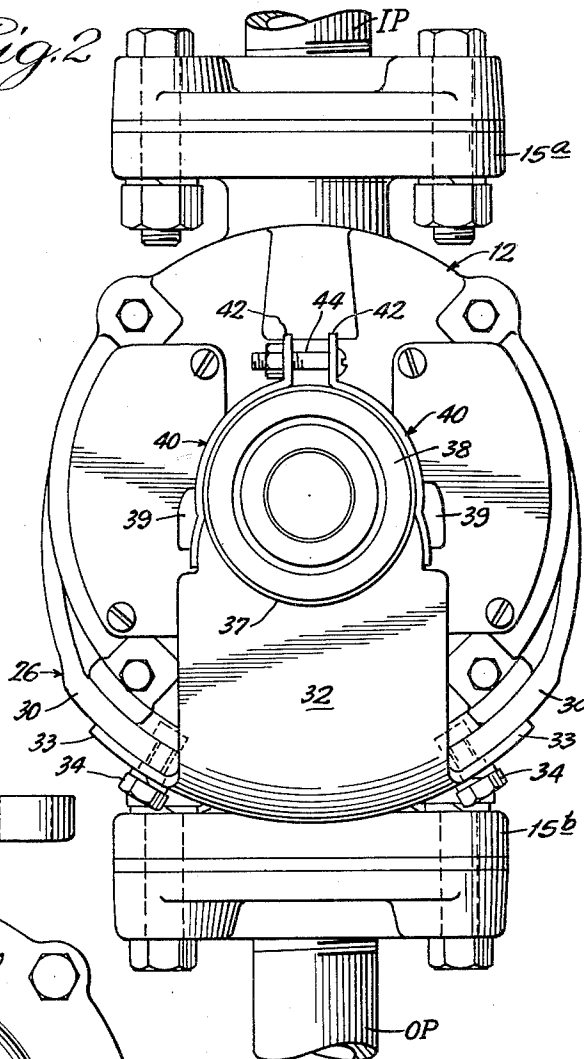
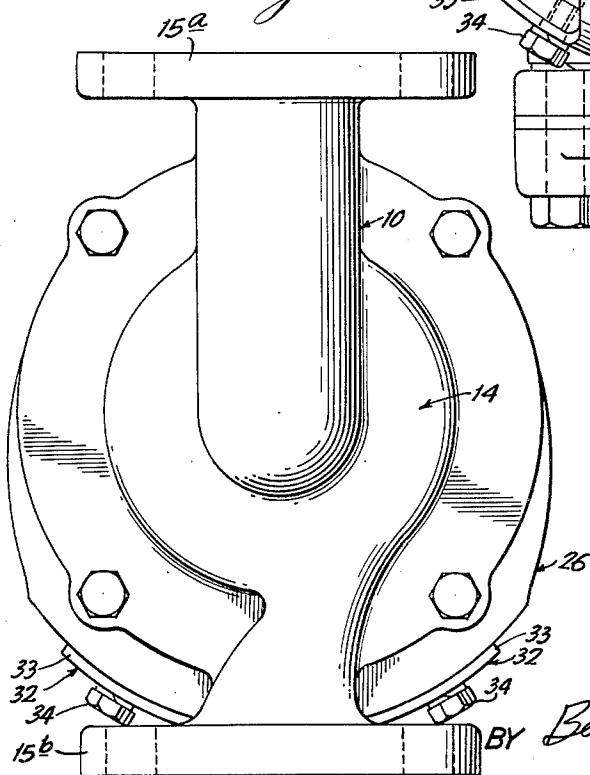


Fig. 3



INVENTOR:

Hans Spring,

BY *Bair, Freeman & Molinare*
ATTORNEYS.

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3,071,075

LIQUID CIRCULATOR

Hans Spring, Reading, Mass., assignor to Watts Regulator Company, Lawrence, Mass., a corporation of Massachusetts

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2 Claims. (Cl. 103-87)

This invention relates to a liquid circulator and more particularly relates to a water circulator wherein the noise level thereof is maintained at a very low level.

Liquid circulators, such as centrifugal water circulators and pumps that may be advantageously used in residential heating and cooling systems, are possessed of the general problem of being maintainable in operation at a low noise level. Quiet operation, particularly in residential installations, is of considerable importance. One of the reasons for a high operating noise level lies in the fact that the motor for the impeller usually has some axial play, and the end to end bouncing and bumping of the motor's rotor produces a relatively high noise level. Heretofore, conventional type centrifugal impeller pumps have been able to keep their noise level down only by effecting substantial separation of the drive motor from the pump impeller. Thus, in existing pumps the motor is separated from the impeller's casing and is mounted on a bracket separate from the casing, and suitable silent coupling and bearing housing are provided between the motor's drive shaft and the pump's impeller.

Thus, one object of this invention is to provide a simple, directly coupled, motor and impeller unit for a liquid circulator which will operate at a very low noise level.

Another object of this invention is to provide a motor and impeller combination for a liquid circulator, which combination is closely coupled to avoid use of large and expensive couplings and pump bearing housings between said motor and impeller, and which combination is characterized both by operation at a low noise level and by simplicity and inexpensiveness of construction.

Conceivably it would be feasible to postulate the existence of a motor wherein axial play of the rotor and drive shaft are substantially eliminated, but it must be appreciated that such a motor would probably be very expensive. For economic reasons, it would be most desirable to utilize existing motors for driving the pump's impeller, and under these circumstances the fact that a motor's rotor will vibrate axially is unavoidable. With the acceptance of the fact that axial vibration will occur in the rotor of standard motors, it may be categorically asserted that the problem of controlling the noise level in a pump wherein the motor is close-coupled directly to the pump's impeller is of major importance mechanically and economically.

Thus, a further object of this invention is to provide a close-coupled motor and impeller combination wherein a motor of standard construction is utilized and wherein means are provided for causing such a close-coupled motor and impeller unit to operate at an acceptably low noise level.

Further objects and advantages of this invention will become apparent as the following description proceeds and the features of novelty which characterize this invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

A preferred embodiment of the invention is shown in the accompanying drawings, in which:

FIGURE 1 is a composite view partly in elevation and partly in vertical axial cross-section, and with certain portions shown of axially reduced dimension, of a close-coupled motor-driven pump constructed in accordance with the invention described herein;

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FIGURE 2 is a reduced end elevation view looking from the left of FIGURE 1;

FIGURE 3 is a reduced end elevation view looking from the right of FIGURE 1;

FIGURE 4 is an enlarged fragmentary, vertical axial cross-section of the mounting for the left-hand end of the rotor for the close-coupled motor shown in FIGURE 1;

FIGURE 5 is an end elevation view of the rotary drive shaft seen in FIGURE 4, and is taken looking from the left of FIGURE 4; and

FIGURE 6 is an elevation view showing certain details of the thrust washer keying found in the motor shown in FIGURES 1 and 4.

Referring now to the drawings, there is shown in FIGURE 1 a liquid circulator, which includes an impeller means generally indicated at 10 and an electric motor drive means generally indicated at 12. The impeller means 10 includes a hollow casing 14 having an upper mounting flange 15a and a lower mounting flange 15b. The upper annular mounting flange 15a surrounds an inlet opening 16 which receives liquid from an inlet pipe IP and leads to a curved inlet passageway 17 that terminates axially of the centrifugal impeller within the impeller housing. The casing also provides a tangential passageway 18 that leads from the impeller to the outlet opening 19 which is surrounded by the lower annular mounting flange 15b and from whence liquid is discharged to an outlet pipe OP. A vaned impeller 20 is positioned within the impeller casing 14 and is of the type to receive the water axially from the flow passageway 17 and to direct it tangentially through the flow passageway 18.

The motor drive means 12 is an electric motor of a type that is well known in industry. More specifically, the motor is of the "Form G" type that is manufactured by General Electric Company. This type of motor is widely used in the circulator industry and is of a design wherein the thrust bearings therefor are both located adjacent one end shield, or end plate, of the motor housing.

As shown in FIGURE 1, the motor 12 has a drive shaft 24 which extends outwardly of the motor housing and which is coupled directly to the vaned impeller 20, so that the motor drive means 12 and the liquid circulator 10 are closely coupled. Such an arrangement is in contrast with other installations wherein special couplings are normally interposed between the drive shaft of the motor and the impeller of the pump, and wherein rather large bearing housings may be interposed between the motor and the pump.

Referring now more specifically to the arrangement of parts by means of which there is achieved a close coupling between the motor drive means 12 and the impeller means 10, FIGURE 1 shows that there has been provided a mounting bracket 26 of relatively heavy material having an annular part which is connected by bolts directly to an annular portion of the impeller casing 14 which surrounds the impeller 20. The bracket 26 has a central annular portion 27 and a lower, support portion 30 which extends axially of a portion of the motor drive means 12. A second support bracket 32 is provided of relatively thinner material than bracket 26, and said second bracket 32 has ear portions 33 for connection to the support portion 30 of the bracket 26. Bolt means 34 operate to rigidly secure the ears 33 of adjustable support bracket 32 to the mounting bracket 26.

The extended end of bracket 32 is shaped to define an arcuate portion 37 which cooperates with an exteriorly grooved resilient mounting 38 that is carried by the casing of the motor drive means 12. The bracket 32 also provides a pair of oppositely extending ears 39 which provide hook, or attachment, means, upon which to secure

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a pair of arcuate strap members 40 which are recessed for cooperative engagement with the ears 39, and which strap members are of somewhat flexible sheet metal. The upper ends of strap members 40 carry flanges 42 which are spaced to permit of selective clamping under the bias of nut and bolt means 44. The structure thus far described provides support means for the distal end of the motor 22.

Turning now to the interconnection of parts at the closely coupled end of motor 22, the impeller 20 is shown as having a hub portion 46 gripped between a pair of spaced flanges 47 and 48 carried on the motor drive shaft 24. The rear side of impeller 20 is recessed and carries therein an annular, cup-shaped mounting ring 50 within which is positioned a ring 52, the rear end of which abuts a shaped ring 53, which is axially movable on formed sheet metal ring 54. The ring 50 may be made of a molded piece of rubber, and the spacer ring 52 may be made from ceramic or the like, and the ring 53 may be made of carbon. A portion of the ring 54 is made to fit the inner contour of the heavy mounting bracket 26. A bellows type shaft seal 55 is provided, which at one end thereof abuts the ring 53 to press ring 53 against part 52 and at the other end abuts a portion of ring 54. The rubber bellows 55, by means of its turned-out flanges as shown, is bonded at one end to ring 54 and at the other end to ring 53. A coil spring 56 is provided between the turned-out flanges of the shaft seal bellows 55 to press said shaped ring 53 against said ring 52.

Also mounted on shaft 24 is a throwoff disc 58 which operates to throw off any liquid which may seep past the seal hereinabove described. The annular portion 27 of bracket 26 is provided with a plurality of radial apertures 27a through which the thrown-off liquid is discharged. The extended end of annular portion 27 receives therein a resilient mounting 60 that is carried by the casing of motor 22.

The motor is, as previously noted, of the type wherein the thrust bearings are located adjacent one end shield of the device. In the device shown herein the end shield 62 at the distal end of motor 22 is the one adjacent which the thrust bearings are located. FIGURE 4 discloses in enlarged detail the portion of end shield 62 adjacent which are located the thrust bearings. The drive shaft 24 is illustrated as having a reduced portion 64 that is journaled in bore 66 through the shield 62. A "Textolite" thrust washer 68 is carried on shaft 24 and abuts the inner side of end shield, or wall, 62. A rubber washer 70 abuts thrust washer 68. A cup washer 72 overlies the peripheral edge of rubber washer 70 and provides axially elongated and circumferentially spaced elements which cooperate with axial grooves in the thrust washer 68 (in the manner as seen in FIGURE 6) so as to restrain any relative rotation between thrust washer 68 and cup washer 72. The motor's end shield is formed with an annular inwardly inclined guard wall 74, the terminus of which is spaced from the shaft 24.

The reduced shaft portion 64 extends outwardly of end shield 62 and has located thereon a "Textolite" thrust washer 76 which abuts the outer side of shield 62. A cup washer 78 is provided which has axially elongated and circumferentially spaced cooperating portions which cooperate with radial recesses in thrust washer 76 (in the manner as seen in FIGURE 6) to insure no rotation therebetween. While the washer assembly on the inner side of shield 62 is provided with the rubber washer 70, in the instant construction of the washer assembly that is located outwardly of shield 62, the rubber washer has been removed and there has been substituted therefor a curved annular spring, or curved spring washer, 80 and a relatively thin spacer washer 82. The annular spring 80 is compressed sufficiently to exert a predetermined axial

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thrust on the shaft 24 of the motor, the thrust being in a direction away from the impeller 20.

Mounted on the terminal portion of shaft 24 is a locking clip 84 having an returned tab which locks in a recess in shaft 24 and which has a radially enlarged portion 86 that engages an outwardly extending tab 88 on cup washer 78. The locking clip 86 operates through cup washer 78 and washer 82 to maintain the annular spring 80 at the desired pre-stressed condition, so that spring 80 constantly exerts an axial force on shaft 24.

It has been found that the inclusion of the single spring 80 successfully eliminates the major portion of the noise that would normally be associated with an installation of the type herein described. In the absence of the spring 80, the end play of the motor's shaft in an axial direction, causing "end bump," when combined with the forces on the impeller 20, the mass of the motor shaft and rotor, the spring gradients of end shield 62, and the forces on the thrust washer assemblies, will have a resonant frequency that will result in an objectionably high noise level and vibration level. The spring 80 is designed to provide such axial thrust on shaft 24 as to eliminate the "end bump" and to prevent axial vibration of the shaft 24. In the actual use of spring 80, frequency amplitude reduction of a very high order has been observed. The spring 80 does not serve merely as a dampening means to absorb vibrations but actually is preloaded to impose a pre-selected axial force on shaft 24 to prevent axial movement and vibration of shaft 24.

It will be understood, from a critical analysis of the device herein described, that the axial forces acting on the motor's shaft are (1) pressure in front of the impeller 20, (2) pressure in back of the impeller, (3) spring forces in the mechanical seals, (4) unbalanced or back pressure on the mechanical seals, (5) pressure differential across the mechanical seals between the system pressure and atmosphere, and (6) axial torque component forces due to skew angle of motor's rotor. Now, the preload on the spring 80 must be greater than the algebraic sum of the foregoing six (6) forces in order to prevent any axial movement of shaft 24. It must be remembered that the force due to the skew angle (No. 6) is an alternating one with a frequency of 120 c.p.s. Furthermore, the preload on spring 80 must not exceed the capacity of the thrust bearings 68 or 76 in either direction.

The location of the spring 80 may be governed by the design of the motor. This application discloses use of the spring 80 in a motor design where the thrust washers are both located adjacent the one end shield of the motor spaced from the connection to the impeller. Some motor designs have one thrust bearing inside each end shield. In the latter construction, the preloaded spring washer should preferably be located on the inside of the one end shield which is located adjacent the pump.

While spring 80 has been disclosed in the form of an annular washer it will be understood that any spring means, or the equivalent, which eliminates axial vibration of the motor's shaft is contemplated to be used in devices constructed in accordance with this invention.

While there has been shown and described a particular embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and, therefore, it is intended in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new, and desire to secure by Letters Patent of the United States, is:

1. A liquid circulator comprising, in combination: a vaned impeller having means adapted to be coupled to a rotating shaft to axially restrain the impeller on the shaft; an electric motor of the type having opposite ends of a rotor mounting drive shaft extending therefrom, one end of the drive shaft being close-coupled directly to said vaned impeller; means defining a journal wall through

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which extends the other end of the drive shaft; thrust bearing means on said drive shaft positioned to cooperate with opposite sides of said journal wall; and single spring means cooperating with said thrust bearing means for preloading said drive shaft in a direction away from said vaned impeller with a force greater than the algebraic sum of axial forces on said vaned impeller so as to reduce axial shaft vibrations of the close-coupled motor driven impeller and minimize the operating noise level.

2. A liquid circulator as in claim 1, wherein said single spring means comprises an annular spring washer on said

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drive shaft, and including retaining means for retaining said annular spring washer on said drive shaft, said retaining means being carried by and rotating with said drive shaft.

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