Jan. 12, 1960 P. SCHAURTE 2,920,578

APPARATUS FOR CONVEYING GASES OR LIQUIDS

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Fig. 1

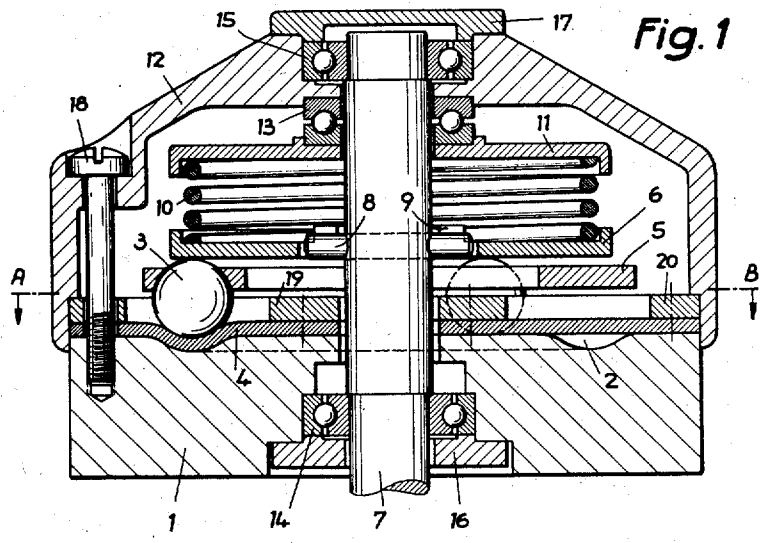
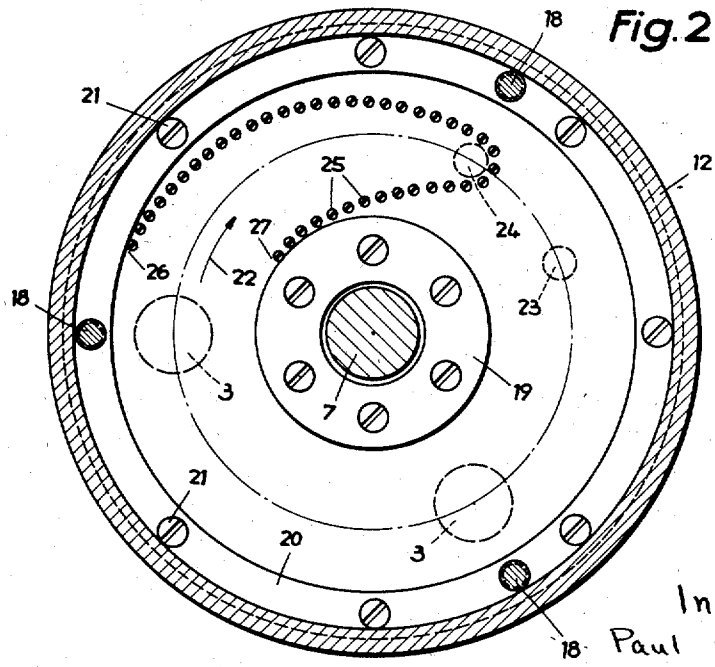


Fig. 2



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Fig.3

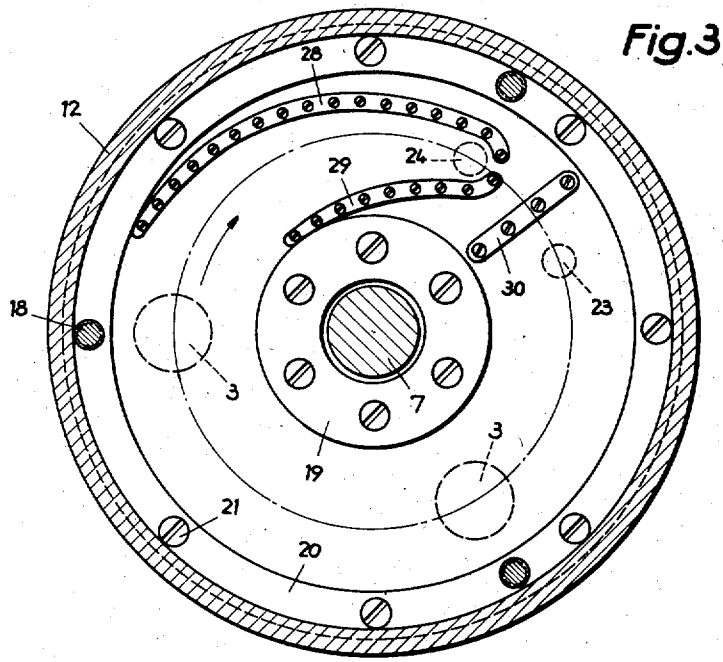
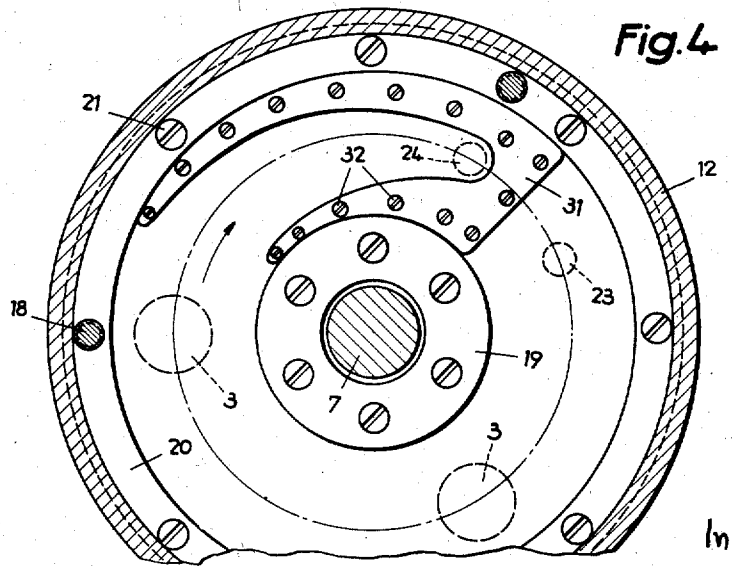


Fig.4



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APPARATUS FOR CONVEYING GASES OR LIQUIDS

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Application April 17, 1956, Serial No. 578,833

Claims priority, application Germany April 29, 1955

14 Claims. (Cl. 103—149)

The present invention relates to improvements in an apparatus for conveying gases or liquids, and more particularly in apparatus of the type as disclosed in my copending application, Serial Number 468,946, filed on November 15, 1954, now U.S. Patent 2,841,091.

In this prior application I have disclosed an apparatus in which gases or liquids may be conveyed by means of a resilient diaphragm which rests upon the surface of a housing having an annular groove or channel therein into which the resilient diaphragm may be depressed by one or more rotatable elements of spherical shape which are moved along such surface by a circular disk mounted on a shaft which extends vertically to the general plane of the diaphragm so as to compress the same into such channel at one or more points and thereby seal off the inlet and outlet openings of the channel relative to each other. The rotatable elements directly engage the surface of the diaphragm, and the annular channel has a cross-sectional shape which consists of a central arc of a circle which smoothly merges on either side into a convex portion and thus gradually into the level upper surface of the housing.

It has now been found that if the pressure in the operating chamber formed by the annular channel and the resilient diaphragm covering the same exceeds a certain limit, it may sometimes occur that the diaphragm will be lifted from the channel on the compression side of such chamber so that the gas or liquid contained therein may leak therefrom.

It is an object of the present invention to provide an apparatus of the type as described in which this deficiency will not occur.

A feature of the invention for attaining this object consists in providing the operating chamber of such a shape that its inner cross-sectional area diminishes to approximately one-third its size in the direction toward the outlet opening.

Further objects, features, and advantages of the invention, and the particular manner in which such reduction in the cross-sectional area may be attained will be apparent from the following detailed description and the accompanying drawings, in which—

Fig. 1 shows a cross section through an apparatus according to the invention, in which the diaphragm is acted upon by three balls;

Fig. 2 shows a cross section taken along line A—B of Fig. 1, in which, adjacent to the outlet opening, the diaphragm is pressed against one portion of the housing of the apparatus by means of a plurality of closely spaced bolts so that the inner cross-sectional area of the operating chamber progressively diminishes in size toward the outlet opening;

Fig. 3 shows a cross section similar to Fig. 2 in which the reduction in cross-sectional area of the operating chamber is obtained by suitably shaped strips; and

Fig. 4 shows a cross section similar to Fig. 3, in which the reduction in the cross-sectional area of the operating chamber is obtained by a plate which is shaped accordingly.

Referring to the drawings, the housing 1 has provided therein an annular groove 2, the generatrix of which substantially consists of a central circular arc terminating into two curved portions so that the common tangent determined by the points of connection with the circular arc appears as a tangent through the point of inflection. The radius of the central arc is made equal to, or smaller than the sum of the radius of the spherical ball 3 and the thickness of the diaphragm 4 filling out the area formed by the groove. It is not required, according to the invention, that the generatrix consisting of three curved sections has an axis of symmetry. A groove designed as thus described has the advantage that the cross-sectional area thereof may be enlarged without requiring the contact surface between the balls 3 and the annular diaphragm 4 also to be enlarged. Frictional losses and the wear upon the diaphragm will thus be reduced.

Balls 3 are being retained within a cage 5 which preferably forms a single element, and they are acted upon by a disk 6 which is positively connected with the rotating shaft 7, for example, by a driving pin 8 or the like, which engages in slots 9 in the disk 6. Such arrangement allows the balls 3 and their cage 5 to rotate at half the angular velocity of the shaft 7. Disk 6 is acted upon by one or more resilient means, such as a spring 10 which at one end presses upon the disk 6 and at the other end upon a disk 11. For preventing the balls 3 from slipping relative to the disk 6, it is advisable to cover the side of the disk 6 facing the balls 3 with a material similar to that of the diaphragm 4. Disk 11 is rotatably supported on the housing cover 12 by means of an axial bearing 13, and shaft 7 by a radial bearing 14 in the housing 1 and another radial bearing 15 in the housing cover 12. Bearing 14 is protected and secured in place by a cap 16, and bearing 15 by a cap 17. Cover 12 and housing 1 are secured to each other by suitable means, such as bolts 18. Diaphragm 4 is fixed in place relative to the housing 1 by two rings 19 and 20, for example, by means of screws 21. Bolts 18 may also act as means for securing the diaphragm 4 relative to the housing 1.

If the balls 3 are rotated so as to revolve in the direction shown by the arrow 22 in Fig. 2, the gases or liquids to be conveyed enter into the operating channel formed between groove 2 and diaphragm 4 through an inlet bore 23 and are discharged therefrom through an outlet bore 24. Bores 23 and 24 communicate with suitable inlet and outlet lines which are not shown in the drawing. In order to prevent the gas or liquid within the operating channel from escaping again through the inlet bore 23 and for preventing it from leaking from such channel if the pressure therein exceeds a certain value, diaphragm 4 is preferably secured to housing 1 by a series of screws 25 which are spaced closely adjacent to each other, and in such a manner that balls 3 will not come into direct engagement with these screws. For this purpose, as shown in Fig. 2, the two rows of screws gradually curve toward each other from their starting points 26 and 27 toward the outlet opening 24, so that their distance from

each other, as seen in a radial direction, gradually decreases toward outlet opening 24 where such distance around the opening is only slightly larger than the diameter thereof. The two rows of screws thus combine and surround the outlet opening 24 at the side facing toward the inlet opening 23. As is apparent from Fig. 2, each row of screws has a length several times greater than the diameter of outlet 24 as well as several times greater than the radial width of the groove 2.

As illustrated in Fig. 3, diaphragm 4 may also be secured by providing suitable curved grooves in the upper surface of housing 1, and by drawing the diaphragm into these grooves by means of two mounting strips 28 and 29 having a length substantially equal to the lengths of the rows of screws of Fig. 2, respectively. Although a single continuous mounting strip may also be used which surrounds outlet opening 24 at the side facing toward inlet opening 23, it is more convenient to secure two separate mounting strips in two corresponding grooves, and to secure an additional mounting strip 30 between the inlet and outlet bores 23 and 24 so that the balls 3 when rolling over this strip 30 will not come into direct engagement therewith. Mounting strip 30 is therefore designed so as to correspond with the curved shape of groove 2 and so that diaphragm 4 will close off the operating channel completely at this point.

The cross-sectional area of the operating channel may, however, also be gradually reduced in size in the direction toward outlet opening 24 by means of a plate 31 which is shaped as illustrated in Fig. 4 so as gradually to restrict the size of the channel along an arcuate length several times greater than the diameter of the outlet opening and also several times greater than the radial width of the groove 2 and at the same time to seal off the area intermediate bores 24 and 23. Plate 31 is superimposed upon diaphragm 4 and is preferably secured to housing 1 by screws 32. The shape of plate 31 is designed so as not to come into direct engagement with balls 3 during their revolution along the upper surface of diaphragm 4. Plate 31 may also be combined with the rings 19 and 20 which secure diaphragm 4 in place on the housing 1, so that all three members form a single unitary element.

The apparatus according to the invention may be produced at a very low cost if the two parts of the housing 1 and 12 are made of a synthetic material. In such event, the grooves in the upper surface of the lower housing part 1 for receiving the mounting strips 28, 29, and 30, as shown in Fig. 3, or the shallow recess in such surface for taking up plate 31 according to Fig. 4 may be molded into this part during the production thereof and will then need no further finishing operation.

The two parts 1 and 12 of the housing may also be produced of sheet metal which is deep-drawn to attain the required shape. The grooves or recesses in the upper surface of the lower part 1 as shown in Figs. 3 and 4, respectively, may then also be formed in the same deep-drawing operation in which the part itself is formed. The hollow lower housing part 1 may then be considerably reinforced by inserting sheet metal laminations or the like into the hollow space therein, and such laminations may also be designed to act as cooling ribs.

The present invention may also be applied if in place of one diaphragm 4, as shown in Fig. 1, two or even more diaphragms are superimposed upon each other so as either to be in contact with or spaced from each other.

Although my invention has been illustrated and described with reference to the preferred embodiments thereof, I wish to have it understood that it is in no way limited to the details of such embodiments, but is capable of numerous modifications within the scope of the appended claims. Thus, for example, while I have herein disclosed the use of a circular groove 2 of substantially arcuate cross section, and spherical balls 3 as the means of acting upon the diaphragm 4, the present invention may also be applied to a groove, operating channel or chamber, and to means for acting upon the diaphragm, all of which are of different shape than those shown herein.

Having thus fully disclosed my invention, what I claim is:

1. An apparatus for conveying a gaseous or liquid medium comprising a housing having an annular groove therein, a resilient diaphragm overlying said groove and forming together therewith a closed annular operating chamber, said housing being formed with two conduits communicating with said chamber and forming, respectively, an inlet opening and an outlet opening of a given diameter substantially adjacent each other for feeding said medium to and discharging it from said chamber, at least one element engaging said resilient member and adapted to compress the same at one point to close said chamber, means operatively associated with said element for driving and guiding the same so as to move it continuously in one direction along a circular path coinciding with a vertical cylindrical plane passing through the center of said annular chamber, as seen in a cross section thereof, and for compressing said resilient member so that said point of compression moves along within a vertical plane passing through said element so as to seal off at least two parts of said chamber intermediate said inlet and outlet openings relative to each other, means for gradually reducing the cross-sectional area of said chamber along an arcuate length thereof several times greater than said diameter in said direction of rotation of said element toward said outlet opening, and means for sealing off said chamber at a point adjacent to and intermediate said inlet and outlet openings, whereby when said element moves along said circular path in said direction of rotation and simultaneously compresses said resilient member, it progressively moves said medium along said chamber from said inlet opening to said outlet opening, and whereby bulging of said diaphragm in the region of said outlet opening is prevented.

2. An apparatus for conveying a gaseous or liquid medium comprising a housing having an annular groove therein, a resilient diaphragm overlying said groove and forming together therewith a closed annular operating chamber, said housing being formed with two conduits communicating with said chamber and forming, respectively, an inlet opening and an outlet opening of a given diameter substantially adjacent each other for feeding said medium to and discharging it from said chamber, at least one element engaging said resilient member and adapted to compress the same at one point to close said chamber, means operatively associated with said element for driving and guiding the same so as to move it continuously in one direction along a circular path coinciding with a vertical cylindrical plane passing through the center of said annular chamber, as seen in a cross section thereof, and for compressing said resilient member so that said point of compression moves along with a vertical plane passing through said element so as to seal off at least two parts of said chamber intermediate said inlet and outlet openings relative to each other, means for gradually reducing the size of the cross-sectional area of at least a substantial portion of said chamber having an arcuate length several times greater than said diameter in said direction of rotation of said element toward and adjacent to said outlet opening to substantially one-third of the size of said chamber near said inlet opening, and means for sealing off said chamber at a point adjacent to and intermediate said inlet and outlet openings, whereby when said element moves along said circular path in said direction of rotation and simultaneously compresses said resilient member, it progressively moves said medium along said chamber from said inlet opening to said outlet opening, and whereby bulging of said diaphragm in the region of said outlet opening is prevented.

3. An apparatus for conveying a gaseous or liquid

medium comprising a housing having an annular groove of a given radial width therein, a resilient diaphragm overlying said groove and together with said groove forming a closed annular operating chamber,, said housing being formed with two conduits communicating with said chamber and forming, respectively, an inlet opening and an outlet opening substantially adjacent each other for feeding said medium to and discharging it from said chamber through said housing, at least one element on said diaphragm, means operatively associated with said element for driving and guiding the same so as to move it continuously in one direction along a circular path coinciding with a vertical cylindrical plane passing through the center of said annular groove, as seen in a cross section thereof, and for pressing said element upon the upper surface of said diaphragm so as to depress the same into said groove within a vertical plane passing through said element so as to fill said groove completely at such plane and to separate at least two parts of said chamber intermediate said inlet and outlet openings from each other, and means for securing said diaphragm to said housing including at least one member extending along said groove and having a length several times greater than the width thereof for gradually reducing the cross-sectional area of said chamber in said direction of rotation of said element toward said outlet opening, and a member for securing said diaphragm to said housing at a point of said groove adjacent to and intermediate said inlet and outlet openings so as to seal off said openings into said chamber relative to each other, whereby when said element moves along said circular path in said direction of rotation and simultaneously depresses said diaphragm into said groove, it progressively pushes said medium along said chamber from said inlet opening to said outlet opening.

4. An apparatus for conveying a gaseous or liquid medium comprising a housing having an annular groove of a given radial width therein, a resilient diaphragm overlying said groove and together with said groove forming a closed annular operating chamber, said housing being formed with two conduits communicating with said chamber and forming, respectively, an inlet opening and an outlet opening substantially adjacent each other for feeding said medium to and discharging it from said chamber through said housing, at least one rotatable element, means operatively associated with said element for driving and guiding the same so as to move it continuously in one direction along a circular path coinciding with a vertical cylindrical plane passing through the center of said annular groove, as seen in a cross section thereof, and for pressing said element upon the upper surface of said diaphragm so as to depress the same into said groove within a plane passing through said rotatable element so as to fill said groove completely at such plane and separate at least two parts of said chamber intermediate said inlet and outlet openings from each other, and means for securing said diaphragm to said housing including a plurality of closely adjacent screws forming at each side of said chamber a row several times longer than said given width of said groove, the distance between said two rows gradually decreasing toward said outlet opening so that directly adjacent to said outlet opening they are spaced from each other a distance substantially corresponding to the diameter of said outlet opening, said two rows of screws merging with each other so as to surround said outlet opening at the side facing toward said inlet opening and to seal off said openings relative to each other, whereby when said element moves along said circular path in said direction of rotation and simultaneously depresses said diaphragm into said groove, it progressively pushes said medium along said chamber from said inlet opening to said outlet opening.

5. An apparatus for conveying a gaseous or liquid medium comprising a housing having an annular groove

therein, a resilient diaphragm overlying said groove and together with said groove forming a closed annular operating chamber, said housing being formed with two conduits communicating with said chamber and forming, respectively, an inlet opening and an outlet opening substantially adjacent each other for feeding said medium to and discharging it from said chamber through said housing, at least one element on said diaphragm, means operatively associated with said element for driving and guiding the same so as to move it continuously in one direction along a circular path coinciding with a vertical cylindrical plane passing through the center of said annular groove, as seen in a cross section thereof, and for pressing said element upon the upper surface of said diaphragm so as to depress the same into said groove within a vertical plane passing through said element so as to fill said groove completely at such plane and to separate at least two parts of said chamber intermediate said inlet and outlet openings from each other, means for securing said diaphragm to said housing, and means for gradually reducing the cross-sectional area of at least a substantial portion of said chamber in said direction of rotation of said element toward and adjacent to said outlet opening, said last means comprising a pair of curved mounting strips on said diaphragm, a shallow curved depression at each side of said groove in the upper surface of said housing, the distance between said depressions gradually decreasing toward said outlet opening, and adjacent to said outlet opening being closely spaced therefrom, means for securing said mounting strips and thus said diaphragm to said housing within said depressions, another shallow depression in said housing extending transversally to said groove at a point intermediate and adjacent to said openings, another mounting strip on said diaphragm, and means for securing said last mounting strip and thus said diaphragm to said housing within said transverse depression for sealing off said openings into said chamber relative to each other, whereby when said element moves along said circular path in said direction of rotation and simultaneously depresses said diaphragm into said groove, it progressively pushes said medium along said chamber from said inlet opening to said outlet opening.

6. An apparatus for conveying a gaseous or liquid medium comprising a housing having an annular groove therein, a resilient diaphragm overlying said groove and together with said groove forming a closed annular operating chamber, said housing being formed with two conduits communicating with said chamber and forming, respectively, an inlet opening and an outlet opening substantially adjacent each other for feeding said medium to and discharging it from said chamber through said housing, at least one element on said diaphragm, means operatively associated with said element for driving and guiding the same so as to move it continuously in one direction along a circular path coinciding with a vertical cylindrical plane passing through the center of said annular groove, as seen in a cross section thereof, and for pressing said element upon the upper surface of said diaphragm so as to depress the same into said groove within a vertical plane passing through said element so as to fill said groove completely at such plane and to separate at least two parts of said chamber intermediate said inlet and outlet openings from each other, means for securing said diaphragm to said housing, and means for gradually reducing the cross-sectional area of at least a substantial portion of said chamber in said direction of rotation of said element toward and adjacent to said outlet opening, said last means comprise a substantially U-shaped depression in the upper surface of said housing at both sides of said groove and surrounding said outlet opening, at the side thereof facing toward said inlet opening, the two arms of said depression extending from a point adjacent to said outlet opening in a direction opposite to said direction of rotation and gradually di-

verging relative to each other, at least one mounting strip on said diaphragm, and means for securing said mounting strip together with said diaphragm to said housing within said depression, whereby when said element moves along said circular path in said direction of rotation and simultaneously depresses said diaphragm into said groove, it progressively pushes said medium along said chamber from said inlet opening to said outlet opening.

7. An apparatus for conveying a gaseous or liquid medium comprising a housing having an annular groove therein, a resilient diaphragm overlying said groove and together with said groove forming a closed annular operating chamber, said housing being formed with two conduits communicating with said chamber and forming, respectively, an inlet opening and an outlet opening substantially adjacent each other for feeding said medium to and discharging it from said chamber through said housing, at least one element on said diaphragm, means operatively associated with said element for driving and guiding the same so as to move it continuously in one direction along a circular path coinciding with a vertical cylindrical plane passing through the center of said annular groove, as seen in a cross section thereof, and for pressing said element upon the upper surface of said diaphragm so as to depress the same into said groove within a vertical plane passing through said element so as to fill said groove completely at such plane and to separate at least two parts of said chamber intermediate said inlet and outlet openings from each other, means for securing said diaphragm to said housing, and means for gradually reducing the cross-sectional area of at least a substantial portion of said chamber in said direction of rotation of said element toward and adjacent to said outlet opening, said last means comprising a substantially U-shaped depression in the upper surface of said housing at both sides of said groove and surrounding said outlet opening at the side thereof facing toward said inlet opening, the two arms of said depression extending from a point adjacent to said outlet opening in a direction opposite to said direction of rotation and gradually diverging relative to each other, a single plate on said diaphragm and shaped substantially corresponding to said depression, and means for securing said plate together with said diaphragm to said housing within said depression at both sides of said groove and intermediate said inlet and outlet openings.

8. An apparatus for conveying a gaseous or liquid medium comprising a housing having an annular groove therein, a resilient diaphragm overlying said groove and together with said groove forming a closed annular operating chamber, said housing being formed with two conduits communicating with said chamber and forming, respectively, an inlet opening and an outlet opening substantially adjacent each other for feeding said medium to and discharging it from said chamber through said housing, at least one element on said diaphragm, means operatively associated with said element for driving and guiding the same so as to move it continuously in one direction along a circular path coinciding with a vertical cylindrical plane passing through the center of said annular groove, as seen in a cross section thereof, and for pressing said element upon the upper surface of said diaphragm so as to depress the same into said groove within a vertical plane passing through said element so as to fill said groove completely at such plane and to separate at least two parts of said chamber intermediate said inlet and outlet openings from each other, means for securing said diaphragm to said housing comprising an inner and an outer ring-shaped member on said diaphragm and secured to said housing, and means for gradually reducing the cross-sectional area of at least a substantial portion of said chamber in said direction of rotation of said element and adjacent to said outlet opening, said last means comprising a substantially U-shaped depression in the upper surface of said housing at both sides of said groove and surrounding said outlet opening at the side thereof facing toward said inlet opening, the two arms of said depression extending from a point adjacent to said outlet opening in a direction opposite to said direction of rotation and gradually diverging relative to each other, a plate on said diaphragm and shaped substantially corresponding to said depression and being connected to said inner and outer ring-shaped members, and means for securing said plate together with said diaphragm to said housing so that said plate then holds said diaphragm within said depression at both sides of said groove and intermediate said inlet and outlet openings.

9. A pump, comprising, in combination, a support having a face formed with an annular groove of a given width therein; a diaphragm arranged on said face and overlying said groove so as to form an annular chamber therewith; spaced inlet and outlet means formed in said support and communicating with said chamber; a compressor element mounted for movement along a circular path over said diaphragm for pressing successive points of said diaphragm into said groove, said element being so shaped that as it presses each point into said groove the effective cross-section of said chamber at said point is zero; means for moving said element along said circular path in a predetermined direction; and means for closing said chamber at a point behind said outlet means and ahead of said inlet means with respect to said direction and for gradually reducing the cross-section of said chamber in said direction toward said outlet means along an arcuate length of said chamber several times greater than said width of said groove until the width of said chamber is substantially equal to that of said outlet means, whereby a fluid medium may be sucked in through said inlet means, be progressively conveyed through said chamber, and be expelled through said outlet means.

10. A pump as defined in claim 9 wherein said groove has portions which are progressively deeper from the outer sides toward the center of the groove and wherein said last-mentioned means comprise a plurality of fastening means for fastening said diaphragm to progressively deeper portions of said groove.

11. A pump as defined in claim 10 wherein said fastening means are in the form of a plurality of screws passing through said diaphragm and engaging said support.

12. A pump as defined in claim 10 wherein said fastening means are in the form of a pair of strips arranged, respectively, on opposite sides of a cylinder coaxial with said annular groove and passing through the point at which said outlet means communicate with said groove and a third strip extending transversely across said groove at said point behind said outlet means and ahead of said inlet means, each of said strips being in face-to-face contact with said diaphragm, and wherein said fastening means further include screws passing through said strips and said diaphragm for securing said strips and diaphragm to said support.

13. A pump as defined in claim 12 wherein strips are integral with each other.

14. In a pump of the type having ball members progressively urging a flexible wall into contact with the bottom of a groove, in combination, a wall having a face formed with an annular groove and formed with inlet and outlet openings communicating with said groove, said outlet opening having a given diameter; a diaphragm covering said groove and engaging said face of said wall so that ball members depressing said diaphragm into said groove and rolling therealong will move fluid between said groove and diaphragm at a portion of the latter between a pair of successive ball members to said outlet opening as the ball members roll toward said outlet opening; and means fixing said diaphragm to said wall at a portion of said face thereof between said openings and

along a pair of elongated portions of said face located in advance of and extending up to said outlet opening, the latter pair of elongated portions of said face having a length several times greater than the diameter of said outlet opening and the distance between said elongated portions of said face becoming gradually smaller as they approach said outlet opening, said distance being only slightly greater than said diameter of said outlet opening in the immediate vicinity of said outlet opening.

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