

June 24, 1930.

A. BAUMANN

1,765,360

ROTARY PUMP

Filed Feb. 7, 1927

3 Sheets-Sheet 1

Fig. 1.

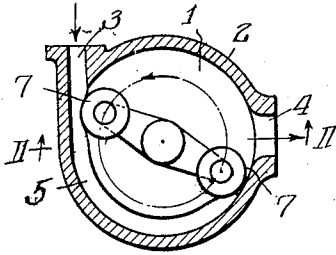


Fig. 2.

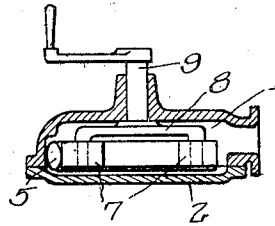


Fig. 3.

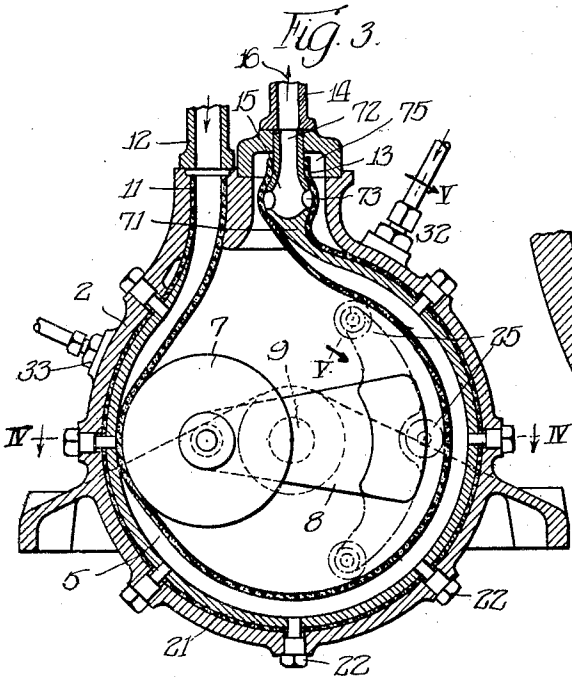


Fig. 5.

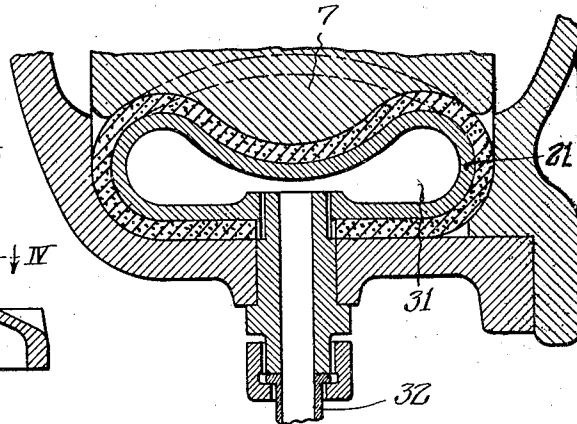


Fig. 6.

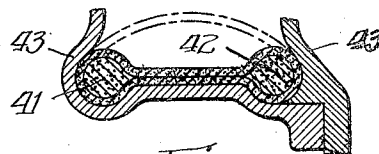


Fig. 7.

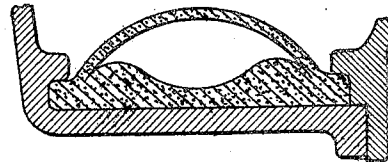
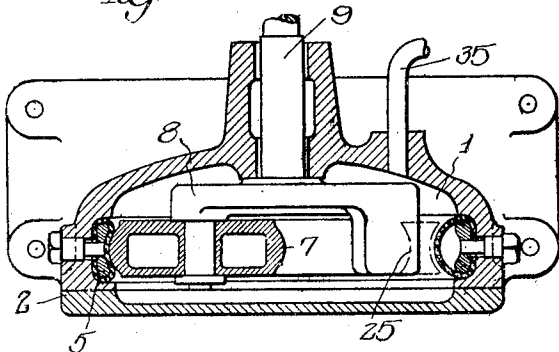


Fig. 4.



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Fig. 9

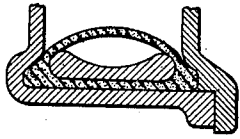


Fig. 10

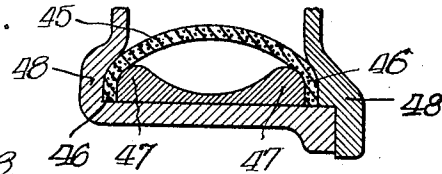


Fig. 8

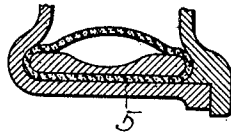


Fig. 11

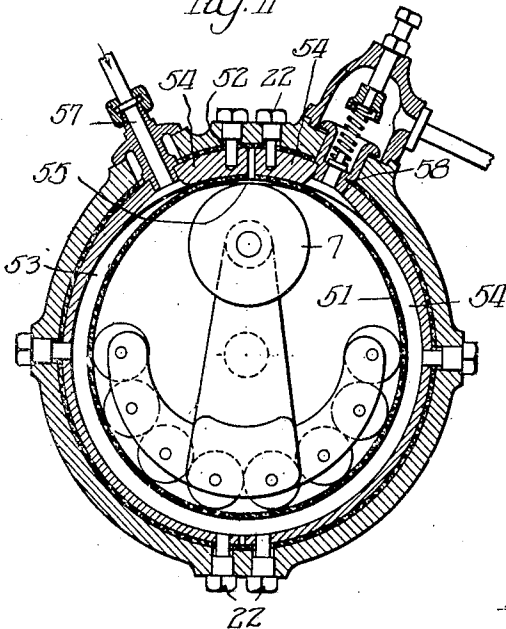


Fig. 12

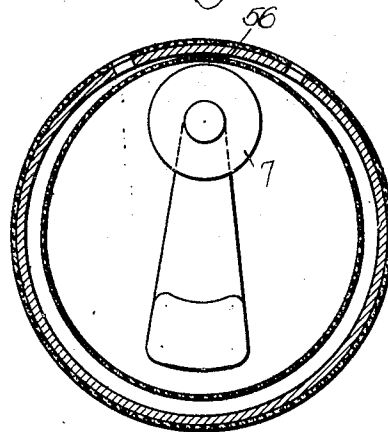
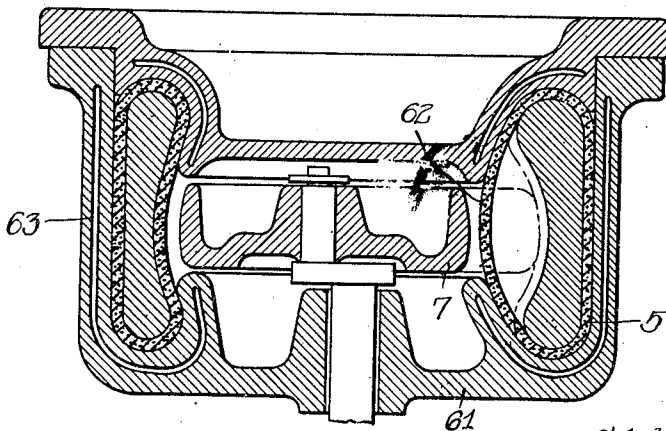


Fig. 13



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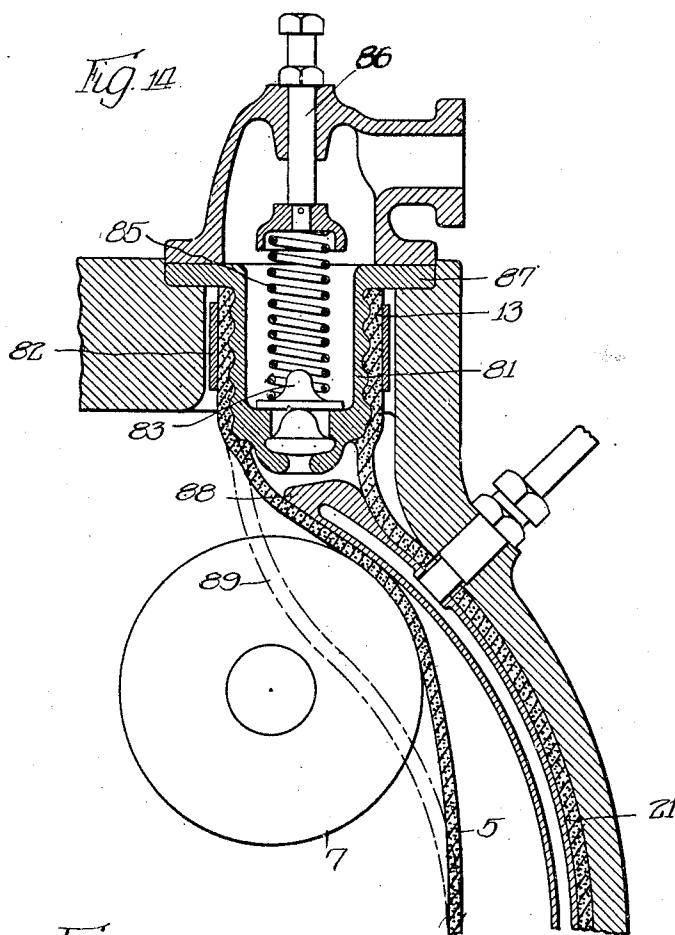
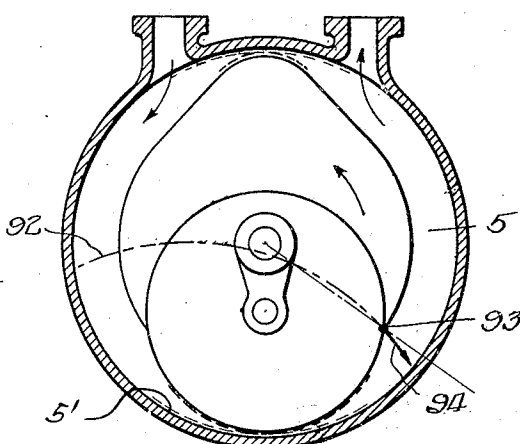
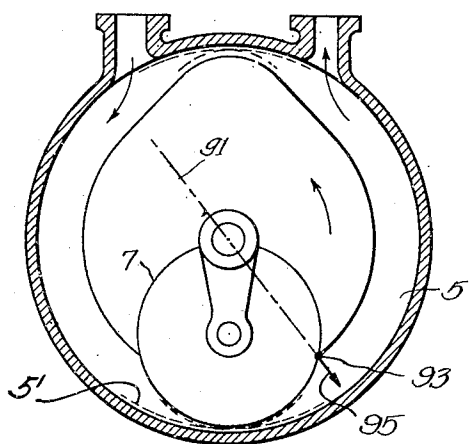


Fig. 15

Fig. 16



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UNITED STATES PATENT OFFICE

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ROTARY PUMP

Application filed February 7, 1927, Serial No. 166,548, and in Germany February 18, 1926.

This invention relates to rotary pumps, and it has particular relation to pumps in which the liquid is impelled in an elastic tube by means of a suitable impeller member that progressively compresses the tube and squeezes the fluid along the same.

The pumps of the foregoing type as known heretofore, have proven deficient on account of the excessive wear of the hollow tube in which the liquid is being impelled; the limitations in respect to the pressure under which such pumps could operate; the necessity of packing means and stuffing boxes; and other drawbacks incident to the manufacture and operation of the same.

Among the objects of the present invention is to provide a pump of this type which overcomes the deficiencies of the prior-art devices of this character, and is readily adapted for economical manufacture.

The features of my invention which I believe to be novel, will appear more clearly from the following description of various exemplifications of my invention, reference being made to the accompanying drawings in which,

Fig. 1 is a vertical sectional view of a simple pump to which my invention pertains;

Fig. 2 is a horizontal sectional view of the pump in Fig. 1 along the lines II—II;

Fig. 3 is a vertical sectional view through a pump exemplifying my invention;

Fig. 4 is a horizontal sectional view of the pump in Fig. 3 along the line IV—IV;

Fig. 5 is a detailed sectional view through a portion of the impeller tube and the adjacent housing along the line V—V in Fig. 3;

Figs. 6 to 10 are sectional views similar to Fig. 5 illustrating various modifications of the construction of the impeller tube and of the mounting thereof;

Figs. 11 and 12 are views similar to Fig. 3 illustrating modifications of the invention;

Fig. 13 is a view similar to Fig. 4 illustrating another modification of the invention;

Fig. 14 is a detailed sectional view of one form of a compression valve used in my improved pump; and,

Figs. 15 and 16 are views similar to Fig. 1

illustrating diagrammatically the principles of construction followed in the design of the improved impeller member according to my invention.

The operating principle of the type of pump to which my invention relates is illustrated in the arrangement of Figs. 1 and 2. In the inner chamber 1 of a pump casing 2 having a fluid inlet 3 and an outlet 4, is disposed an elastic tube 5 of rubber, or the like. One end of the tube is fitted into the inlet opening; the tube being disposed adjacent to the circular walls of the chamber 1, and having its other end terminate near the outlet 4. An impeller member 6 in the form of rollers 7 arranged to be rotated by a crank member 8 through a shaft 9 extending through the casing, is so arranged within the chamber as to progressively contact with the tube 5 and gradually roll flat a portion thereof, in the direction from the inlet 3 toward the outlet 4. This action of the roller members 7 thus, to a certain extent, squeezes the liquid in the direction towards the outlet 4, thereby forcing the liquid towards the delivery side 4 of the pump. The two rollers 7 of the impeller member are so arranged that as one roller is leaving the elastic tube 5, the other is just beginning the compression cycle at the point of the tube adjacent the pump inlet 3, thereby preventing backward flow of the fluid.

A pump made as described above has a number of disadvantages outlined above, and it is among the objects of the present invention to so improve this type of pump as to greatly increase its field of application and at the same time permit its economic manufacture.

One of the disadvantages of the prior-art pump is the excessive wear of the flexible impeller tube 5 by reason of the squeezing or pinching action that takes place in the operation of the prior-art pumps of this character. One feature of my invention is the provision of an improved type of impeller tube having combined therewith a special lining or insert for increasing its resistance to the wear incident to the movement of the roller or impeller thereon for reduc-

ing the squeezing or pinching action thereon. Another feature of the invention consists in the utilization of a roller of such diameter as to eliminate the squeezing and pinching action on the tube while progressing thereon in the course of rotation in the pump.

Another feature of the improved pump resides in the provision for cooling the impeller tube and the space adjacent the same, either by circulating liquid in the adjacent casing walls, or through the inner chamber of the casing, or through the lining associated with the impeller tube.

A further feature of the invention resides in the improved means for holding the impeller tube in position within the casing through the action of the elastic lining, and through the suitable mounting means associated therewith.

Another feature of the invention resides in the arrangement for causing the elastic impeller tube to return to its expanded condition after the passage of the roller over a portion thereof, and the utilization of a partial vacuum or underpressure in the crank case of the pump for this purpose. Other features of the invention reside in the provision of an impeller tube that extends directly through between the inlet of the pump and the outlet thereof, thus permitting complete segregation of the fluid that is being impelled in the pump from the crank case. This arrangement avoids the necessity for pressure-tight packings and stuffing boxes at the point where the impeller shaft is to lead through the walls of the pump casing. It also prevents the admixture of grease, oil, or other lubricating substances and the like, that may be employed in the pump mechanism to the fluid that is being impelled through the pump.

A distinct feature of the invention is the provision of an improved compression valve at the delivery end of the impeller tube of the pump.

Still other features of my invention reside in the utilization of the partial vacuum within the crank case chamber for withdrawing the working fluid in case the elastic impeller tube should become leaky; the utilization of auxiliary rollers for preventing excessive expansion or inflation of the portions of the impeller tube in which the liquid is being compressed; and other features which will appear more clearly from the further description of the several forms of the invention.

Referring to Figs. 3 and 4, the impeller tube 5 has its intake end 11 directly attached to the intake or suction pipe 12, and its delivery end 13 is directly connected to the delivery pipe 14, a compression valve 15 being included in the connection between the delivery end of the tube and the delivery pipe

14. The two ends of the impeller tube are preferably so brought out from the circular portion of the casing 2 as to avoid sharp bends or angles.

The impeller tube 5 is made of an elastic flexible material, such as rubber, and so arranged as to retain its expanded, open or hollow shape. It is mounted within the casing so as to form a substantially circular annular body having its outer surface backed against the circular inner walls of the casing. The impeller member 7 in the form of a roller, is supported on a crank member 8 and driven by the shaft 9 in counter-clockwise direction, the roller surface pressing the inner wall of the impeller tube 5 against the wall of the casing 2. As the result of this action of the impeller member the tube is flattened at the portion where the impeller member presses against it, the point of flattening traveling progressively from near the intake end 11 of the tube toward the delivery end 13 thereof, thereby forcing the fluid within the tube in the direction of the arrows 16.

In order to preserve the flexible impeller tube and prevent its rapid destruction incident to the cyclical action of the impeller member 7, the tube is provided with a special insert or lining 21, which is so arranged as to hold the tube fixed in its operating position, with its outer walls against the walls of the casing 2, and furthermore, to permit complete collapsing of the tube under the action of the impeller member 7 without introducing sharp bends in the tube walls, and excessively straining the same.

There are a variety of constructions permitting an arrangement of the tube to secure the foregoing objects. In the construction of Figs. 3 and 4, the lining is formed in the shape of a substantially circular flat ring arranged inside the tube adjacent the outer wall thereof, the sides of the circular rim forming somewhat enlarged rounded beads lying adjacent to the exterior and side walls of the impeller tube, as shown at the right-hand side of the view in Fig. 4. This lining may be made of substantially rigid material, but I prefer to have it made elastic, but less flexible than the tube. It may, for instance, be made of a rubber body that is harder than the walls of the tube 5. The rigidity of the lining will in most cases be sufficient to hold the tube in shape against the walls of the casing 2. However, if necessary, the tube may be additionally secured against the casing by bolts 22 which clamp the lining towards the casing walls.

The particular shape of the lining in the interior of the tube shown in the drawing is so chosen that when the inner wall of the tube is collapsed inwardly and pressed outwards, the inner surface of the lining is substantially co-extensive with the inner surface

of the tube portion which is to be pressed against said lining surface. In other words, the total outer surface of the lining is substantially equal to the inner area of the tube when in collapsed condition, as shown in the
 5 left hand side of the view in Fig. 4. This arrangement prevents pinching of the tube walls while compressed by the impeller member. It also secures very complete impelling
 10 action, since it permits complete compressing or sealing off of the tube under the action of the impeller member pressing against the inner walls of the tube. In this way the suction and delivery spaces of the pump are completely separated and undesirable reverses
 15 of the flow are prevented.

The outer surface of the roller 7 is so shaped as to substantially conform to the inner periphery of the lining, or the collapsed condition of the tube when it is pressed
 20 against the lining, respectively. In the preferred arrangement the width of the lining is so chosen that only a relatively limited portion of the tube at the interior side thereof is subjected to the action of the roller, and
 25 is moved between the open and the collapsed position, respectively, the side walls of the tube and the exterior thereof being substantially free from any strains.

Under some operating conditions the pressure in the portion of the tube between the impeller and the compression valve 15 may be so large as to tend to produce excessive inflation of the elastic tube. In order to prevent, and safeguard against, such excessive
 35 inflation, I provide the tube with special means for limiting the inward radial movement of the inner walls of the impeller tube. Such means may have the form of a plurality of guide rollers 25 carried on an extension
 40 of the crank 8, opposite the impeller roller 7. While the impeller roller is so mounted that the outer surface thereof, contacts with the surface of the tube when in collapsed condition, the guide rollers are so
 45 arranged as to contact with the impeller tube when it is in open or undeformed condition.

As shown in the detailed view of Fig. 5, the lining 21 may be made hollow with a
 50 chamber 31 in the interior thereof to permit circulation of a liquid in order to cool the impeller tube and the associated portions of the pump, or for any other purpose, such as to bring the fluid that is impelled in the pump
 55 in a heat-exchanging relation with another fluid. Cooling of the impeller tube is very often desirable, particularly where the temperature conditions are such that the constant bending of the flexible tube produces
 60 therein sufficient friction losses as to cause a temperature rise beyond an allowable value.

Fig. 5 shows the impeller tube in collapsed or deformed condition, the dash-dotted line
 65 of the tube after the roller has moved to

another portion thereof. Suitable pipe connections 32 and 33, serve to supply and lead away the cooling fluid that is circulated through the chamber 31. In the lining of the impeller tube the cooling fluid is preferably
 70 supplied near the delivery end of the impeller tube, and withdrawn at a point near the suction end of said tube.

The walls of the casing 2 adjacent to the sides of the impeller tube are shown so shaped
 75 as to conform to the rounded sides of the tube and the lining, and serve to additionally clamp the impeller tube in place against the outer casing walls. By reason of the particular
 80 shaping of the inner surface of the lining and the roller, the tube will be collapsed without pinching the side portions thereof between the roller and the casing walls, and at the same time a complete closure of the tube at the point where the roller acts thereon
 85 will be obtained.

Additional cooling of the tube and the associated portions of the pump may be secured by circulating through the interior of the
 chamber 1 a suitable fluid, for instance, by
 90 means of a pipe connection indicated at 35. In the preferred arrangement of my invention the pressure within the crank-case chamber 1 around the impeller tube 5, is maintained below the pressure of the fluid within
 95 the impeller tube. This partial vacuum or pressure difference between the interior of the impeller tube and the exterior thereof, will assist the tube in returning to its normal undeformed or expanded position after the
 100 roller which flattens the same has passed to another portion. It will also protect against leakage of the tube and lead away any portions of the fluid that may get into the crank-case chamber through a leak.

In Figs. 6 to 10, there are shown a number of modifications of the tube mounting and the associated lining. In the construction of Fig. 6 a result similar to that obtained with the arrangements of Figs. 3 and 4 is obtained
 110 by making the lining in the form of two rings, 41 and 42, of rubber or similar elastic material. The rings 41, 42 are disposed opposite each other adjacent the side walls of the tube and are held in place within the
 115 tube between the side walls 43 of the casing which partially overlaps the elastic tube and the lining, like in the mounting of tires in motor car wheels. With such arrangement no further attachment of the lining and the
 120 tube is required.

In the modification of Fig. 7 the tube and the lining constitute a unitary body, a reinforced suitably shaped portion of the tube taking the place of a separate lining.
 125

Fig. 8 shows an arrangement for supporting the tube and the lining in annular grooves on both sides of the casing similar to the construction shown in Figs. 3 and 4, but with a more pronounced bead effect.
 130

In the arrangement of Fig. 9 the flexible lining has substantially the same shape as that used in the beadless construction of Figs. 3 and 4, but the side walls of the flexible tubes have reinforced extensions which form beads for clamping in the annular grooves of the side walls of the casing similar in construction to that of Fig. 7.

In the form of the invention shown in Fig. 10, the impeller tube does not have the form of a closed integral tube, but it has a flexible portion 45 which constitutes the inner wall of the impeller tube, and has its sides 46 clamped to the side walls 47 of the lining which constitutes the other portion of the impeller tube. The clamping of the flexible portion of the impeller tube to the lining is effected by the overlapping portions of the casing walls at 48.

In the form of the invention shown in Fig. 11, the impeller tube is made in the form of a substantially closed ring 51 which is split at the top 52 where the two ring ends meet and abut against each other. In this construction the suction or intake side 53 and the delivery side 54 of the pump of the impeller tube are separated by enlarged portions 54 of the lining. The lining is made of two halves which may be separately inserted into the tube through the ends thereof at the point 52 where it is split, the enlarged portions of the lining at 54 serving as plugs to close the two ends of the tube. The lining is suitably clamped to the casing walls by the bolts 22, a sleeve 55 being fitted over the two tube ends at the point where they meet to hold these portions securely in place.

The entire arrangement is such that when the inner wall of the impeller tube is considered in collapsed position adjacent to the inner surface of the lining, it will have a substantially circular surface around the center of rotation of the impeller member 7. With the foregoing construction the impeller roller 7 remains continuously in contact with the flexible tubular member, whereas, in the arrangement shown in Figs. 3 and 4, the roller had to pass over a gap at the portion between the intake and delivery ends of the impeller tube.

In the form of the invention shown in Fig. 12, both the tube and the lining form a complete circle, whereas, in the construction shown in Fig. 11 the impeller tube is of somewhat elongated shape. In the construction of Fig. 12, the inner surface of the tube is tightly secured to the lining at 56, by cementing, riveting, or otherwise, in order to separate the delivery and suction portions of the impeller tube. The circular construction of the ring is helpful in preserving the flexible tubular member and extending the life thereof.

Both in the constructions of Fig. 11 and Fig. 12, the suction and delivery pipes are

connected to the ends of the tube by means of radial attachments 57 and 58 disposed in radial direction in a manner similar to the valves of pneumatic tires of automobiles and the like.

The form of the invention shown in Fig. 13 is particularly suitable for high pressures, the casing 61 being so shaped as to practically enclose and surround the entire outer walls of the impeller tube 5, leaving only a comparatively narrow gap 62 through which the impelling roller 7 may press against the tube and impel the liquid therein.

In this construction the casing walls 61 are shown provided with hollow passages 63 adjacent to the portions where they contact with the impeller tube 5 to permit circulation of additional cooling liquid through said passages, or for any other heat-exchanging operations.

The direct connection of the two ends of the impeller tube to the suction pipe and the delivery pipe, respectively, as shown in Figs. 3, etc., is very desirable from the viewpoint of maintaining the fluid that is impelled by the pump completely segregated from the moving mechanisms of the pump and of dispensing with packings, stuffing boxes, and the like. The working fluid is thus entirely enclosed by an air tight elastic compression chamber entirely dispensing with glands, stuffing boxes, and the like.

In the preferred embodiment of the invention, I provide in the delivery end of the impeller tube a compression valve, such as indicated at Figs. 3 and 11, in order to prevent back-flow of the liquid into the impeller tube in case a leak should develop therein, and also in order to avoid continuous subjection of the impeller tube to the full pressure of the compressed fluid. The provision of the compression valve makes it also possible to use a single impelling roller 7 instead of two rollers, such as are required in case a construction of the type shown in Fig. 1, without the compression valve, is utilized.

The compression valve, as shown in Fig. 3, is formed by an enlargement 71 of the elastic lining 21 near the delivery end of the impelling tube. This enlargement 71 constitutes a substantially circular body which has a hollow tubular chamber 72 at its upper end. The delivery pipe 14 is directly connected to the upper end of the tubular chamber 72 which is provided at its lower end with a plurality of perforations 73 extending radially outward through the walls of the chamber. The delivery end 13 of the impeller tube is fitted over the enlarged portion 71 of the lining and forms an enclosure around the space provided with the perforations 73.

In operation, the liquid compressed in the impeller tube by the action of the impelling roller 7 will be impelled towards the delivery end of the impeller tube, and cause said end

to be inflated at the space around the perforations 73, thus delivering the fluid through said perforations into the hollow chamber 72 and therethrough into the delivery pipe 14. A suitable clamping ring 75 around the delivery end 13 of the impeller tube may serve to hold the same sealed to the adjacent portions of the valve.

In Fig. 14 is shown another valve construction comprising a tubular valve chamber 81 having a threaded outer surface over which the delivery end 13 of the impeller tube is fitted and held clamped by means of a ring 82. A closure member 83 is held pressed against the co-operating valve seat in the valve chamber 81 by means of a spring 85 which is held in a co-operating portion 86 of the valve to permit the adjustment of the spring 85 in a familiar manner. The valve chamber is held in place within the pump casing by means of a suitable flange 87. The insert 21 within the tube has an enlarged portion 88 at the end thereof adjacent to the lower part of the valve chamber 81 in order to make the dead space at the end of the compression part of the impeller tube as small as possible, as seen in the drawing in which the impeller tube 5 is shown in deformed position, being pressed down by the impelling roller 7 corresponding to its position at the end of the compression cycle. The shape of the impeller tube in undeformed condition is indicated by the dash-dotted line 89.

One of the reasons for the excessive wear of the impeller tube in the pumps as made heretofore, is the tangential pull on the material behind the roller and the tendency to form a wave in front of the roller, the latter leading very often to puckering and pinching of the tube.

In accordance with my invention the impelling means are so designed with respect to the impeller tube as to eliminate this drawback. To this end I so correlate the size and the shape of the impeller means with respect to the dimensions and shape of the impeller tube that the movement of the roller on the tube is not accompanied by any forces tending to pull the tube walls in a direction in which it would cause the formation of folds, or the like. In the construction shown in Figs. 3, etc., I attain this object by making the diameter of the impelling roller 7 substantially equal or larger than one-half of the internal diameter of the tube when in depressed condition.

In Fig. 15 there is illustrated diagrammatically the case where the diameter of the impelling roller 7 is half the diameter of the base circle 5' upon which it is rolled, corresponding to the tube 5 in the deformed condition. The curve described by a point 93 on the roller circle 7 is in this case a hypocycloid in the shape of a straight radially-extending line 91.

In the case illustrated by Fig. 16 wherein the diameter of the rolling circle is more than one-half the diameter of the base circle 5', the curve described by a point 93 on the rolling circle is a curved hypocycloid 92 which has at the point of intersection with the tube 5 in the undeformed condition a tangent 94 which is backwardly directed.

If we now consider the case corresponding to Fig. 15 then a point 93 on the roller will, upon continuation of the rolling movement exercise upon the inner wall of the tube 5, a force in radial direction without subjecting the tube to any tangential pull in the direction of the arrow 95. This will be the case, however, only if the roller were just making contact with the tube without applying any pressure to the walls thereof. Under such conditions the walls of the tubes would be subjected only to radial forces corresponding to the arrow 95, and would be free from tangential stresses.

However, if the roller is pressed against the elastic tube, the material of the latter will be "rolled out" in the direction of the roller motion, even if no sliding should occur. Accordingly, there will be a tendency to form puckers and the tube walls will be subjected to a certain amount of tangential pull, which would be, however, only a fraction of the pull that would be present in case the diameter of the roller were made less than one-half of the diameter of the base circle.

By making the diameter of the roller greater than one-half the diameter of the base circle, the foregoing "rolling action" can be completely compensated as seen from the diagrammatic view in Fig. 16. In the latter case the point 93 will not move in radial direction, but will be forced backward, thus offsetting the force component which tends to move the material in forward direction when compressed by the roller. By suitably dimensioning the roller, the formation of puckers may thus be completely prevented, and the useful life of the tube extended.

My invention is susceptible of many other modifications than those described and specifically pointed out hereinabove, and it is my desire that the appended claims be given a broad construction commensurate with the scope of my invention which, as shown hereinabove, not only avoids the difficulties met in the prior-art constructions, but embodies in addition a number of features which greatly extend the usefulness of the type of pump under consideration.

The particular construction of the pump in which the impelled fluid is completely segregated from contact with the rotating or other moving members of the pump mechanism, safeguards the fluid against contamination with the impurities, such as oil, grease, etc. This feature makes the pump particularly suitable for impelling chemically active fluids

and for circulating the heat-transfer mediums of refrigerators and the like. The complete absence of glands and packings makes the pump also particularly adapted for use in connection with poisonous substances, as the escape of such substances is positively excluded. The absence of packings and points of leakage makes the pump also very effective for producing high vacua.

I claim as my invention:

1. In a pump comprising a tubular impeller chamber of elastic material and means for propelling fluid through said chamber by successively flattening portions of said tubular chamber in the direction in which the fluid is to be moved, means associated with and disposed in said chamber and providing for complete closure of any section thereof without introducing sharp bends into the flexible working walls thereof.

2. In a pump comprising an impeller tube having an elastic wall and impeller means for progressively closing sections of said tube by successively compressing portions of the flexible wall in the direction in which the fluid is to be impelled, means associated with and disposed in said tube to constitute a relatively stable support for the flexible wall thereof when in depressed condition.

3. In a pump comprising an impeller tube having an elastic wall and impeller means for progressively closing sections of said tube by successively compressing portions of the flexible walls in the direction in which the fluid is to be impelled, means associated with said tube to constitute a relatively stable support for the flexible walls thereof when in depressed condition, said support being rounded to prevent sharp bends in the flexible portions of the tube.

4. In a pump comprising an impeller tube having a flexible wall portion and impelling means for progressively closing said tube by successively compressing the flexible walls thereof in the direction in which the fluid is to be impelled, a lining associated with said tube to act as a support for said flexible wall when in deformed condition, said lining being relatively rigid with respect to the flexible portions of said tube and permitting complete flattening of sections of said tube without introducing sharp bends in the flexible portions thereof.

5. In a pump comprising an impeller tube having an elastic wall and impeller means for progressively closing sections of said tube by successively compressing portions of the flexible wall in the direction in which the fluid is to be impelled, means associated with said tube to constitute a relatively stable support for the flexible wall thereof when in depressed condition and being provided with a fluid passage, and connections providing for the flow of cooling fluid through said passage.

6. In a pump comprising an impeller tube having a flexible wall portion and impelling means for progressively closing said tube by successively compressing the flexible wall thereof in the direction in which the fluid is to be impelled, a lining associated with said tube to act as a support for said flexible wall when in deformed condition, said lining being relatively rigid with respect to the flexible portions of said tube and permitting complete flattening of sections of said tube without introducing sharp bends in the flexible portions thereof, and means associated with said lining for cooling the same.

7. In a pump comprising an impeller tube having a flexible wall portion and impelling means for progressively closing said tube by successively compressing the flexible wall thereof in the direction in which the fluid is to be impelled, a lining associated with said tube to act as a support for said flexible wall when in deformed condition, said lining being relatively rigid with respect to the flexible portions of said tube and permitting complete flattening of sections of said tube without introducing sharp bends in the flexible portions thereof, said lining having a hollow conduit for circulating therethrough a fluid in heat-exchanging relation therewith.

8. In a pump comprising an impeller tube having a flexible wall portion and impelling means for progressively closing said tube by successively compressing the flexible wall thereof in the direction in which the fluid is to be impelled, a lining associated with said tube to act as a support for said flexible wall when in deformed condition, said lining being relatively rigid with respect to the flexible portions of said tube and permitting complete flattening of sections of said tube without introducing sharp bends in the flexible portions thereof, said lining being hollow, and means communicating with the hollow portions of said lining.

9. In a pump comprising an impeller tube having a flexible wall portion and means for impelling a fluid in said tube by progressively flattening sections of said tube in the direction in which the fluid is to be impelled, a substantially rigid casing having walls supporting the portions of said tube against which the flexible portions thereof are pressed, and means for holding the portions of said tube adjacent to the walls of the casing in substantially rigid condition throughout the operation thereof.

10. In a pump, a substantially circular casing, a substantially annular impeller tube adjacent to the walls of said casing, means for holding one wall of said tube in substantially rigid position against the walls of said casing, the opposite wall of said tube being relatively flexible and arranged to be compressed against the rigid wall portion to permit complete flattening of the sections of

said tube, impeller means arranged to be driven along said tube to successively flatten portions thereof in the direction in which the fluid is to be impelled, said tube being so shaped and supported as to prevent sharp bends in the flexible portions thereof under the action of said impeller means.

11. In a pump, a substantially circular casing, a substantially annular impeller tube adjacent to the walls of said casing, means for holding one wall of said tube in substantially rigid position against the walls of said casing, the opposite wall of said tube being relatively flexible and arranged to be compressed against the rigid wall portion to permit complete flattening of the sections of said tube, impeller means arranged to be driven along said tube to successively flatten portions thereof in the direction in which the fluid is to be impelled, said tube being so shaped and supported as to prevent sharp bends in the flexible portions thereof under the action of said impeller means, bead members extending along said tube, and means associated with said casing for clamping said bead members thereto to hold said tube in position.

12. In a pump, a substantially circular casing, a substantially annular impeller tube adjacent to the walls of said casing, means for holding one wall of said tube in substantially rigid position against the walls of said casing, the opposite wall of said tube being relatively flexible and arranged to be compressed against the rigid wall portion to permit complete flattening of the sections of said tube, impeller means arranged to be driven along said tube to successively flatten portions thereof in the direction in which the fluid is to be impelled, said tube being so shaped and supported as to prevent sharp bends in the flexible portions thereof under the action of said impeller means, bead members extending along said tube, and means associated with said casing for clamping said bead members thereto to hold said tube in position, said impeller means being so arranged with respect to said tube as to substantially eliminate tangential pull of the flexible tube walls incident to the progressive movement of the impelling means.

13. In a rotary pump comprising a substantially circular impeller tube, a fluid intake connection at one end of said tube and a fluid delivery connection at another end of said tube, said tube being collapsible to permit successive closure of the sections thereof in the direction from the intake end to the delivery end thereof to impel the fluid, an impeller roller movable on said tube to progressively close sections thereof and impel the fluid towards the delivery end of said tube, said impeller roller being so dimensioned with respect to the path on which it rolls that the force component exercised by said roller on the co-operating walls of said tube is

directed substantially perpendicular to the walls of said tube in undeformed condition.

14. In a rotary pump comprising a substantially circular impeller tube, a fluid intake connection at one end of said tube and a fluid delivery connection at another end of said tube, said tube being collapsible to permit successive closure of the sections thereof in the direction from the intake end to the delivery end thereof to impel the fluid, an impeller roller movable on said tube to progressively close sections thereof and impel the fluid towards the delivery end of said tube, said impeller roller being so dimensioned with respect to the path on which it rolls as to substantially eliminate pull on the flexible portion of said tube in the direction of the movement of the roller.

15. In a rotary pump comprising a substantially circular impeller tube, a fluid intake connection at one end of said tube and a fluid delivery connection at another end of said tube, said tube being collapsible to permit successive closure of the sections thereof in the direction from the intake end to the delivery end thereof to impel the fluid, an impeller roller movable on said tube to progressively close sections thereof and impel the fluid towards the delivery end of said tube, the curvature of said roller being so related to the curvature of the path on which it rolls as to substantially eliminate forces tending to pull the flexible walls of said tube in the direction of the impeller movement.

16. In a rotary pump comprising a substantially circular impeller tube, a fluid intake connection at one end of said tube and a fluid delivery connection at another end of said tube, said tube being collapsible to permit successive closure of the sections thereof in the direction from the intake end to the delivery end thereof to impel the fluid, an impeller roller movable on said tube to progressively close sections thereof and impel the fluid towards the delivery end of said tube, said impeller roller being so dimensioned with respect to the path on which it rolls that the force exerted by a point of the roller on the cooperating walls of the tube is directed substantially perpendicular to said path or in a direction back thereof.

17. In a rotary pump comprising a substantially circular impeller tube, a fluid intake connection at one end of said tube and a fluid delivery connection at another end of said tube, said tube being collapsible to permit successive closure of the sections thereof in the direction from the intake end to the delivery end thereof to impel the fluid, an impeller roller movable on said tube to progressively close sections thereof and impel the fluid towards the delivery end of said tube, the diameter of said roller being equal to one-half or more than the diameter of the

path on which it is arranged to roll on said tube.

18. In a pump comprising a casing and an impeller tube disposed within said casing, a fluid intake connection at one point of said tube and a fluid delivery connection at another point of said tube to direct circulation of said fluid under substantial segregation from the other portions of said casing, said tube having a flexible wall arranged to be progressively compressed, and impeller means for progressively compressing portions of said flexible wall in the direction from the intake point of said tube to the delivery point thereof to impel a fluid towards said delivery point, said casing exterior of said tube being maintained at such pressure as to cause the tube to return to the uncompressed undeformed condition.

19. In a pump comprising a casing and an impeller tube disposed within said casing, a fluid intake connection at one point of said tube and a fluid delivery connection at another point of said tube to direct circulation of said fluid under substantial segregation from the other portions of said casing, said tube having a flexible wall arranged to be progressively compressed, and impeller means for progressively compressing portions of said flexible wall in the direction from the intake point of said tube to the delivery point thereof to impel a fluid towards said delivery point, said casing exterior of said tube being maintained at a pressure below the pressure of the fluid within said tube.

20. In a pump, an impeller tube having a fluid intake connection at one point thereof and a fluid delivery connection at another point thereof, said tube having a flexible wall permitting successive flattening of portions of said tube between the intake point and the delivery point to impel the fluid therein, an impeller means successively acting on said portions of the flexible wall to impel said fluid and compress the same in the portion of the tube between said impeller means and the delivery point thereof, and guide means for supporting the undeformed portions of said impeller tube to prevent excessive inflation thereof under the action of the pressure of the fluid in the interior thereof.

21. In a pump, an impeller tube having a fluid intake connection and a fluid delivery connection, said tube having a flexible wall permitting successive flattening of portions of said tube to impel a fluid within the same, impeller means for progressively compressing the flexible portions of said tube and impel said fluid, and guide means acting against the flexible portions of said tube outside the portion compressed by said impeller means to prevent excessive inflation of said tube incident to the compression of fluid therein, and means imparting a progressive move-

ment to said impeller means and said guide means along said tube.

22. In pump apparatus, a collapsible fluid-impeller tube, means for effecting progressive collapsing of said tube from the inlet end to the outlet end thereof, and valve means disposed within and cooperating with the outlet end of said tube to prevent backward flow of fluid with respect thereto.

23. In pump apparatus, a collapsible fluid-impeller tube, means for effecting progressive collapsing of said tube from the inlet end to the outlet end thereof, and a member disposed within the outlet end of said tube and providing a valve seat for such end, said outlet end cooperating with said member in such manner as to provide a valve action with respect to said tube to prevent backward fluid-flow in said tube while permitting of forward fluid-flow therein.

24. In pump apparatus, a fluid-impeller tube having a collapsible wall, means for effecting progressive collapsing of said tube from the inlet end to the outlet end thereof, and supporting means for said wall disposed within said tube, the end of said supporting means adjacent the outlet end of said tube cooperating with the latter to provide a valve action with respect to said tube preventing backward fluid-flow therethrough while permitting of forward fluid-flow through the same.

In testimony whereof I have hereunto subscribed my name at Zurich, Switzerland, on the 13th day of January, A. D. 1927.

ADOLPH BAUMANN.