United States Patent

Lepak

[15] **3,644,068**

[45] **Feb. 22, 1972**

[54] PUMP ARRANGEMENT

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[22] Filed: **Mar. 12, 1970**

[21] Appl. No.: **18,919**

[52] **U.S. Cl.** **417/477**

[51] **Int. Cl.** **F04b 43/08**

[58] **Field of Search** 417/474, 475, 476, 477, 900; 418/45; 92/13.2

[56] **References Cited**

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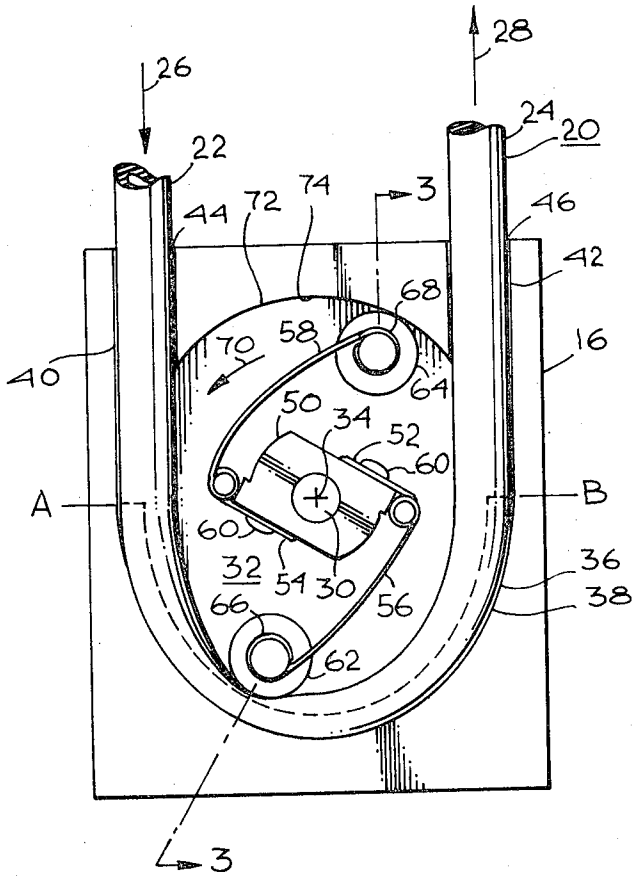
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[57] **ABSTRACT**

There is described herein an improved pump arrangement for pumping materials contained entirely within a resilient tube. The material to be pumped is in a resilient tube which is positioned within a case means adjacent of bearing wall. A motor rotates a shaft upon which are a pair of spring-mounted spools. The springs urge the spools outwardly into contact with the resilient tube and the force exerted by the spring on the spool causes the spools to sequentially compress the resilient tube as the spools roll thereon. At least one spool is in contact with and compressing the tube at all times. Rotation of the shaft pumps the material contained within the tube by the sequential compressing of the tube by the spool means.

5 Claims, 3 Drawing Figures



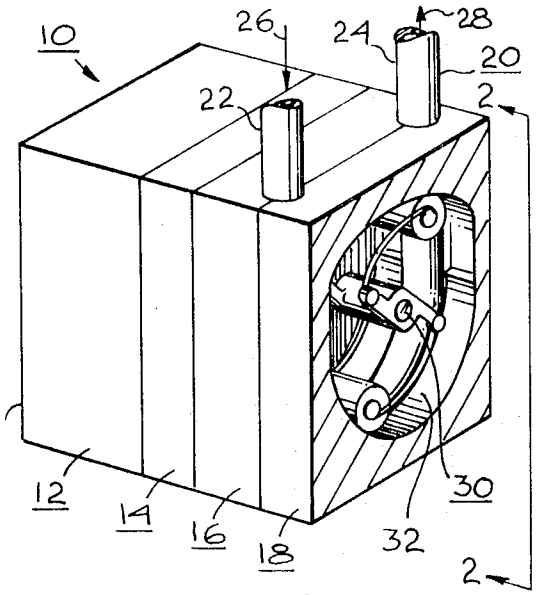


Fig. 1

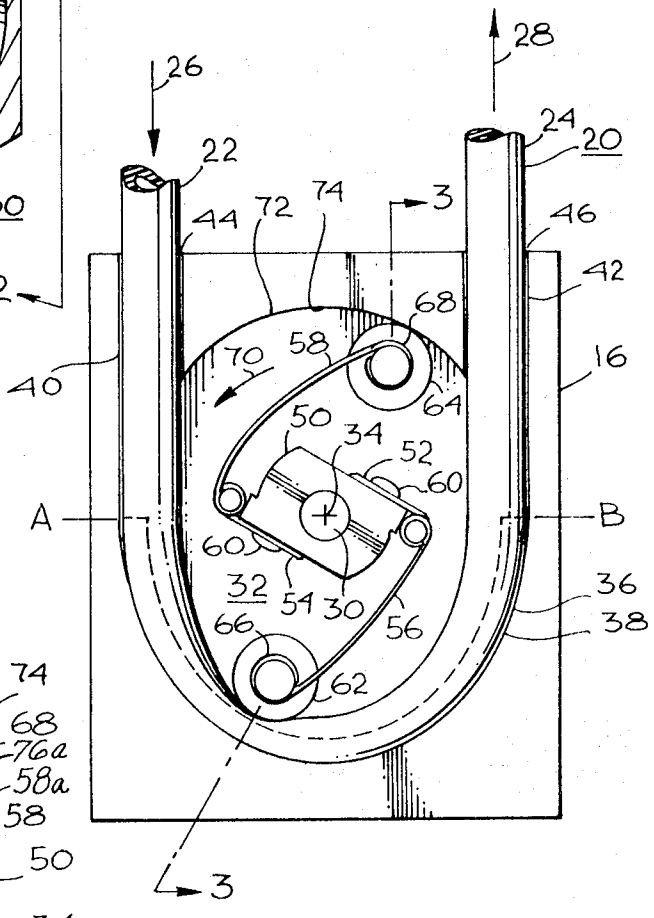


Fig. 2

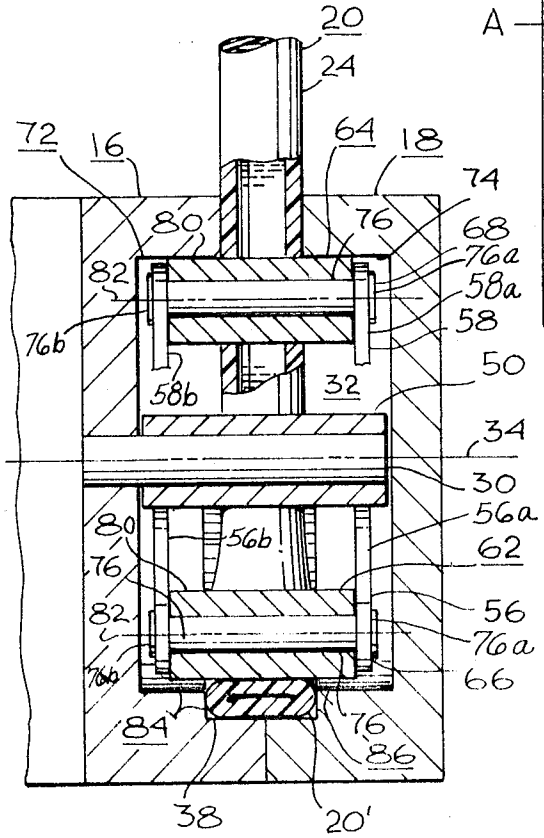


Fig. 3

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PUMP ARRANGEMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the pumping art and, more particularly, to improved tube-type pumping arrangement.

2. Description of the Prior Art

In many types of pumping arrangements it is desired that the material to be pumped remain at all times within a preselected tube. For example, in pumping corrosive materials that would be harmful if allowed to come in contact with the mechanical structures defining other types of pumps, the corrosive material is kept entirely within a resilient tube and the resilient tube is inert to the corrosive effects of the material being pumped. Similarly, in many hygienic applications such as pumping blood plasma, etc. it is desired that completely sanitary conditions be maintained and thus no contact with foreign bodies is allowed for the material being pumped. Such materials are also often contained within resilient tubes and the pumping arrangement pumps the material by contact only with the resilient tubes and not with the material itself.

In this class of tube-type pumps there exists a type of tube pump in which a pair of spools are rigidly mounted on a rotating head and sequentially compress the resilient tube as the spools roll along the tube in an arcuate path about the center of rotation. Such an action, it is obvious, clinches a preselected amount of material between the pair of spools and thus moves this material from inlet portion of the tube to an outlet portion of the tube. However, in such arrangements with a rigid motor head, it has been found that impurities such as solid particles which may be contained within a liquid that is to be pumped resulted in serious damage either to the pump or to the tube since the rigidly mounted spools completely crushed or tore the tubing when encountering such solid particles, or, alternatively, if the solid particle was sufficiently wedged within the tube, the pump would stall. Also, the pump structure over extended periods of operation often prevented complete sealing by the spools as they rotated since such spools were constrained to move only in circular paths about the center of rotation. In addition, with such pumps a high degree of precision was required in the fabrication of the arcuate walls against which the resilient tube was compressed so that the exact proper clearance was always maintained for the rigidly mounted spools to allow the desired compression thereof. Small dimensional changes could result in either damage to the tubing due to overcompression or imperfect sealing during the pumping operation. To insure complete sealing such rigidly mounted spools were often required to be in contact with and compressing the resilient tube over a greater arc than 180° of rotation.

Thus, there has long been a need in the pumping art for a tube-type pump which would be capable of extended periods of operation without maintenance and in which wear or dimensional changes would not adversely effect the successful operation of the pump. Further, it has also long been desired to have a tube-type pump in which the inclusion of solid or unyielding particles within the tube that is compressed will not adversely effect the pumping operation or the structure of the tube or pump itself.

SUMMARY OF THE INVENTION

Accordingly, it is an object of applicant's invention herein to provide an improved pumping arrangement.

It is another object of applicant's invention herein to provide an improved tube-type pumping arrangement.

It is yet another object of applicant's invention herein to provide an improved pumping arrangement in which dimensional changes and/or the inclusion of solid particles within the material to be pumped does not adversely effect operation of the pump.

The above and other objects are achieved, according to a preferred embodiment of applicant's invention, by providing a tube-type pump in which a resilient tube is positioned within a cavity of the pump and adjacent to a bearing surface thereof. As utilized herein, the word resilient applied to the tubing utilized in applicant's invention refers to that characteristic of a tubing which allows it to be sequentially compressed and released and the tube returns to its original uncompressed shape after each cycle of compression.

A motor means is provided in the preferred embodiment of applicant's invention for rotating a shaft about a preselected axis of rotation. The bearing surfaces on the case means of the pumping arrangement is an arcuate path about the axis of rotation and it need not be either concentric therewith or defining a circular path having an axis of rotation as a center of curvature. A rotor head means may be coupled to the shaft means and the rotor head means has spring receiving surfaces that are spaced radially outwardly from the center of rotation and are offset therefrom. A pair of springs are coupled to the spring bearing surfaces of the rotor head and a pair of spool means are coupled to the spring means and spaced radially outwardly from the preselected axis by the springs. The springs urge the spool means into compressing contact with the resilient tube means against the bearing surface and, as the shaft rotates, the spool means roll along the resilient tube sequentially compressing the tube against the bearing surface. As the spools roll from an inlet portion of the resilient tube to an outlet portion of the resilient tube, material to be pumped contained within the tube means is moved from the inlet to the outlet and thence to regions external the pumping arrangement. Since the bearing surface occupies approximately 180° of rotation of the spool means, limit means are provided for limiting the outward movement of the spool means during those portions of each rotation when the spool means is not in contact with the resilient tube means.

The pumping arrangement may also include other wall portions adjacent the bearing surface for defining a substantially U-shaped channel for containing the tube means to prevent walking or creeping thereof during the pumping operation.

BRIEF DESCRIPTION OF THE DRAWING

The above and other embodiments of applicant's invention may be more clearly understood from the following detailed description taken together with the accompanying drawings or in similar referenced characters referred as similar elements throughout and in which:

FIG. is a prospective view of one embodiment of applicant's invention herein;

FIG. 2 is a view along the line 2—2 of FIG. 1; and

FIG. 3 is a sectional view along the line 3—3 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The accompanying drawing is primarily intended to illustrate clearly a presently preferred form or embodiment of the improved pumping arrangement of applicant's invention herein. Those skilled in the design and construction of pumps will readily understand that other differently appearing pumps may be easily constructed on the basis of the disclosure embodied within the accompanying drawing within this description so as to utilize the inventive features defined in the appended claims.

Referring now to the drawings there is shown a pumping arrangement generally designated **10** according to the principles of applicant's invention herein. The pumping arrangement **10** is comprised of a motor means, which, in this embodiment of applicant's invention, may be an electric motor and, if necessary, a gear box **14** to provide a desired speed change from the rotational speed of the motor to the desired pump rotational speed. The pump arrangement **10** also includes a case means **16** and an end cap **18** coupled to the external surfaces of the case means **16**.

A resilient tube means **20** is positioned within the case means **16** and end cap **18** as described below in greater detail. Material to be pumped is contained within the resilient tube means **20** and is to be pumped from an inward portion **22** to an

outward portion 24, thereof, in the directions indicated by the arrows 26 and 28.

The motor 12 and/or gear box 14 rotate a shaft 30 extending into a pumping cavity 32 defined by the case means 16 and end cap 18 and the shaft 30 rotates about a preselected axis 34. The case means 16 has front wall 36 defining a arcuate bearing surface 38. The arcuate bearing surface 38 according to applicant's invention herein, need not be the arc of a circle about the preselected axis of rotation 34 nor, in fact, need it be concentric therewith or circular. As described below in greater detail, the arcuate bearing surface 38 need only be any desired arcuate shape that will allow the containment of the resilient tube 20 during at least 180° of rotation of the shaft 34.

The case means 16 is also provided with second walls 40 and 42 defining, respectively, tube inward passage 44 and a tube outward passage 46.

The resilient tube 20 is positioned within the pumping cavity 32 and adjacent to the bearing surface 38. The inward portion 22 of the resilient tube 20 is in the inward passage 44 and the outward portion 24 of the resilient tube 20 is in the outward passage 46.

A rotor head means 50 is coupled to the shaft means 30 for rotation therewith about a preselected axis 34. In this preferred embodiment of applicant's invention the rotor head means 50 has a pair of spring attachment portions 52 and 54 that are displaced radially outwardly from the preselected axis 34. A pair of springs 56 and 58 are coupled to the spring mounting surfaces 52 and 54, respectively, by for example, screw means 60.

A pair of spool means 62 and 64 are coupled, respectively, to the outer ends 66 and 68 of the springs 56 and 58, respectively. The spring means 56 and 58 yieldingly urge the spool means 62 and 64 radially outwardly from the preselected axis 34 and into tube compressing relationship with the resilient tube means 20 for compressing the resilient tube means 20 against the arcuate bearing surface 38 thereof.

As the shaft 30 rotates about the preselected axis 34 in the direction indicated by the arrow 70, the spool means 62 and 64 are urged outwardly by the spring means 56 and 58, respectively, and sequentially compress the resilient tube means 20 from the inward portion 22 thereof to the outward portion 24 thereof. In this embodiment of applicant's invention, the bearing surface 38 need only be approximately 180° of arc of rotation about the preselected axis 34 so that at least one spool means is always in compressing contact with the resilient tube 20 during any portion of the rotation thereof. Thus, during the first portion of rotation the spool means 62 and 64 sequentially compress the resilient tube means 20 against the bearing surface 38 from the point A on the inlet side thereof to the point B on the outward side thereof. Consequently, the material within the tube 22 is to be pumped is moved from the inlet portion 22 thereof to the outward portion 24 thereof and to regions external the pump arrangement 10 by the action of the spool means 62 and 64 thereon. However, during second portions of rotation that is in the direction indicated by the arrow 70 from the point B to the point A the spring means 56 and 58 urge the spool means 62 and 64, respectively, radially outwardly from the axis of rotation 34 and thus there is provided limit means 72 comprising walls defining a generally arcuate shape surface 74 that communicates with the walls 44 and 46 to allow continuous motion of the spool 62 and 64 from the outlet side back to the inlet side during each second portion of rotation thereof. It is apparent then, that the spring mounting of the spool means 62 and 64 provides both the force necessary for compressing the resilient tubing 20 against the bearing surface 38 as well as allowing radially inward movement of the spool means 62 and 64 if, during the first portion of rotation, there should be a solid object contained within the tube means 22. Thus, the spool means 62 and 64 will merely bounce or ride over the projection or bulge caused by such a solid object without deleterious effect to either the pump arrangement 10, the resilient tube 20 or the like.

As shown more thoroughly on FIG. 3, each of the spool means 62 and 64 are comprised of an axle means 76 that, in this embodiment of applicant's invention, are detachably coupled to the spring means 56 and 58. A roller means 80 is rotatably mounted on each of the axle means 76 and, as the shaft 30 rotates the roller means 80 rotates both therewith about the preselected axis of rotation 34 as well as about the axis 82 of each of the spool means 62 and 64. Fig. 3 shows the spool means 62 compressing the resilient tube 20 and providing a substantially complete seal thereof. Thus, no inadvertent pressure from the outward side 24 can force material back through the tube past the point where the spool 62 is in compressing relationship therewith.

If desired, the spring means 56 and 58 may be comprised, as shown in FIG. 3, of first spring members 56*a* and 58*a*, respectively, and second spring members 56*b* and 58*b*, respectively. The first spring members 56*a* and 58*a* are detachably coupled to a first end 76*a* of each of the axles 76 and the second spring members 56*b* and 58*b* are detachably coupled to the second end 76*b* of each of the axles 76. It will be appreciated that, in addition to the advantages set forth by the structural mounting of the spool means 62 and 64 for rotatable motion directly on the spring means 56 and 58, respectively, such mounting also allows lateral axial tilting of the spool means 62 and 64 in the presence of an inclusion of a solid or unyielding particle contained within the tube means 22. By lateral axial tilting is meant movement of one end of the axle 76 towards or away from the tube means 22 in an amount greater than the other end thereof. Thus, 2° of freedom of movement are provided in the spool means 62 and 64 with respect to the tube 22. That is, both the above-mentioned lateral axial tilting of the spool means 62 and 64 is allowed as well as movement of the spool means 62 and 64 towards and away from the tube means 22. Further, neither of these degrees of freedom are constrained to preselected paths but may occur, because of the mounting thereof directly upon the spring means 56 and 58, either separately or together and in any amount and in any path necessary during pump operation.

To prevent walking or displacement of the tube 20 during the pumping operation under the influence of the spool 62 and 64, applicant has found that it is advantageous to provide restraining means to limit any possible lateral movement of the tube means 20. Thus, applicant provides wall surfaces 84 on the case means 16 defining a shoulder adjacent to the bearing surface 38. The shoulder 84 is spaced radially inwardly a preselected distance from the bearing surface 38 and the preselected distance is a distance that is less than the thickness of the tube means 20 when it is in the compressed condition as illustrated at 20'. In the preferred embodiment of applicant's invention, the spool means 62 and 64 have a width greater than the extent of the bearing surface 38 and to ensure that adequate compression of the resilient tube 20 is obtained the above width relationship of the spool means 62 and 64 to the bearing surface 38 is desired. The radial clearance ensures that the spool means 62 and 64 between the points A and B will not engage the walls 84 but rather will remain in contact with the resilient tube 20. The end cap 18 which is coupled to the case means 16 has a flange portion 86 that is similar to the shoulder portion 84 of the case means 16 in that the walls thereof together with the bearing surface 38 and the walls 84 define a generally flat sided U-shaped channel for containing the resilient tube means 20. It will be appreciated that this U-shaped channel need only continue, as shown in FIG. 2, for approximately 180° of rotation about the axis 34. The shoulder 84 and the flange 86 are afine curves to the arcuate bearing surface 38. That is, they are preferably the same curvature throughout the extent thereof. However, as noted above, this need not be circular arcs but may be any desired configuration that will still allow the spool means 62 and 64 to compress the resilient tube 20 as illustrated in FIG. 3.

This concludes the description of the preferred embodiment of applicant's invention herein. From the above it can be seen that applicant has provided an improved tube-type pumping

arrangement in which the spring mounting of the rollers prevents damage to the pump and/or the resilient tube during the pumping operation of solids should be encountered within the material to be pumped that is contained within the resilient tube **20** and, further, precise tolerances in the manufacture of the various components thereof need not be maintained and yet the pump will still operate efficiently over extended periods of time.

Those skilled in the art may find many variations and adaptations of applicant's invention herein, and the following claims are intended to cover all such variations and adaptations falling within the true scope and spirit thereof.

What is claimed is new and desired to be secured by letters Patent of the United States is:

1. In a pump of the type in which a resilient tube is sequentially compressed by a pair of spool means against a case means to move the contents thereof through said tube means and wherein a motor means is provided to rotate said pair of spools about a preselected axis, the improvement comprising, in combination:

said case means having first walls defining a substantially arcuate bearing surface around said preselected axis, and second walls defining tube inlet and tube outlet passages, and said tube inlet and tube outlet passages communicating with said bearing surface;

said resilient tube means positioned within said case means adjacent said bearing surface and having an inlet portion in said tube inlet passage and an outlet portion in said tube outlet passage;

a shaft means coupled to said motor means for rotation about said preselected axis;

a pair of spring means coupled to said shaft means and each of said spool means rotatably mounted on one of said spring means, and said spring means allowing resilient movement of each of said spool means towards and away from said tube means and lateral axial tilting movement of each of said spool means with respect to said tube means, and said spring means resiliently urging each of said spool means outwardly from said shaft means into tube compressing contact with said resilient tube means for compressing said resilient tube means against said bearing wall during a first portion of each rotation of said shaft means, and said shaft means rotating said pair of spool means from said tube inlet passage towards said tube outlet passage;

restraining means for restraining said tube means adjacent said bearing wall;

and limit means for limiting the outward movement of said pair of spool means during a second portion of each rotation of said shaft means; and

said spool means rotating on said spring means during said first and said second portions of each rotation of said shaft means.

2. The arrangement defined in claim **1** wherein:

said restraining means comprises a backplate adjacent said bearing surface and said backplate having an arcuate shoulder portion afine to said arcuate bearing surface and spaced a preselected distance radially inwardly toward said preselected axis therefrom;

and an endcap adjacent to said case means and said endcap having an arcuate flange portion afine to said arcuate bearing surface and spaced a preselected distance radially inwardly towards said preselected axis therefrom; and

said arcuate shoulder, said arcuate bearing wall and said arcuate flange defining a generally flat-sided U-shaped tube receiving channel.

3. The arrangement defined in claim **1** wherein:

said limit means comprises walls spaced a preselected distance from said preselected axis and intermediate said tube inlet and said tube outlet passages.

4. The arrangement defined in claim **2** wherein:

each of said pair of spool means comprises an axle portion having a first end and a second end for detachable coupling to said spring means and a roller portion mounted for rotary motion on said axle means, and said roller portion having an axial length greater than the compressed width of said resilient tube means; and

each of said pair of spring means comprises a first spring member detachably coupled to a first end of said axle portion and a second spring member detachably coupled to a second end of said axle portion.

5. The arrangement defined in claim **4** further comprising:

a rotor head means coupled to said shaft means; and

said rotor head means having a pair of spring engaging portions extending outwardly from and offset from said predetermined axis for coupling to said pair of spring means.

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