July 1, 1958 P. SCHAURTE 2,841,091

APPARATUS FOR CONVEYING GASES OR LIQUIDS

Filed Nov. 15, 1954 3 Sheets-Sheet 1

Fig. 1

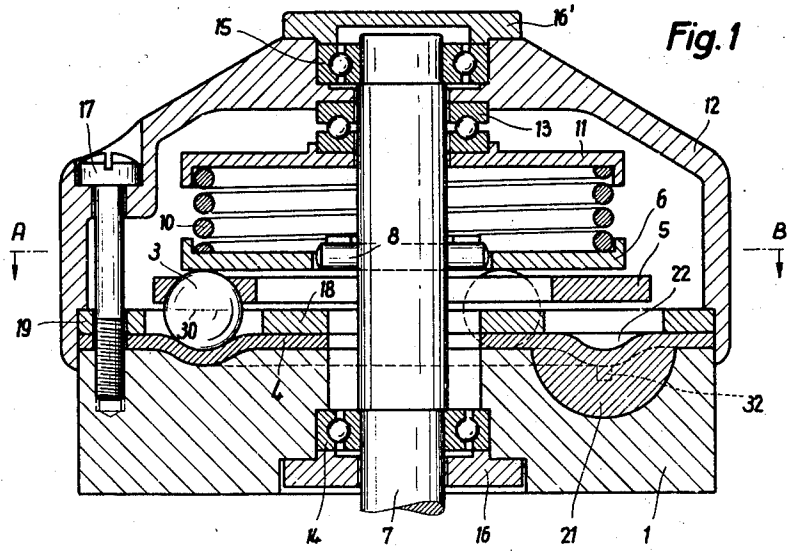
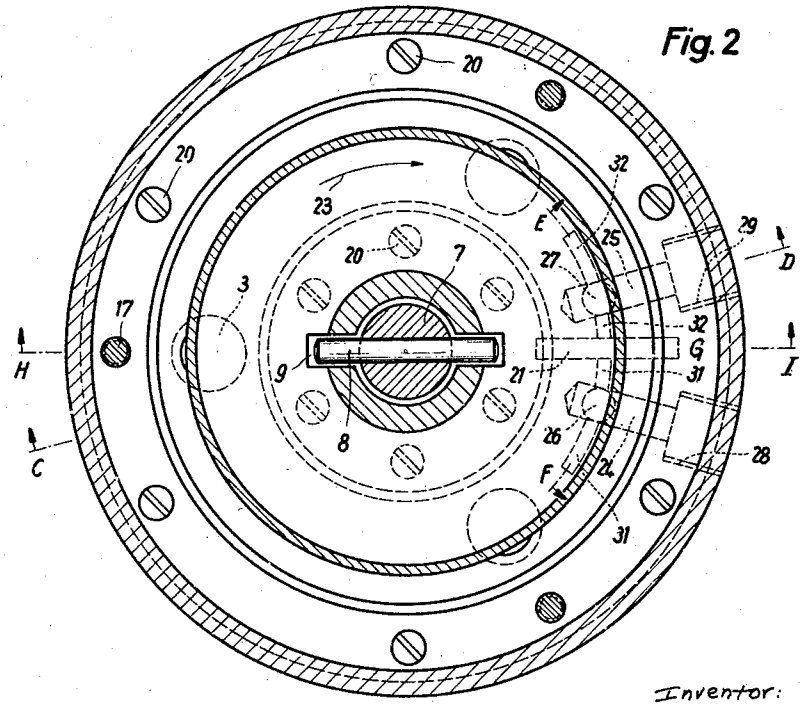


Fig. 2



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Fig. 3

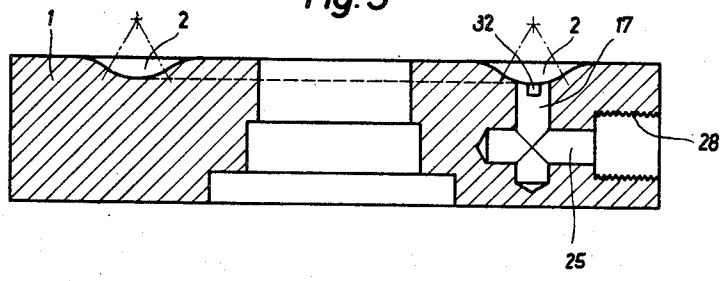


Fig. 4

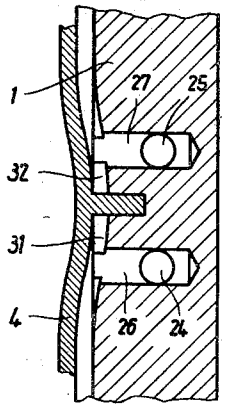


Fig. 5

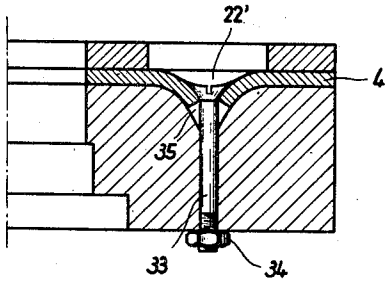


Fig. 8

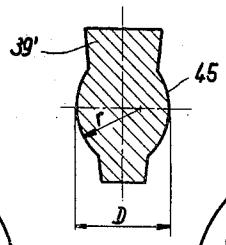


Fig. 6

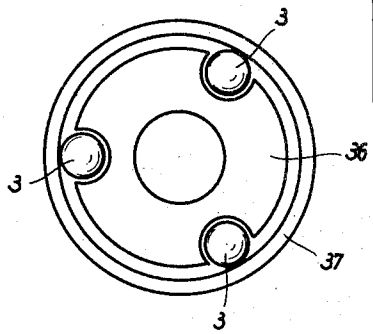
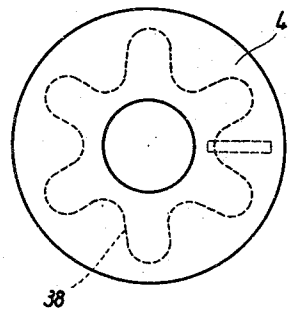


Fig. 7



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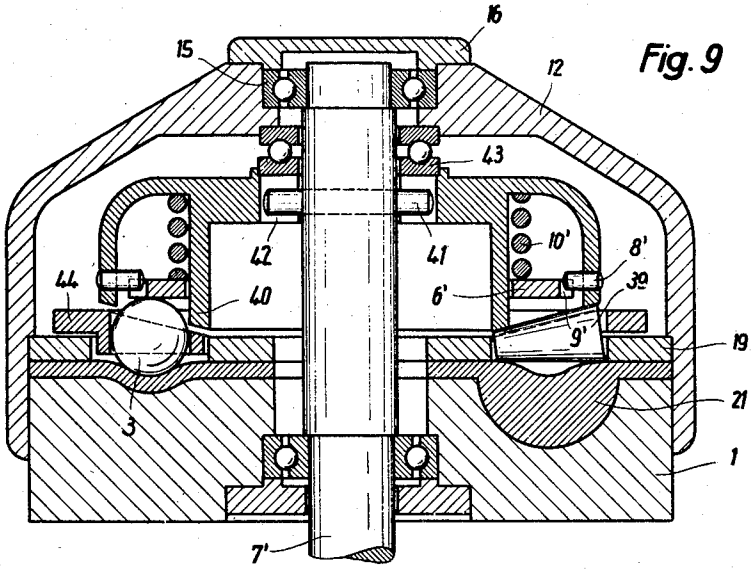


Fig. 9

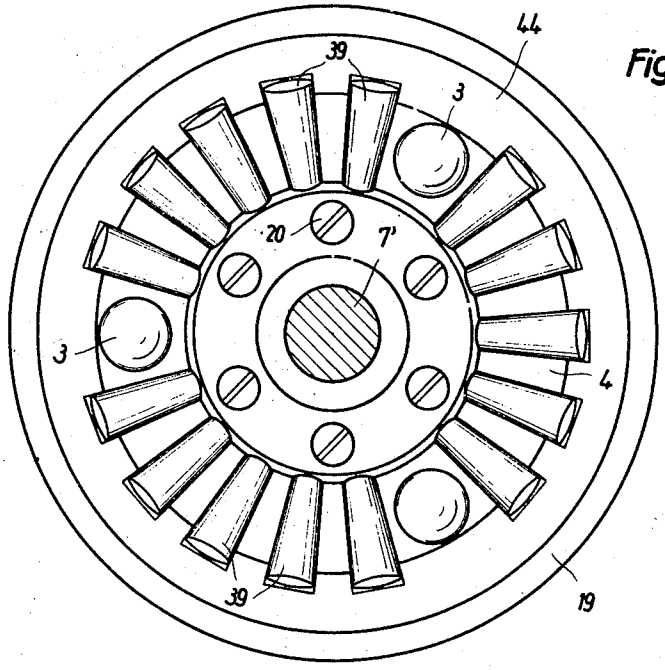


Fig. 10

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APPARATUS FOR CONVEYING GASES OR LIQUIDS

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Claims priority, application Germany November 16, 1953

16 Claims. (Cl. 103—149)

The present invention relates to an apparatus for conveying gases or liquids.

More particularly, the invention relates to conveyors, pumps, flow meters or the like of the type in which a liquid or gaseous medium is being moved within an annular resilient channel or the like which is progressively compressed by one or more elements which are being moved about a central axis so as to roll along the surface of the annular channel, thereby pushing the respective medium within the channel from its inlet toward its outlet openings which are separated from each other by a suitable wall or the like, the channel portions immediately after being released by the compression elements springing back to their original cross-sectional area for admitting another charge of medium to be pushed along by the rolling element as it comes around again to the inlet side of the annular resilient channel.

Various designs of such pumps have previously been made including the type in which the annular resilient channel overlies an annular groove into which the channel is depressed by one or more elements which are moved along the upper surface of the channel, thereby progressively depressing the channel into the groove. In some of these designs pressure elements were moved along the resilient channel so as to press it only upon the central part of the groove, leaving the side walls substantially untouched by the resilient channel, while in other designs the pressure element together with the resilient channel were filling the groove at that particular place entirely.

Although pumps of this general type have the great advantage over other types of pumps of not requiring any control means such as valves, slides, or the like, and of being of simple construction, not requiring a very high degree of accuracy of manufacture, they have not proved successful in actual practice primarily for the reason that in all the designs known the circulating pressure elements either do not close off the resilient channel entirely, thus permitting a portion of the respective medium to flow back and resulting in an inefficient operation, or the pressure elements exert a squeezing or mashing action upon the resilient channel and tend to drag along the resilient material in the direction of their movement, thus resulting in excessive wear upon the resilient material. The amount of service required by pumps of these types, if they were to operate at all efficiently insofar as their actual pumping action or the quantity of medium conveyed thereby is concerned, was so large due to the necessary frequent changes of the resilient conveying means that the cost and trouble of such service far outweighed their advantages.

It has now been found according to the invention that the failure of the prior designs of pumps of this general type are due primarily to the fact that their pressure elements were mounted rigidly on the rotating drive shaft, thus exerting a mashing, squeezing, or tearing action upon the resilient channel, rather than a resilient rolling action

which automatically adapts itself to the yieldingness of the channel material and the pressure in such channel.

According to another type of pump previously known, the resilient channel of the designs as described above was replaced by a resilient diaphragm which was spaced a certain distance from an inner surface of the pump housing so as to form an intermediate channel which connected the inlet and outlet openings of the pump. This channel was then partitioned progressively at one point after another by a series of tappets or rams pressing the resilient diaphragm toward the inner surface of the housing and thus successively closing the channel or reducing the cross-sectional area theerof, or moving the partition thus formed along the housing surface toward the outlet. According to a preferred embodiment of this prior design, the housing was made of annular shape within which the rams or tappets were provided about a central revolving shaft and successively actuated in a radial direction by a cam on such shaft lifting the tappets against the resilient diaphragm to press the same progressively toward the cylindrical inner surface of the pump housing. In still another embodiment of such prior design, the channel formed intermediate the nonresilient surface and the resilient annular diaphragm was located within a plane vertically to the drive shaft which exerted a pressure upon the diaphragm by means of rollers mounted on an axis extending vertically to, and positively secured to, the drive shaft, thus rolling such rollers along the surface of the diaphragm about such central driving axis and pressing the points contacted by the rollers toward the nonresilient surface.

Either one of these pump designs in which the conveying channel was formed intermediate a nonresilient surface and a resilient diaphragm had the disadvantage that the pump could work only if the medium to be conveyed thereby entered the pump under pressure, and that such pressure within the conveying channel had to be sufficient to return the tappets or rams after pressing upon the diaphragm, to their original position. These designs had the further considerable disadvantage that they only allowed a partial compression of the conveying channel, thus being very inefficient in their operation, and that the movement of the tappets was directed at substantially a right angle relative to the direction of flow, so that the pressure of the medium itself tended to jam the tappets and prevented them from returning to their original position.

It is the object of the present invention to devise an apparatus for conveying gaseous or liquid media which is adapted to be used either as a pump, as a flow meter, or the like, and which in some respects is similar to the prior pump designs as above described insofar as it operates according to the same general principle, but overcomes all the disadvantages of such prior deisgns, thus rendering it highly efficient and reliable in operation, requiring little, if any, service or repair, and being adapted to be produced at a low cost.

The essential features of the invention for attaining such object reside in the provision of a conveying channel of a particular cross-sectional curvature, the generatrix of which essentially consists of a central circular arc which terminates toward both ends into an opposite curvature, and in the cooperation with such groove or channel of a resilient diaphragm overlying such groove or channel and being depressed therein by one or more spherical balls which, while being rolled along the surface of the diaphragm, are being held under a resilient pressure in accordance with the resiliency of the diaphragm and the pressure of the respective medium to be conveyed.

An important advantage of the invention resides in the fact that, through the cooperation of the resilient ele-

ments acting upon the balls, the particular manner of guiding these balls so as to roll along the surface of the diaphragm, and the particular curved shape and the dimensions of the groove or channel, the balls may act upon the diaphragm so as to close off the channel entirely at the particular point where the balls exert their pressure upon the diaphragm without, however, thereby causing any considerable friction between the balls and the resilient material of the channel which might be harmful thereto.

Another feature of the invention resides in the provision of tapered rollers intermediate adjacent balls for the control of higher pressures in the conveying channel and for preventing the resilient diaphragm from being forced outwardly by such high pressure.

Further objects, features, and advantages of the present invention 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 present invention, in which the diaphragm is acted upon by three balls;

Fig. 2 is a cross section taken along line A—B of Fig. 1;

Fig. 3 is a cross section taken along line C—D of Fig. 2;

Fig. 4 is a fractional section taken at a right angle to Fig. 2 along line E—F as seen from the point G in Fig. 2;

Fig. 5 is a partial section taken along line H—I of Fig. 2 showing another embodiment of the invention in which the diaphragm is secured relative to the housing;

Fig. 6 is a top view in reduced size of the guide means which are designed to take up the centrifugal forces of the balls;

Fig. 7 is a top view in reduced size of a diaphragm according to the invention;

Fig. 8 shows a cross section through a tapered roller, the central part of which is ball-shaped;

Fig. 9 shows a cross section through an apparatus according to the invention, in which the diaphragm is acted upon by balls and tapered rollers; while

Fig. 10 is a top view of the apparatus shown in Fig. 9 prior to the installation of the resilient guiding means for the balls and tapered rollers and the housing cover.

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 body **3** and the thickness of the diaphragm **4** which is superposed upon the groove and is capable of 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. The stretch of the diaphragm in a radial direction will thus be the same regardless of the cross section thereof, that is, equal to the angle of pressure times π times the sum of the radius of the ball plus the thickness of the diaphragm plus the radius of the outer arc of the generatrix.

Such a design of the groove coupled with the use of balls permits the resilient material when acted upon by the balls to be pressed evenly and fully upon the inner surfaces of the groove, since the parts on both sides of the central arc of the generatrix of the groove are curved in the opposite direction.

In the embodiment of the invention shown in Figs. 1 and 2, the balls **3** are being retained within a cage **5** forming 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 bodies **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 being protected and secured in place by a cap **16**, and bearing **15** by a cap **16'**. Cover **12** and housing **1** are secured to each other by suitable means, such as bolts **17**. Diaphragm **4** is fixed in place relative to the housing **1** by two rings **18** and **19**, for example, by means of screws **20**. Bolts **17** may also act as means for securing the diaphragm **4** relative to the housing **1**. Diaphragm **4** carries a downwardly projecting lug **21** which extends in a radial direction and vertically to the diaphragm body, forming a part thereof. At the point where the lug **21** is connected to the body of the diaphragm **4**, the latter is shaped so as to form a troughlike depression **22** which, as seen in a radial cross section, has the same generatrix which the diaphragm assumes through the pressure of the rolling bodies **3** at those points acted upon by them. The projecting lug **21** acts as a partition to separate the inlet and outlet sides of the troughlike groove. If the balls **3** are being rotated so as to move in the direction of the arrow **23**, the gases or liquids to be conveyed enter the apparatus through the inlet **24** and emerge therefrom through the outlet **25** which communicate with channels **26** and **27**, respectively, which terminate into the troughlike groove **2**. Threaded sockets **28** and **29** may be provided at the outer ends of channels **24** and **25** into which suitable conduits, such as pipes, hoses, or the like may be screwed for passing the gases or liquids into and from the groove or channel **2** in the housing **1**. When the shaft **7** is being rotated, the balls **3**, since they are being resiliently forced by the rotating disk **6** against the annular diaphragm **4**, roll about their horizontal axis **30** in the direction of the arrow **23** at an angular velocity equal to half the speed of rotation of shaft **7**.

Thus, since three balls **3** are provided, they are being pressed at three different, equally spaced points against the diaphragm **4** so that the troughlike groove **2** is being filled out by the diaphragm at these points and partitioned to form three intermediate chambers which do not communicate either with the inlet **24** or the outlet **25**. As a result of the rotary movement of the balls **3**, the liquid or gaseous medium contained in these chambers will be conveyed along the groove **2** until it emerges from the housing **1** through the outlet channels **25** and **27**. At the same time, additional amounts of such medium are being drawn into the troughlike groove **2** through the inlet **24**, while another intermediate chamber filled with the respective medium is being moved along the groove.

In order to insure a smooth operation of the apparatus without knocking, compensating slots **31** and **32** may be provided in the bottom of the groove **2** at each side of the lug **21** so as to prevent the inlet and outlet openings from being closed entirely by the rolling balls.

If the apparatus is to be used, for example, as a flow meter, the pressure of the respective medium to be measured entering into the groove **2** itself effects the rotation of the balls **3** and thereby of the shaft **7**, which in such a case is to be coupled with a suitable register of customary design.

The troughlike groove **2** may also be partitioned in a manner different from that illustrated in Figs. 1 and 2 by

the lug 21. Thus, as shown in Fig. 5, it may be fully sufficient to draw the diaphragm 4 by means of a bolt 33 with a nut 34 into a recessed portion 35 in such a manner that a troughlike groove 22' similar to groove 22 will be formed.

Also, in place of the cage 5 consisting of a single element, a cage 36 may be provided, as illustrated in Fig. 6, which is open toward the outside. In such a case, a ring 37 may be provided which lies within the plane of the rotary axis 30 of the balls 3 and takes up the centrifugal forces occurring therein.

For increasing the resilient strength of the diaphragm 4 especially at the suction side of the apparatus, an elastic insert 38, as shown in Fig. 7, may be provided within the diaphragm 4. Such insert may consist, for example, of an endless wire, several individual wires, or synthetic fibrous material essentially arranged in a radial direction.

By a suitable selection of the appropriate resilient means 10 which act upon the balls 3 it is possible to limit the pressure exerted upon the medium to be conveyed. If the predetermined pressure is being exceeded, the diaphragm will not lie solidly against the wall surface of groove 2 so that a liquid layer may slide between the diaphragm 4 and the wall of groove 2 and lift the disk 6. Thus, if an excessive pressure should occur, the driving means may be stopped, for example, by the disk 6 which is shifted in an axial direction, then actuating suitable control means which, in turn, act upon the respective driving means. In this connection it is also advisable to provide suitable means for adjusting the tension of the resilient means 10 during the operation of the apparatus.

Since at higher pressures the diaphragm 4 may be resiliently bent upwardly toward the side of the rollers 3, it is advisable, as illustrated in Figs. 9 and 10, to provide substantially tapered rollers 39 in a suitable cage between adjacent balls 3, such rollers, on the one hand, acting against the surface of the diaphragm 4, and, on the other hand, against an annular, bell-shaped member 40.

The bell-shaped member 40 as well as the disk 6' acting upon the balls 3 may be positively connected to the shaft 7' by a driving pin or pins 41 fitting into slots 42. The bell-shaped member 40, as distinguished from the disk 6', is, however, unable to shift in the axial direction of shaft 7' since it is directly connected to the housing cover 12 through the axial bearing 43. Disk 6', on the other hand, acts upon the annular member 40 through resilient means, for example, one or more springs 10'. Disk 6' is being driven by pins 8' which are secured to the member 40 and engage into recesses 9' within the peripheral wall of disk 6'.

In the embodiment shown in Figs. 9 and 10, a common cage 44 is provided for the ball rollers 3 as well as the tapered rollers 39. The diaphragm 4 is secured within the housing 1 in the same manner as in the embodiment shown in Fig. 1. The tapered rollers 39 may also have a spherical central portion 39', as shown in Fig. 8, the diameter D of which is smaller than twice the radius r of the generatrix 45 thereof. Depending upon the number of individual chambers into which the troughlike groove 2 is partitioned, a smaller or larger number of balls and tapered rollers may be provided. If the groove 2 is to be partitioned at only one point, it is advisable to provide three balls 3.

While the invention has been described in detail with respect to certain now preferred examples and embodiments thereof, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention as defined in the appended claims.

Having thus described my invention, what I claim as new is:

1. An apparatus for conveying a gaseous or liquid medium comprising a housing, a central shaft rotatable within said housing, said housing having a substantially level surface therein extending at a right angle to said shaft, an annular groove within said surface coaxially with said shaft, a resilient diaphragm superposed upon said groove, said groove and diaphragm together forming an annular channel, an inlet and an outlet for said medium near each other in said housing and communicating with said channel in such a manner that communication between said inlet and said outlet is established through said groove by way of a long arcuate chamber as well as by way of a short arcuate chamber, a partition within said short arcuate chamber of said groove and forming an integral part of said diaphragm so as to close off the communication between said inlet and outlet by way of said short arcuate chamber of said groove, at least one spherical element, means for guiding said element so as to roll 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, pressure means connected with said shaft so as to rotate therewith and pressing upon said spherical element and in frictional contact therewith, said annular groove when seen in cross section having a central concave portion in the shape of an arc of a circle having a diameter substantially equal to the diameter of said spherical element plus the thickness of said diaphragm, and a convex portion at each side of said central portion gradually merging into said level surface in said housing, said spherical element being depressed by said pressure means upon said diaphragm, thus pressing said diaphragm into said groove so as to fill out said groove at such particular point completely, whereby when said spherical element rolls along said circular path in one direction and simultaneously depresses said diaphragm into said groove, it progressively pushes said medium along said channel from the inlet to the outlet thereof.

2. An apparatus for conveying a gaseous or liquid medium compressing a housing, a central shaft rotatable within said housing, said housing having therein a lower portion with an upper substantially level surface extending at a right angle to said shaft, an annular groove within said upper surface coaxially with said shaft, a resilient diaphragm on said surface and superposed upon said groove, said groove and diaphragm together forming an annular channel, an inlet and an outlet for said medium substantially adjacent each other in said housing and communicating with said channel in such a manner that communication between said inlet and said outlet is established through said groove by way of a long arcuate chamber as well as by way of a short arcuate chamber, a partition within said short arcuate chamber of said groove and forming an integral part of said diaphragm so as to close off the communication between said inlet and outlet by way of said short arcuate chamber of said groove, at least one spherical element, means for guiding said element so as to roll 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 resilient means in frictional contact with said spherical element, said last means being positively connected with said shaft so as to rotate therewith but allowing resilient movement of said spherical element in axial direction of said shaft, said annular groove when seen in cross section having a central concave portion in the shape of an arc of a circle having a diameter substantially equal to the diameter of said spherical element plus the thickness of said diaphragm, and a convex portion at each side of said central portion gradually merging into said level upper surface of said lower housing portion, said resilient means pressing said spherical element upon said diaphragm, and thus said diaphragm into said groove so as to fill out said groove at such particular point completely, said spherical element, when rolling along said circular path in one direction and simultaneously depressing said diaphragm into said groove, progressively pushing said

medium along said channel from the inlet to the outlet thereof.

3. A pump for conveying a gaseous or liquid medium comprising a housing, a central drive shaft rotatable within said housing, said housing having therein a lower portion with an upper, substantially level surface extending at a right angle to said shaft, an annular groove within said upper surface coaxially with said shaft, a resilient diaphragm on said surface and overlying said groove, said groove and diaphragm together forming an annular channel, an inlet and an outlet for said medium substantially adjacent each other in said housing and communicating with said channel in such a manner that communication between said inlet and said outlet is established through said groove by way of a long arcuate chamber as well as by way of a short arcuate chamber, a partition within said short arcuate chamber of said groove and forming an integral part of said diaphragm so as to close off the communication between said inlet and outlet by way of said short arcuate chamber of said groove, a plurality of spherical elements in direct contact with the upper surface of said diaphragm, means for guiding said elements so as to roll 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 resilient means in frictional contact with said spherical elements, said last means comprising an annular disk, said disk being positively connected with said shaft so as to rotate therewith but adapted to slide in axial direction of said shaft, and a spring mounted on said drive shaft and acting upon said disk to press the same resiliently upon said spherical elements and thus said elements upon said diaphragm, and said diaphragm into said groove so as to close said groove entirely at such points, said groove when seen in cross section having a concave central portion in the shape of an arc of a circle having a diameter substantially equal to the diameter of said spherical elements plus the thickness of said diaphragm, and a convex portion at each side of said central portion gradually merging into said level upper surface of said lower housing portion, whereby when said drive shaft rotates in one direction, said medium enters within that portion of said annular channel which is formed between said partition and the spherical element adjacent thereto in the driving direction, and, as the rotation continues is moved into that portion of said annular channel which is formed between said element and the next rearwardly adjacent element, whereupon said medium contained in said chamber is moved in a rotary motion toward said outlet, while simultaneously the next rearwardly adjacent chamber picks up a charge of medium from said inlet and then proceeds in the same manner toward said outlet.

4. An apparatus for conveying a gaseous or liquid medium comprising a housing, a central shaft rotatable within said housing, said housing having therein a lower portion with an upper, substantially level surface extending at a right angle to said shaft, an annular groove within said upper surface coaxially with said shaft, a resilient diaphragm on said surface and overlying said groove, said groove and diaphragm together forming an annular channel, an inlet and an outlet for said medium substantially adjacent each other in said housing and communicating with said channel in such a manner that communication between said inlet and said outlet is established through said groove by way of a long arcuate chamber as well as by way of a short arcuate chamber, a partition within said short arcuate chamber of said groove and forming an integral part of said diaphragm so as to close off the communication between said inlet and outlet by way of said short arcuate chamber of said groove, a plurality of spherical elements in direct contact with the upper surface of said diaphragm, means for guiding said elements in a fixed spaced relation to each other and so as to roll 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, at least one roller intermediate adjacent spherical elements, means for guiding said rollers in a fixed spaced relation to said spherical elements and so as to roll along the upper surface of said diaphragm, and resilient means in frictional contact with said spherical elements, said last means comprising an annular disk, said disk being positively connected with said shaft so as to rotate therewith, but adapted to slide in axial direction of said shaft, and a spring mounted on said drive shaft so as to rotate therewith and acting upon said disk to press the same resiliently upon said spherical elements, and thus said elements upon said diaphragm, and said diaphragm into said groove so as to close said groove entirely at such points, said groove when seen in cross section having a central concave portion in the shape of an arc of a circle having a diameter substantially equal to the diameter of said spherical elements plus the thickness of said diaphragm, and a convex portion at each side of said central portion gradually merging into said level upper surface of said lower housing portion, said diaphragm having a depression in its upper surface substantially at a point above said partition and of a dimension and curvature substantially equal to the impression made in the upper surface of said diaphragm by said spherical elements, said depression in the direction of said circular path of said spherical elements gradually merging into said level upper surface of said diaphragm, whereby when said drive shaft rotates in one direction, said medium enters into that portion of said annular channel which is formed between said partition and the spherical element adjacent thereto in the driving direction, and, as the rotation continues, is moved into that portion of said annular channel which is formed between said element and the next rearwardly adjacent element, whereupon said medium contained in said chamber is moved in a rotary motion toward said outlet, while simultaneously the next rearwardly adjacent chamber picks up a charge of medium from said inlet and then proceeds in the same manner toward said outlet.

5. An apparatus for conveying a gaseous or liquid medium comprising a housing, a central shaft rotatable within said housing, said housing having therein a lower portion with an upper substantially level surface extending at a right angle to said shaft, an annular groove within said upper surface coaxially with said shaft, a resilient diaphragm on said surface and overlying said groove, said groove and diaphragm together forming an annular channel, an inlet and an outlet for said medium substantially adjacent each other in said housing and communicating with said channel in such a manner that communication between said inlet and said outlet is established through said groove by way of a long arcuate chamber as well as by way of a short arcuate chamber, a partition within said short arcuate chamber of said groove and forming an integral part of said diaphragm so as to close off the communication between said inlet and outlet by way of said short arcuate chamber of said groove, a plurality of spherical elements in direct contact with the upper surface of said diaphragm, means for guiding said elements in a fixed spaced relation to each other and so as to roll 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, a plurality of tapered truncated rollers so arranged that at least one tapered truncated roller is intermediate adjacent spherical elements, the axes of said rollers passing through the axis of said drive shaft, means for guiding said rollers in a fixed spaced relation to said spherical element and so as to roll along the upper surface of said diaphragm, and resilient means in frictional contact with said spherical elements, said last means comprising an annular disk, said disk being positively connected with said shaft so as to rotate therewith, but adapted to slide in axial direction of said shaft, and a

spring mounted on said drive shaft so as to rotate therewith and acting upon said disk to press the same resiliently upon said spherical elements and thus said elements upon said diaphragm, and said diaphragm into said groove so as to close said groove entirely at such points, said groove when seen in cross section having a central concave portion in the shape of an arc of a circle having a diameter substantially equal to the diameter of said spherical elements plus the thickness of said diaphragm, and a convex portion at each side of said central portion gradually merging into said level upper surface of said lower housing portion, said diaphragm having a depression in its upper surface substantially at a point above said partition and of a dimension and curvature substantially equal to the impression made in the upper surface of said diaphragm by said spherical elements, said depression in the direction of said circular path of said spherical elements gradually merging into said level upper surface of said diaphragm, whereby when said drive shaft rotates in one direction, said medium enters into that portion of said annular channel which is formed between said partition and the spherical element adjacent thereto in the driving direction, and, as the rotation continues, is moved into that portion of said annular channel which is formed between said element and the next rearwardly adjacent element, whereupon said medium contained in said chamber is moved in a rotary motion toward said outlet, while simultaneously the next rearwardly adjacent chamber picks up a charge of medium from said inlet and then proceeds in the same manner toward said outlet.

6. An apparatus for conveying a gaseous or liquid medium comprising a housing, a central shaft rotatable within said housing, said housing having therein a lower portion with an upper, substantially level surface extending at a right angle to said shaft, an annular groove within said upper surface coaxially with said shaft, a resilient diaphragm on said surface and superposed upon said groove, said groove and diaphragm together forming an annular channel, an inlet and an outlet for said medium substantially adjacent each other in said housing and communicating with said channel in such a manner that communication between said inlet and said outlet is established through said groove by way of a long arcuate chamber as well as by way of a short arcuate chamber, a partition within said short arcuate chamber of said groove and forming an integral part of said diaphragm so as to close off the communication between said inlet and outlet by way of said short arcuate chamber of said groove, a plurality of spherical elements in direct contact with the upper surface of said diaphragm, a plurality of tapered truncated rollers so arranged that at least one tapered truncated roller is intermediate adjacent spherical elements, the axes of said rollers passing through the axis of said drive shaft, common means for guiding said spherical elements and said rollers in a fixed spaced relation to each other and so as to roll on the upper surface of said diaphragm along a circular path, the center of which coincides with a vertical cylindrical plane passing through the center of said annular groove, a bell-shaped member secured to said drive shaft, the lower end of said bell-shaped member substantially in sliding contact with said rollers for retaining the same in position in an upward direction, and resilient means in frictional contact with said diaphragm, said last means comprising an annular disk in contact with said spherical elements, said disk being positively connected with said bell-shaped member so as to rotate therewith, but adapted to slide in axial direction of said shaft within said bell-shaped member, and a spring mounted within said bell-shaped member and acting upon said disk to press the same resiliently upon said spherical elements and thus said elements upon said diaphragm, and said diaphragm into said groove so as to close said groove entirely at such points, said groove when seen in cross section having a central concave portion in the shape of an arc of a circle having a diameter

substantially equal to the diameter of said spherical elements plus the thickness of said diaphragm, and a convex portion at each side of said central portion gradually merging into said level upper surface of said lower housing portion, said diaphragm having a depression in its upper surface substantially at a point above said partition and of a dimension and curvature substantially equal to the impression made in the upper surface of said diaphragm by said spherical elements, said depression in the direction of said circular path of said spherical elements gradually merging into said level upper surface of said diaphragm, whereby when said drive shaft rotates in one direction, said medium enters into that portion of said annular channel which is formed between said partition and the spherical element adjacent thereto in the driving direction, and, as the rotation continues, is moved into that portion of said annular channel which is formed between said element and the next rearwardly adjacent element, whereupon said medium contained in said chamber is moved in a rotary motion toward said outlet, while simultaneously the next rearwardly adjacent chamber picks up a charge of medium from said inlet and then proceeds in the same manner toward said outlet.

7. An apparatus for conveying a gaseous or liquid medium comprising a housing, a central shaft rotatable within said housing, said housing having therein a lower portion with an upper, substantially level surface extending at a right angle to said shaft, an annular groove within said upper surface coaxially with said shaft, a resilient diaphragm on said surface and superposed upon said groove, said groove and diaphragm together forming an annular channel, an inlet and an outlet for said medium substantially adjacent each other in said housing and communicating with said channel in such a manner that communication between said inlet and said outlet is established through said groove by way of a long arcuate chamber as well as by way of a short arcuate chamber, a partition within said short arcuate chamber of said groove and forming an integral part of said diaphragm so as to close off the communication between said inlet and outlet by way of said short arcuate chamber of said groove, a plurality of spherical elements in direct contact with the upper surface of said diaphragm, a plurality of tapered truncated rollers so arranged that at least one tapered truncated roller is intermediate adjacent spherical elements, the axes of said rollers passing through the axis of said drive shaft, each of said tapered rollers having a substantially elliptical central projection the diameter of which is smaller than the diameter of said spherical elements, common means for guiding said spherical elements and said rollers in a fixed spaced relation to each other and so as to roll on the upper surface of said diaphragm along a circular path, the center of which coincides with a vertical cylindrical plane passing through the center of said annular groove, a bell-shaped member secured to said drive shaft, the lower end of said bell-shaped member substantially in sliding contact with said rollers for retaining the same in position in an upward direction, and resilient means in frictional contact with said diaphragm, said last means comprising an annular disk in contact with said spherical elements, said disk being positively connected with said bell-shaped member so as to rotate therewith, but adapted to slide in axial direction of said shaft within said bell-shaped member, and a spring mounted within said bell-shaped member and acting upon said disk to press the same resiliently upon said spherical elements and thus said elements upon said diaphragm, and said diaphragm into said groove so as to close said groove entirely at such points, said groove when seen in cross section having a central concave portion in the shape of an arc of a circle having a diameter substantially equal to the diameter of said spherical elements plus the thickness of said diaphragm, and a convex portion at each side of said central portion gradually merging into said level

upper surface of said lower housing portion, said diaphragm having a depression in its upper surface substantially at a point above said partition and of a dimension and curvature substantially equal to the impression made in the upper surface of said diaphragm by said spherical elements, said depression in the direction of said circular path of said spherical elements gradually merging into said level upper surface of said diaphragm, whereby when said drive shaft rotates into one direction, said medium enters into that portion of said annular channel which is formed between said partition and the spherical element adjacent thereto in the driving direction, and, as the rotation continues, is moved into that portion of said annular channel which is formed between said element and the next rearwardly adjacent element, whereupon said medium contained in said chamber is moved in a rotary motion toward said outlet, while simultaneously the next rearwardly adjacent chamber picks up a charge of medium from said inlet and then proceeds in the same manner toward said outlet.

8. An apparatus as defined in claim 6, wherein said tapered rollers each have a central portion of substantially elliptical cross sectional configuration, the radius of the generatrix of said central portion being larger than half the maximum diameter of said central portion.

9. An apparatus as defined in claim 3, wherein said guiding means comprise a cage for holding said spherical elements in a fixed spaced relation to each other, said cage having outwardly directed recesses adapted to receive said elements therewithin.

10. An apparatus as defined in claim 3 wherein said guiding means comprise a cage for holding said spherical elements in a fixed spaced relation to each other, said cage having outwardly directed recesses adapted to receive said elements therewithin, and a ring surrounding said cage, said sperical elements having a pointlike contact with the inner edge of said ring.

11. An apparatus as defined in claim 3, wherein said guiding means comprise a platelike cage for holding said spherical elements in a fixed spaced relation to each other and completely enclosing said elements within the plane of said cage.

12. An apparatus as defined in claim 3, wherein said guiding means comprise a cage for holding said spherical elements in a fixed spaced relation to each other, said cage having inwardly directed recesses adapted to receive said elements therewithin.

13. An apparatus as defined in claim 3, wherein the surface of said disk in contact with said spherical elements consists of a material similar to that of said diaphragms.

14. An apparatus as defined in claim 1 wherein said diaphragm has elastic inserts for reinforcing the same.

15. An apparatus as defined in claim 2, wherein said groove has a narrow slot in its wall on each side of the inlet and outlet thereof and extending in the direction of said circular path for preventing the spherical element when rolling over said inlet and outlet of said groove, respectively, from closing the same completely.

16. An apparatus as defined in claim 1, wherein said partition comprises means for drawing said diaphragm at least at one point into said groove and for securing it tightly to the wall thereof.

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