

July 22, 1941.

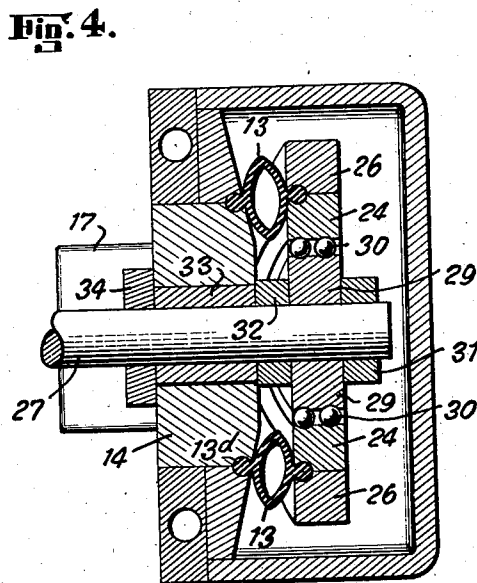
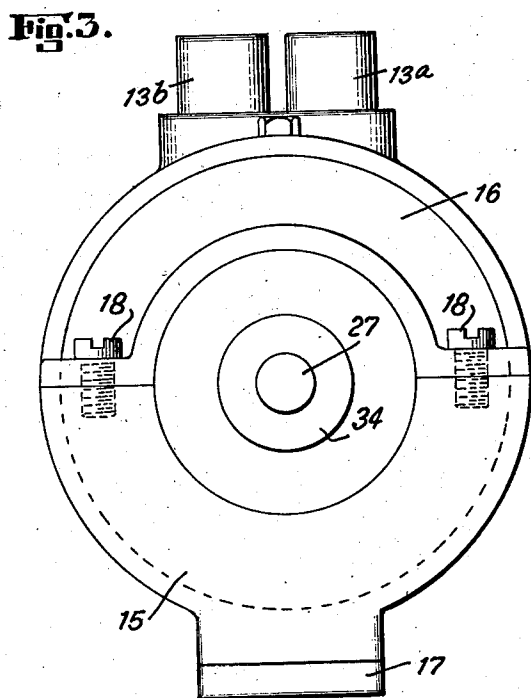
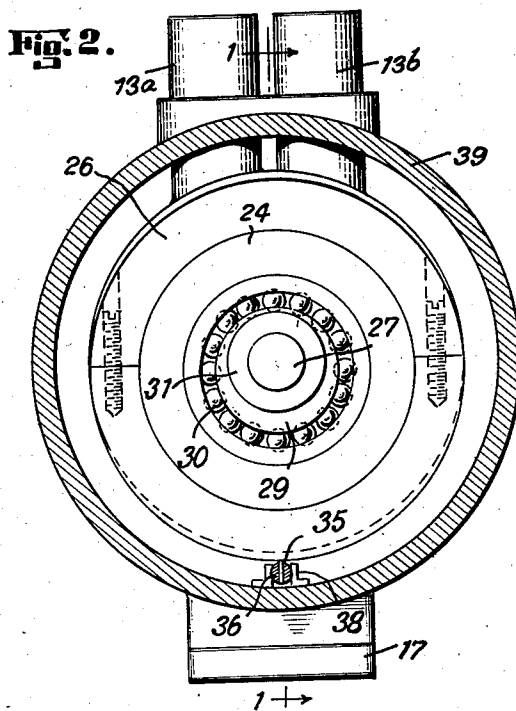
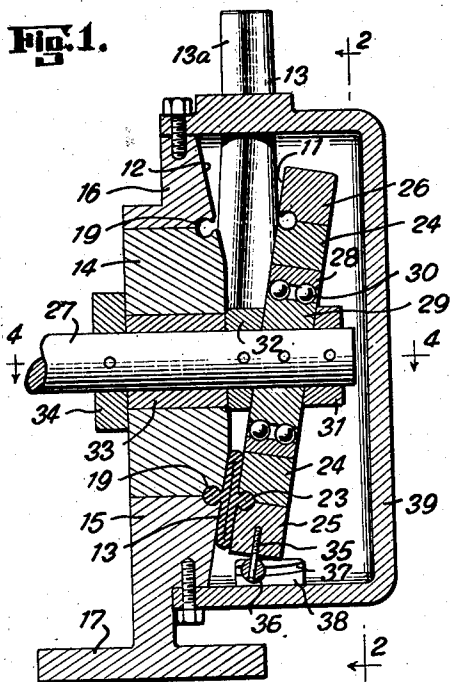
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2,249,806

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2 Sheets-Sheet 1



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Fig. 5.

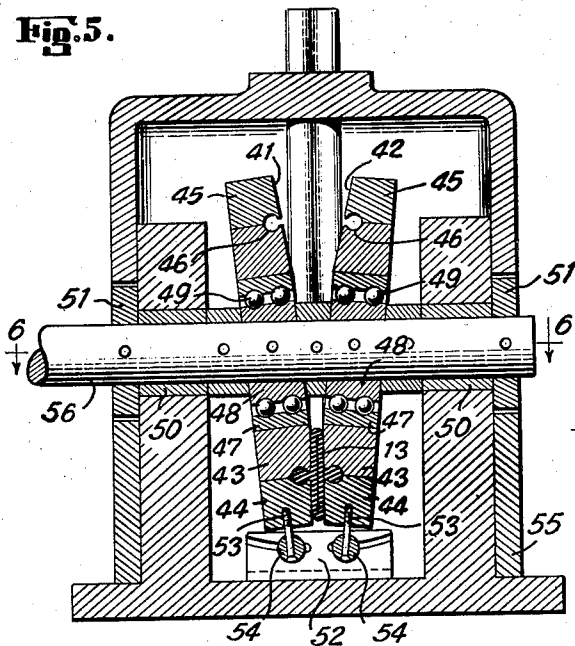


Fig. 7.

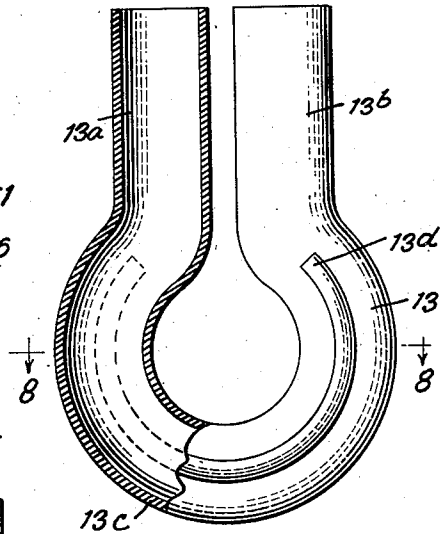


Fig. 6.

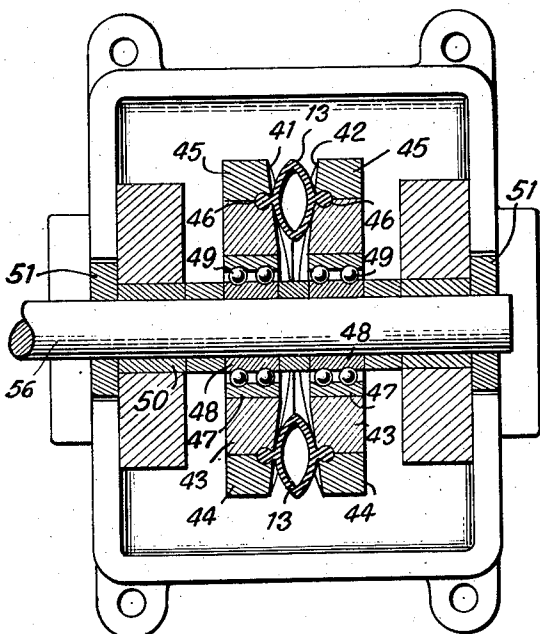
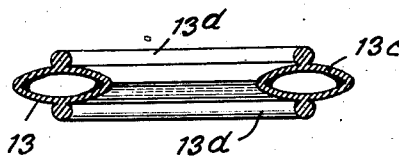


Fig. 8.



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8 Claims. (Cl. 103-149)

This invention relates to pumps, and particularly to pumps having a flexible tube adapted to carry the fluid being transferred, and has for an object the provision of improvements in this art.

Pumps employing flexible tubes have been proposed heretofore, as for example, the pump shown in the patent to Funk No. 513,315. In the previously known forms, a revolving roller squeezes a flexible tube progressively from its intake end to its outlet end to cause movement of fluid therethrough, the fluid being subjected to pressure ahead of the roll and fresh fluid being drawn into the tube behind the roll by the suction created by the re-expansion of the tube.

Several serious disadvantages of such pumps have been observed which have prevented their commercial use. One trouble is that the roller constantly pushes one wall of the tube in a forward direction, tending to produce a wave in the wall in advance of the roller, thus causing very severe strains which weaken and soon destroy the tube. Moreover, the rolling causes an abrading action which causes rapid disintegration of the tube. Another disadvantage has been that the suction created by the re-expansion of the tube has been insufficient for most purposes.

It is an object of the present invention to provide a commercially practical pump of this type which shall avoid the strains and abrasion referred to, and which shall be capable of operating for long periods of time without damage to the flexible tube.

It is a further object of the invention to provide means for positively expanding the tube in order to increase the suction effect on the intake side.

Other objects and advantages of the invention will appear hereinafter.

A preferred embodiment of the invention selected for purposes of illustration is shown in the accompanying drawings, in which,

Figure 1 is a vertical axial section of a pump embodying the invention, the view being taken on the line 1-1 of Figure 2.

Figure 2 is a vertical transverse section taken on the line 2-2 of Figure 1.

Figure 3 is a side elevation looking at the right side of Figure 1.

Figure 4 is a horizontal axial section taken on the line 4-4 of Figure 1.

Figure 5 is a vertical axial section of a modified form of the invention.

Figure 6 is a horizontal axial section taken on the line 6-6 of Figure 5.

Figure 7 is a side elevation partly in section of the flexible tubular member alone; and

Figure 8 is a horizontal section taken on the line 8-8 of Figure 7.

According to the present invention a flexible tube, preferably in the form of a loop, is located between two opposed working surfaces having relative gyratory movement adapted to compress and expand the tube progressively along its length. In one form of the invention one of said surfaces is fixed, and the other is mounted to gyrate. In another form of the invention both surfaces are mounted to gyrate. In either case, however, the gyrating surface or surfaces are mounted to gyrate about a center or centers located on a line perpendicular to the principal plane of said loop, passing through the plane of the loop at a point within the periphery of the loop, preferably at the center of the loop. The center of gyration of any gyrating surface should also be preferably located in or near the plane of said gyrating surface.

Means are provided to gyrate any surface mounted for gyration, and means are also provided to restrain such surface against rotation. As a result, any given point on a gyrating surface oscillates about the center of gyration, moving toward and away from an opposed point on the opposite surface in a direction substantially perpendicular to the plane of the loop. As gyration proceeds, a rolling action is produced which compresses and expands the tube progressively along its length and advances the fluid through the tube, but the objectionable strains and abrasion to which the tubes of previous pumps have been subjected are avoided.

In the embodiment illustrated in Figures 1 to 4 one of said working surfaces is a conical surface and the other is a plane surface, the said surfaces being so arranged that the axis of the conical surface passes through the plane surface, but with the plane surface intersecting the axis of the conical surface at an angle substantially equal to the angle at which said conical surface intersects its axis.

Either surface may be mounted for gyration with respect to the other, but in the embodiment illustrated in Figures 1 to 4 the conical surface is fixed and the plane surface is mounted to gyrate.

Thus, referring to Figures 1 to 4, opposed working surfaces 11 and 12 are provided, the surface 11 being a plane surface and the surface 12 being a conical surface. The surface 12 is a fixed

surface and the surface 11 is mounted for gyration as hereinafter explained.

Mounted between the said surfaces is a flexible tube 13, separately illustrated in Figures 7 and 8, which comprises straight portions 13a and 13b for inlet and outlet connections and a circular loop portion 13c therebetween. An integral bulbous rib 13d is provided on each side of the loop portion 13c of the tube, and these ribs are anchored in the structures forming the opposed surfaces 11 and 12.

With respect to the fixed surface 11, such structures comprise the ring 14, and split members 15 and 16, the member 15 being an extension of the base 17, and the member 16 being secured thereto by bolts 18. An undercut slot 19 is formed in these members to receive and hold the rib 13d on this side.

With respect to the gyrating surface, such structures comprise the ring 24 and split ring 25, 26, said members having an undercut slot 23 to receive and hold the rib 13d on this side.

The means for mounting the surface 11 for gyration and the means for gyrating the same include the shaft 27 and a bearing comprising outer race 28, inner race 29 and balls 30. The axis of the shaft coincides with the axis of the conical surface 12 and passes through the center of the plane surface 11. However, the shaft 27 passes through the race 29 in such manner that the surface 11 intersects the axis of the shaft at an angle substantially equal to the angle at which said conical surface intersects its axis. Thus, when the working surfaces are at the position of closest approach, as shown at the bottom of Figure 1, said surfaces are substantially parallel and compress the tube tightly to provide a tight seal.

The outer race 28 is, of course, fast in the ring 24, and the inner race 29 is fast on the shaft 27, being held between collars 31 and 32. The shaft 27 may be journaled in the sleeve 33, which may be replaced by a ball bearing, if desired, and is held against endwise movement in one direction by collar 34.

It will be observed that the gyrating surface is restrained from rotation by the tube itself, since the tube is anchored to fixed members 14, 15 and 16, but for some purposes, in order to relieve any torsional stress on the tube, additional restraining means may be provided. Thus the ring 25 may be provided with one or more studs 35 each having a ball 36 rotably mounted thereon, which said ball moves in arcuate grooves 37 formed in fixed brackets 38. Preferably the grooves are curved on an arc having its center at the center of gyration, but the ball may slide longitudinally of the stud to compensate for irregularities. The brackets 38 may be mounted on the casing shell 39, which may be provided to surround and enclose the moving parts, or may be mounted on any other fixed member.

In operation, the shaft 27 is rotated, causing the race 29 to rotate. This, in turn, causes the surface 11 to gyrate about a center of gyration located on the axis of the shaft 27 at the plane of the surface 11. Rotation of the surface 11 is restrained, however, first, by the fact that the structure is anchored to the tube, and second, by the stud 36 and associated parts. Consequently each point in the surface 11 oscillates toward and away from an opposed point in the surface 12. As gyration proceeds, the point of closest approach between the surfaces moves

along progressively compressing the tube to force the fluid through the tube. At the same time the tube is positively expanded at the other side by the ribs 13d, thus tending to produce a vacuum to draw more fluid into the intake. When the upper part of the gyrating surface moves to the point of closest approach to the surface 12, both intake and outlet passages may be closed momentarily.

In the pump illustrated in Figures 5 and 6, opposed working surfaces 41 and 42 are provided, both of these surfaces being conical surfaces. Both surfaces are mounted for gyration, and a flexible tube 13, of the same construction as previously described, is mounted between said surfaces and anchored to the structures forming said surfaces. Such structures are identical and comprise rings 43 and split rings 44, 45 with undercut slots 46 to receive and hold the ribs 13d.

The means for mounting the surfaces 41 and 42 for gyration and the means for gyrating the same are similar to the means previously described and comprise a shaft 56 and identical bearings comprising outer races 47, inner races 48 and balls 49. The axis of the shaft intersects the axes of the conical surfaces 41 and 42, and the shaft passes through the races 48 in such manner that the axes of the conical surfaces are equally but oppositely inclined to the axis of the shaft. The arrangement is such that when the working surfaces are at the position of closest approach, as shown at the bottom of Figure 5, said surfaces are substantially parallel and compress the tube tightly to provide a tight seal.

As before, the outer races 47 are fast in the rings 43 and the inner races 48 are fast on the shaft 56. The shaft may be journaled in sleeves 50, which may be replaced by ball bearings, if desired, and is held against endwise movement by collars 51.

Means to restrain the gyrating surfaces from rotation may also be provided, comprising grooved bracket 52 cooperating with studs 53 and balls 54 as previously described. If desired, the working parts of the pump may be enclosed within a casing shell 55.

In operation, the shaft 56 is rotated causing the races 48 to rotate, which in turn causes the surfaces 41 and 42 to gyrate about centers of gyration located on the axis of the shaft. Rotation is restrained by the studs 53 and associated parts. Consequently, opposed points on said gyrating surfaces move toward and away from each other, and as before, the point of closest approach between the surfaces moves along progressively compressing the tube to force the liquid through the tube. As before, the tube is positively expanded on the other side.

The pump is very simple, requiring no valves, no packing and no internal lubrication, and may be easily disassembled for inspection and repair. By the proper selection of suitable flexible material for the tube from among the many natural and synthetic rubber compounds and other substances now available, it is possible to handle almost every type of fluid, both liquid and gas, without deterioration of the tube.

The pump may be used both for compression and for suction and may be used in multiple units if desired, as for example for producing high vacuums. It may also be used as a motor or as a meter, if desired.

It will be understood that the invention may

be variously modified and embodied within the scope of the subjoined claims.

I claim as my invention:

1. A pump or the like, comprising, in combination, a pair of opposed surfaces, each of said surfaces being mounted for gyratory movement relative to the other, each of said surfaces being a conical surface having an axis passing through its respective center of gyration, and a flexible tube having a portion thereof in the form of a loop disposed between said surfaces, said tube being provided with inlet and outlet openings.

2. In a pump, in combination, a looped compressible tube having a fluid inlet at one end and a fluid outlet at its other end, a first annular supporting member, means extending along one side of said tube for securing said tube to said member and holding said ends in juxtaposition, a second annular supporting member and means along the opposite side of said tube for securing said tube to said second supporting member, means independent of said tube for anchoring said members against relative rotative movement but permitting relative axial movement therebetween, and means for producing relative axial movement between said members to move the members progressively toward and away from each other to compress the tube progressively therebetween beginning at the inlet end and continuing toward the outlet end and simultaneously positively to expand the tube diametrically opposite the portion under compression.

3. In a pump, a looped compressible tube having a fluid inlet at one end and a fluid outlet at its other end, a first supporting member, means along one side of said tube for securing said tube to said member and holding said ends in juxtaposition, a second supporting member, means along the opposite side of said tube for securing said tube to said second supporting member, means independent of said tube for anchoring said supporting member against relative rotating movement but permitting free relative axial movement therebetween, a shaft, means for mounting one of said supporting members on said shaft comprising a radial ball or roller bearing having an inner and an outer race, means for securing one of said races to said shaft at an angle with respect thereto and means for securing the other of said races to said supporting members whereby rotation of said shaft produces relative axial movement between said supporting members to compress said tube progressively beginning at the inlet end and continuing toward the outlet end, and simultaneously to expand positively that portion of said tube diametrically opposite the portion under compression.

4. In a pump, in combination, a looped compressible tube having a fluid inlet at one end and a fluid outlet at its other end, a first supporting member, means along one side of said tube for securing said tube to said member and holding said ends in juxtaposition, a second supporting member, means along the opposite side of said tube for securing said tube to said second supporting member, a shaft, means for mounting one of said supporting members at an angle on said shaft comprising a radial ball or roller bearing having an inner and an outer race, said inner race being secured at an angle to said shaft and said outer race supporting said supporting member whereby rotation of said shaft produces axial gyration of said supporting member to produce relative axial movement between said supporting

members to compress progressively said tube from the inlet end toward the outlet end thereof, and simultaneously to expand positively that portion of the tube diametrically opposite the portion being compressed, and means independently of said tube for anchoring said supporting members against relative rotating movement but permitting said relative axial movement therebetween.

5. In a pump, in combination, a looped compressible tube having a fluid inlet at one end and a fluid outlet at its other end, an annular stationary supporting member, means integral with said tube and extending along one side thereof for securing said tube to said stationary supporting member and holding said ends in juxtaposition, an annular movable supporting member, and means along the opposite side of said tube and integral therewith for supporting said second member, a shaft coaxial with said supporting members and said tube, means for mounting said movable supporting member on said shaft including a radial ball or roller bearing having an inner and an outer race, said inner race being secured at an angle to said shaft and said outer race supporting said movable supporting member whereby rotation of said shaft produces axial gyration of said movable supporting member to compress said tube progressively from the inlet end toward the outlet end thereof, and simultaneously to expand positively that portion of the tube diametrically opposite the portion under compression, and means independent of said tube for anchoring said movable supporting member against relative rotating movement with respect to said stationary supporting member but permitting said relative axial movement therebetween.

6. In a pump, in combination, a looped compressible tube having a fluid inlet at one end and a fluid outlet at its other end, a rotatable shaft coaxial with said tube, opposing supporting members on either side of said tube and means for positively securing the respective sides of said tube to the supporting members, means for mounting said respective supporting members on said shaft, comprising radial ball or roller bearings having inner and outer races, said inner races being so secured to said shaft that the respective axes of said inner races lie at an angle to the axis of said shaft and with respect to each other, and said outer races respectively supporting said supporting members, and means independent of said tube for anchoring said supporting members against relative rotating movement therebetween but permitting relative axial movement therebetween whereby rotation of said shaft produces progressive relative axial movement between said supporting members to compress and expand said tube simultaneously.

7. An integral compressible tube for a rotary pump comprising, a circular looped portion and juxtaposed straight portions continuing from the respective ends of the looped portion, said looped portion having an elliptical cross-section and integral bulbous ribs extending exteriorly around the opposing sides of said looped portion.

8. In a pump, in combination, a compressible tube having a fluid inlet at one end and a fluid outlet at its other end, a first supporting member, means extending along one side of said tube for securing said tube to said member for holding said ends in proper relationship, a second supporting member and means along the opposite side of said tube for securing said tube to said second supporting member, means independent

of said tube for anchoring said members against transverse relative movement but permitting relative to and fro movement therebetween, and means for producing relative to and fro movement between said supporting members to move the supporting members progressively toward and

away from each other to compress the tube progressively therebetween beginning at the inlet end and continuing toward the outlet end and simultaneously positively to progressively expand the tube following the compression.

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