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(54) ELASTOMERIC CHECK-VALVE

(71) I, FREDERICK HAROLD HUMPHREY, a citizen of Canada, of 7 Orchard Street, Markham, Ontario, Canada, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to check-valves.

Many liquids, such as window sprays, can presently be purchased on the market in containers which are equipped with a small pumping device adapted to dispense the liquid in small quantities in the form of a spray or a jet. Most such pumping mechanisms involve the use of one-way ball valves, springs, sliding pistons, sealing elements etc., and suffer from some or all of the following disadvantages.

The first disadvantage of conventional pumping mechanisms is an economic one. Because of the large number of parts that are required for the pumping mechanism, they are comparatively expensive to manufacture.

A disadvantage of those conventional pumping mechanisms which involve a rectilinearly reciprocable piston is the fact that the user must depress the plunger along a given direction. Any lateral pressure could cause binding. For this reason, some spray mechanisms of this type are awkward to use.

All of the conventional pumping mechanisms in which the valve openings are defined by rigid material, such that the cross-sectional area of the open valve is unchangeable, are susceptible of being clogged by solid particles that find their way into the pumping mechanism.

Many of the conventional pump mechanisms include parts which are made from materials, often metals, which are susceptible to corrosion.

Many of the pumping mechanisms of the conventional type are constructed in such a way that it is difficult to gain access to the inner components for cleaning or inspection.

Some of the conventional pumping mechanisms require a particular orientation with re-

spect to the force of gravity in order to function properly.

Certain conventional pumping mechanisms are capable of pumping liquids, but not gases.

According to the present invention, there is provided a check-valve comprising a base member having a surface through which two ports open, and an integral elastomeric member; the elastomeric member including a recess portion having a peripheral rim seated against said surface to define therewith a closed chamber communicating with said two ports, and a partition in said recessed portion and integral therewith; said partition having an edge resting resiliently against the surface of said base member between said ports, thereby dividing said chamber into two compartments, each communicating with one port, and said partition being in sloping relationship with every line which is (a) tangential to said surface where the latter contacts said edge, and (b) normal to said edge.

The check-valve is capable of use with either liquids or gases, with substantially leak-free characteristics, and for this reason the term "fluid" will be generally used in the remainder of this specification to describe the medium passing through the check-valve.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:—

Figure 1 is a perspective view of a first embodiment of a check-valve;

Figure 2 is an axial sectional view of the check-valve of Figure 1;

Figure 3 is a perspective view of a pump incorporating a second embodiment of check-valve;

Figure 4 is a sectional view of the pump of Figure 3;

Figures 5 and 6 are sectional views similar to Figure 4, showing two phases in the operation of the pump;

Figure 7 is a perspective view, from under-

neath, of a pump incorporating a third embodiment of check valve;

Figure 8 is a view from beneath of a fourth embodiment of check valve;

5 Figure 9 is a vertical, longitudinal sectional view of the check valve of Figure 8; and

Figure 10 is a vertical sectional view of a container cap assembly incorporating the check valve of Figure 8.

10 Turning first to Figures 1 and 2, a check-valve indicated generally at 10 consists of a cylindrical base 11 having an inlet passage 12 and an outlet passage 13, both parallel with the axis of the cylindrical base 11.

15 The upper surface 14 of the cylindrical base 11 thus has two ports, a first port 16 communicating with the inlet passage 12, and a second port 18 communicating with the outlet passage 13. Tubes 19 can be provided for passages 12 and 13 as shown.

20 An integral elastomeric member 20 includes a recessed portion 22 having a peripheral rim 23 which seals the recessed portion 22 against the surface 14 to define therewith a closed chamber 24 communicating with the two ports 16 and 18. The recessed portion 22 has a partition 26 of which the edge 28 is adapted to rest resiliently against the surface 14 between the two ports 16 and 18, thereby to divide the chamber 24 into two compartments, a first compartment 30 communicating with the port 16, and a second compartment 32 communicating with the port 18. It will be observed that the partition 26 is substantially planar, and is in sloping relation to the surface 14.

30 It should be noted here that it is not essential that the surface 14 be flat. To begin with, the contour of the surface 14 is only important in the immediate area where it contacts the edge 28 of the partition 26. The contour of the surface 14 within the two compartments 30 and 32 has no effect on the function of the check-valve 10. However, should the surface 14 adjacent the edge 28 be other than a plane surface, proper functioning of the check-valve requires that the partition be in sloping relationship with every line which is (a) tangential to the surface 14 where the latter contacts the edge 28, and (b) normal to the edge 28. To state this criterion another way, all dihedral angles between the partition 26 and the hypothetical surface which is tangential to the surface 14 along the line of contact between the partition 26 and the surface 14 must be acute on one side of the partition.

40 Although the partition 26 shown in Figures 1 and 2 is substantially planar, this is not essential to the proper functioning of the check-valve. Some departure from the planar characteristic is permissible without impeding function, and it will be shown presently in connection with the pump embodiment that

a particular curvature in the partition may have special advantages.

It will be seen that an integral outward flange 33 extends from the peripheral rim 23, the outer diameter of the flange 33 being the same as the diameter of the cylindrical base 11. The flange 33, although not essential to the check valve, is useful for the securing of the elastomeric member 20 to the surface 14, as for example by means of glue.

70 The term "elastomeric" used throughout this specification, is intended to include polymeric substances which exhibit suitable elastic resilience, and thus covers within its ambit natural and synthetic rubbers, and a large number of plastic materials having elastic properties. From the wide field of suitable elastomers, the following materials have been tested and found satisfactory as the material forming the integral elastomeric member for all four embodiments herein described:

Plasticized PVC
Ethyl vinyl acetate
Styrene-butadiene rubber
Butyl rubber
Natural rubber
Silicone rubber

90 The choice of a material for any given application would of course be governed by economic considerations, as well as by the performance criteria of the particular application and the solvent characteristics of the fluid being valves or pumped.

95 As can best be seen in Figure 2, the elastomeric member 20 cooperates with the surface 14 to form a check-valve between the ports 16 and 18. Fluid can flow in the direction from port 16 to port 18, but cannot flow in the reverse direction. The reason for this is the slope of the partition 26. If the fluid pressure in compartment 30 rises above that in compartment 32, the fluid pressure will be exerted perpendicularly to the partition 26, and this pressure will be so directed as to lift the lower edge of the partition 26 upwardly away from the surface 14, thereby allowing fluid to pass from compartment 30 into compartment 32 beneath the edge 28. If, however, the fluid pressure in compartment 32 exceeds the fluid pressure in compartment 30, the resulting pressure acting perpendicularly against the partition 26 will urge the latter downwardly, and as a result the edge 28 will be pushed more firmly against the surface 14, thereby preventing transference of fluid from the compartment 32 to the compartment 30.

100 Although in the embodiment shown in Figures 1 and 2 the recessed portion 22 is substantially hemispherical, it will be appreciated that the proper functioning of the check-valve is not dependent upon a hemi-

spherical shape, provided the outer wall is thick enough to resist "ballooning" deformation caused by high fluid pressure in compartment 32. With this proviso, the recessed portion 22 could have an elliptical or rectangular horizontal section, a rectangular vertical section, etc. However, if the hemisphere walls are thin enough to be deformed by fluid pressure, any shape other than a substantially hemispherical one may tend to deform in the direction of becoming a hemisphere under high fluid pressure, due to the "ballooning" effect. This deformation could have the result of lifting the partition 26 upwardly away from the surface 14, thereby breaking the back-pressure seal.

Attention is now directed to Figure 3, which shows a pump attachment 36 for use with a container 37. The pump attachment 36 includes a base member 38 which has a threaded female coupling 40 for engagement with the neck 42 of the container 37. The base member 38 extends upwardly at an angle from the coupling 40, and the upwardly extending portion will hereinafter be called a tabular member 43. In the embodiment shown, the tabular member 43 has an upper, flat, oblique surface 44 from which an aperture 45 extends through the tabular member 43. The base member also has a passage 46 communicating the surface 44 with the interior of the coupling 40. A tube 48 communicates with the passage 46 and extends downwardly therefrom into the container 37.

An integral elastomeric member 50 is provided, having a recessed portion 51 in sealed engagement with the surface 44 to define therewith a closed chamber communicating with the aperture 45 and the passage 46.

As best seen in Figure 4, the recessed portion 51 contains two partitions 53 and 54 which divide the chamber defined by the recessed portion 51 into a first compartment 56 communicating with the aperture 45, a second compartment 58 communicating with the passage 46, and a third compartment 60 between the partitions 53 and 54 and intermediate the first and second compartments 56 and 58. Each partition 53 and 54 has an edge 61 and 62, respectively, adapted to rest resiliently against the surface 44. Both partitions 53 and 54 slope in the same direction with respect to the surface 44, the slope being such that the surface 44 within the first compartment 56 defines an obtuse angle 64 with the partition 53 defining the first compartment 56. The partitions 53 and 54 shown in Figures 3, 4, 5 and 6 are substantially flat partitions.

The third compartment 60 has an upwardly protruding bubble 66, the purpose of which will now be explained with reference to Figures 5 and 6.

Figures 5 and 6 show two phases of the pumping action of the pump 36 when the

latter is used with liquid. It will be appreciated from what follows that the pump shown in Figures 3—6 is also useful for pumping gases. In Figure 5 it is assumed that liquid has already been drawn up into the second compartment 58, but that it has not yet entered the third compartment 60. In Figure 5, inward pressure has been applied to the bubble 66 as shown by the arrow. As a result, the bubble 66 is inverted into the third compartment 60, thereby decreasing the volume of the latter, and increasing the pressure of the air contained in the compartment. The increased air pressure in compartment 60 urges the edge 62 of the partition 54 tightly against the surface 44, and causes the edge 61 of the partition 53 to be raised away from the surface 44, permitting air to pass from the compartment 60 into the compartment 56, and thence out the aperture 45. When inward pressure on the bubble 66 is released, it returns to its outward position as shown by the arrow in Figure 6. The outward movement of the bubble 66 causes the volume of the compartment 60 to increase, thereby lowering the pressure in compartment 60 with respect to the compartments 56 and 58, and this causes the edge 62 of the partition 54 to be raised away from the surface 44 to allow liquid to pass from compartment 58 into compartment 60, and causes the edge 61 of the partition 53 to be urged firmly against the surface 44.

It will now be obvious that the next succeeding inward stroke on the bubble 66 will close partition 54 and open partition 53, with substantially the same quantity of liquid remaining in the third compartment 60 as is shown in Figure 6. Release of inward pressure on the bubble 66 will then cause the partition 53 to close and the partition 54 to open and permit more liquid to pass from the second compartment 58 into the third compartment 60. This process continues until the third compartment 60 is full, whereupon liquid will be pumped into the first compartment 56 and thence out the aperture 45.

Attention is now directed to Figure 7, in which is illustrated the third embodiment of check valve, incorporating a different shape for partitions 53 and 54. The partitions 53 and 54 in Figure 7 are sloped to the same degree as those in Figure 3, but instead of being substantially flat, they are curved, preferably in a substantially cylindrical shape. Put more specifically, the intersections between the partitions in Figure 7 and hypothetical planes normal to the surface 44 and parallel with the long dimension of the elastomeric member 50 are sloped and substantially rectilinear, while the intersections between the partitions and hypothetical planes parallel with the surface 44 are curved, the centres of curvature of the last-mentioned intersections lying on the same side of each partition as the com-

partment in which the angle between that partition and the surface 44 is obtuse.

The reason for the curved shape of the partitions shown in Figure 7 is as follows. When the partitions are planar, the passage of fluid therebeneath requires that the partitions be stretched as well as flexed, since the partitions are integral with the sides of the recessed portion 51, and the lower edges of the latter are secured to the surface 44. By curving the partitions in the manner shown in Figure 7, however, passage of fluid from one compartment to another beneath a partition requires only flexing of the partition. The flexed shape of a curved partition is shown in partition 53 in Figure 7. It will be observed that the central portion of the partition adjacent the edge is, in a sense, inverted, allowing the edge to be displaced a considerable distance from the surface 44 without the restraint which would arise from stretching if the partition were planar as in Figure 3.

It will be appreciated that a curved partition could also be used in the check-valve of Figures 1 and 2, with the same advantage.

It should be emphasized, in connection with the second and third embodiments of check valve, that the bubble 66 is not essential to the operation of the pump. The pump shown in Figures 3—6 would work if the recessed portion of the integral elastomeric member 51 had a constant cross-sectional profile without the bubble 66, provided that inward pressure above the compartment 60 would cause the volume of the latter to decrease. Provision of the bubble, however, permits a considerable volume change in compartment 60, and therefore permits a greater pumping rate.

Although in the second and third embodiments of check valve, shown in Figures 3—7, it is preferred that the surface 44 be substantially flat, this is not essential. Firstly, the contour of the surface 44 is only important in the immediate area where it contacts the edges 61 and 62 of the partitions 53 and 54. Secondly, the contour in these immediate areas may depart from a plane to some extent without disrupting the function of the pump. For example, the surface 44 may be spherical or cylindrical, concave or convex, in the immediate areas where it contacts the edges 61 and 62. The contour of the surface 44 within compartments 56, 58 and 60 has no effect on the operation of the partitions 53 and 54. Regardless of whether the surface 44 in the areas immediately adjacent the edges 61 and 62 is a plane surface or a curved surface, it is considered that the proper functioning of the pump shown in Figures 3—7 requires that the first partition 53 define an acute angle with every line in the third compartment 60 which is (a) tangential to the surface 44 where the latter contacts the

edge 61 of the first partition 53, and (b) normal to the edge 61 of the first partition 53, and also requires that the second partition 54 define an acute angle with every line in the second compartment 58 which is (a) tangential to the surface 44 where the latter contacts the edge 62 of the second partition 54, and (b) normal to the edge 62 of the second partition 54. This criterion can be stated another way, as it was above with reference to the check-valve 10 shown in Figures 1 and 2: all dihedral angles between each partition and the hypothetical surface which is tangential to the surface 44 along the line of contact between the particular partition and the surface 44 must be acute on one side of the partition.

Figures 8, 9 and 10 show the fourth embodiment of check valve, which differs in minor ways from the second embodiment shown in Figures 3—6. Figure 9 is a sectional view, while Figure 8 is a view from underneath, of an elastomeric member 70 which is roughly elliptical in plan, and humped, or blister-like, in profile and in vertical section. As in the other embodiments, a recessed portion 71 has a peripheral rim 72 which is adapted to seal the recessed portion 71 against a surface 74 of a tabular member 75 (Figure 10). To improve the seal between the rim 72 and the surface 74, an integral bead 77 protrudes from the lower surface of the rim 72 as best seen in Figure 9. A first partition 78 and a second partition 80 are provided to fill the same functions as their counterparts 53 and 54 in the second embodiment shown in Figures 3—6. Looking at Figure 10, the closed chamber 82 defined between the surface 74 and the recessed portion 70 is divided by the partitions 78 and 80 into a first compartment 84, a second compartment 85, and a third compartment 86. The tabular member 75 has a first port 88 adapted to open into the first compartment 84, and a second port 90 adapted to open into the second compartment 85. The tabular member 75 has a protruding portion 92 upon which is fitted a nozzle cap 93 having a nozzle 94. The nozzle 94 communicates with the port 88 as shown in Figure 10. The port 90 communicates with a vertical tube 96 adapted to extend downwardly into a container having a threaded neck to which a screw-cap 98 can be screwed. The screw-cap 98 is integral with the tabular member 75.

A frusto-conical cap 100 is adapted to fit tightly over the entire assembly and has ledge surfaces 102 adapted to urge the rim 72 of the elastomeric member 70 against the surface 74. The cap 100 also has an opening 104 to allow passage therethrough of the protruding portion 92 of the tabular member 75, and a roughly circular opening 106 through which a portion of the elastomeric member 70 protrudes, as shown in Figure 10. Around

the base of the cap 100 is a rim 107 which is adapted for a snap-fit around the periphery of an integral disc-like, horizontal plate portion 108 forming a part of the tabular member 75.

The major differences between the second embodiment and the fourth embodiments are as follows. Firstly, the partitions 78 and 80 define a larger acute angle with the surface 74. Trials have shown that, provided the angle between a given partition and the surface remains acute, the actual value of the angle can be varied within wide limits.

Secondly, the lower edges 110 and 111 of the partitions 78 and 80 respectively have a slope of approximately 30° so that each edge and its respective partition have acute angles leading into the same respective compartment (Figure 9). The knife-edge seal thereby obtained between each partition and the surface 74 is believed to improve the efficiency and the resistance to leakage of the fourth embodiment. It will be noted in Figure 9 that the sloping bottom edges 110 and 111 of the partitions extend downwardly a distance equal to the depth of the bead 77. When the elastomeric member 70 is clamped in position as shown in Figure 10, the bead 77 is flattened to some degree and compressed upwardly into the material of the rim 72, which is why the bead 77 is not visible in Figure 10. Because of the upward compression of the bead 77, the lower edges 110 and 111 of the partitions 78 and 80 are urged positively against the surface 74, resulting in the slight curvature at the edges which is visible in Figure 10. The first and second differences detailed above can also be incorporated into the check-valve. Also, the check-valve could be provided with a bead similar to the bead 77 in Figure 9, and for the same purpose. Lastly, an optional variation is shown in Figure 10, whereby the surface of the tabular member 75 is designed in such a way that it extends upwardly into the third compartment 86, as shown by the dotted-line profile 113 in Figure 10. The profile 113 has a concave or dished central portion 115 which conforms approximately to the shape of the inverted wall of the elastomeric member 70 when thumb or finger pressure has been applied from the outside. The reason for the provision of the upstanding profile 113 is to avoid the necessity of repeated pumping depressions of the elastomeric member 70 in order to fill the third compartment 86 and begin spraying the liquid. By providing the concavity 115, the pumping stroke is not restricted, and a volume reduction in the third compartment 86 can be achieved.

It was found that satisfactory pumping operation was obtained with a blister-like elastomeric member shaped as shown in Figures 8, 9 and 10, and made from ethyl

vinyl acetate. The dimensions of the tested elastomeric member were as follows:

Total length along major axis, including rim:	1.14 inches	
Total width along minor axis, including rim:	.820 inches	70
Thickness of partitions:	0.030 inches	
Thickness of main "blister" wall:	0.060 inches	
Depth of bead 77:	.020 inches	
Width of top surface of rim 72:	.100 inches	
Thickness of rim 72:	.060 inches	75
Acute angle between partitions and surface:	75°	
Acute angle between bottom edges 110 and 111 and the surface:	30°	

The advantages of a construction wherein each partition defines a large as opposed to a small acute angle with the surface are (a) the conservation of longitudinal space required for the partition and for the entire elastomeric member, and (b) the obvious ease of moulding. When the acute angle is small, the partition is more difficult to mould, but there is the advantage of requiring a smaller pressure differential to open the partition to permit fluid to flow. By the same token, a smaller acute angle provides a tighter seal against back-pressure, and permits a larger opening cross-section for a given material deflection as compared to a larger acute angle.

With regard to the thickness of the partition, it will be obvious that the less the thickness, the less stiff is the partition, hence a smaller pressure differential is required to open the partition. Also, by reducing the thickness of the partitions, an economy of material is effected. If the partitions are made thicker, a larger pressure difference is required to activate or open them. Thicker partitions can be of advantage in applications where it is desired completely to eliminate trickling in either direction when the partition is intended to be closed. The provision of thicker, more rigid partitions permits constructions wherein a "threshold" opening pressure differential is required. In other words, the pressure differential in the forward or "opening" direction must rise above a certain minimum or "threshold" pressure before the partition will be lifted away from the surface to permit fluid to flow.

It should also be pointed out that it is advantageous to locate the partitions as far as possible away from the location where pressure is to be applied to the outside wall of the third or central compartment. If the partition is integral with the outside wall at a location too close to the point of pressure application, there is a risk that the partition will be distorted and possibly be raised away from the surface when it should not be.

It will be appreciated to those skilled in the art to which this invention pertains that

it is not essential for the two partitions of the pump embodiments to be either identical or parallel. Firstly, the acute angles defined between each partition and the surface need not be identical for the two partitions. Secondly, it is possible for the two partitions to have different contours: for example, one could be curved as in Figure 7, and the other could be flat as in Figure 3. Thirdly, the lines along which the bottom edges of the partitions contact the surface need not be parallel or congruent. For example, the lines of contact for the edges of two flat partitions could be angled to one another, e.g. at right angles.

It will further be appreciated that there have been described above inexpensive pressure-operated pumps, each consisting of a supporting surface and a single, integrally-moulded item adapted to co-operate with said supporting surface, thereby appreciably reducing the number of pump components and effecting a cost saving. In these pumps the application of pressure to operate the pump is not restricted to a single direction; the risk of clogging by solid particles is substantially reduced; and, in most instances, valve blockage by foreign material can be overcome by an increase in operating pressure. Furthermore, the pump parts can be constructed of material which resists corrosion by the media being pumped and the pump design is suitable for pumping any kind of fluid, wither liquid or gaseous. A considerable size versatility and design latitude are achieved, thereby permitting miniaturization or very large designs while maintaining leak-free characteristics. The pumps can be designed for easy opening to permit cleaning or inspection access to the valve surface. The pumps can function in any position relative to the force of gravity, and are of entirely glandless construction.

WHAT I CLAIM IS:—

1. A check-valve comprising a base member having a surface through which two ports open, and an integral elastomeric member; the elastomeric member including a recessed portion having a peripheral rim seated against said surface to define therewith a closed chamber communicating with said two ports, and a partition in said recessed portion and integral therewith; said partition having an edge resting resiliently against the surface of said base member between said ports, thereby dividing said chamber into two compartments, each communicating with one port, and said partition being in sloping relationship with every line which is (a) tangential to said surface where the latter contacts said edge and (b) normal to said edge.

2. A check-valve as claimed in claim 1, wherein said partition is a first partition, and wherein said recessed portion also includes

a second partition, this second partition having an edge adapted to rest resiliently against the surface of said base member between said ports, whereby the two partitions divide said chamber into: a first compartment containing one port and defined on one side by said first partition, a second compartment containing the other port and defined on one side by said second partition, and a third compartment defined between said first partition and said second partition; said first partition forming an acute angle with every line in said third compartment which is (a) tangential to said surface where the latter contacts the edge of the first partition, and (b) normal to the edge of the first partition; said second partition forming an acute angle with every line in said second compartment which is (a) tangential to said surface where the latter contacts the edge of the second partition, and (b) normal to the edge of the second partition.

3. A check-valve as claimed in claim 1 or 2, in which the or each partition is substantially planar.

4. A check-valve as claimed in claim 1 or 2, in which the or each partition is concave with respect to the compartment in which said sloping relationship is acute.

5. A check-valve as claimed in claim 2 or 3, in which said first and second partitions are in parallel planes.

6. A check-valve as claimed in any one of the preceding claims, in which the surface of said base member is a substantially flat surface.

7. A check-valve as claimed in any one of the preceding claims, in which said edge of the or each partition is a sloping plane with respect to said surface, the sloping plane and the partition itself both defining acute angles into the same compartment.

8. A check-valve as claimed in claim 6 or 7, in which the hypothetical intersections between the or each partition and hypothetical planes parallel with said surface are curved, the centres of curvature of said intersections lying on the same side of the or each partition as the or each compartment in which the angle between the or each partition and said surface is obtuse.

9. A check-valve as claimed in claim 2 or any one of claims 3 to 7 as appendant directly or indirectly to claim 2, in which said edges of said first and second partitions are parallel straight lines.

10. A check-valve as claimed in claim 2 or any one of claims 3 to 8 as appendant directly or indirectly to claim 2, in which said edges of said first and second partitions are congruent curvilinear lines.

11. A check-valve as claimed in any one of the preceding claims, in which said peripheral rim has an integral outward flange by which the elastomeric member is secured against said base member.



it is not essential for the two partitions of the pump embodiments to be either identical or parallel. Firstly, the acute angles defined between each partition and the surface need not be identical for the two partitions. Secondly, it is possible for the two partitions to have different contours: for example, one could be curved as in Figure 7, and the other could be flat as in Figure 3. Thirdly, the lines along which the bottom edges of the partitions contact the surface need not be parallel or congruent. For example, the lines of contact for the edges of two flat partitions could be angled to one another, e.g. at right angles.

It will further be appreciated that there have been described above inexpensive pressure-operated pumps, each consisting of a supporting surface and a single, integrally-moulded item adapted to co-operate with said supporting surface, thereby appreciably reducing the number of pump components and effecting a cost saving. In these pumps the application of pressure to operate the pump is not restricted to a single direction; the risk of clogging by solid particles is substantially reduced; and, in most instances, valve blockage by foreign material can be overcome by an increase in operating pressure. Furthermore, the pump parts can be constructed of material which resists corrosion by the media being pumped and the pump design is suitable for pumping any kind of fluid, whether liquid or gaseous. A considerable size versatility and design latitude are achieved, thereby permitting miniaturization or very large designs while maintaining leak-free characteristics. The pumps can be designed for easy opening to permit cleaning or inspection access to the valve surface. The pumps can function in any position relative to the force of gravity, and are of entirely glandless construction.

WHAT I CLAIM IS:—

1. A check-valve comprising a base member having a surface through which two ports open, and an integral elastomeric member; the elastomeric member including a recessed portion having a peripheral rim seated against said surface to define therewith a closed chamber communicating with said two ports, and a partition in said recessed portion and integral therewith; said partition having an edge resting resiliently against the surface of said base member between said ports, thereby dividing said chamber into two compartments, each communicating with one port, and said partition being in sloping relationship with every line which is (a) tangential to said surface where the latter contacts said edge and (b) normal to said edge.

2. A check-valve as claimed in claim 1, wherein said partition is a first partition, and wherein said recessed portion also includes

a second partition, this second partition having an edge adapted to rest resiliently against the surface of said base member between said ports, whereby the two partitions divide said chamber into: a first compartment containing one port and defined on one side by said first partition, a second compartment containing the other port and defined on one side by said second partition, and a third compartment defined between said first partition and said second partition; said first partition forming an acute angle with every line in said third compartment which is (a) tangential to said surface where the latter contacts the edge of the first partition, and (b) normal to the edge of the first partition; said second partition forming an acute angle with every line in said second compartment which is (a) tangential to said surface where the latter contacts the edge of the second partition, and (b) normal to the edge of the second partition.

3. A check-valve as claimed in claim 1 or 2, in which the or each partition is substantially planar.

4. A check-valve as claimed in claim 1 or 2, in which the or each partition is concave with respect to the compartment in which said sloping relationship is acute.

5. A check-valve as claimed in claim 2 or 3, in which said first and second partitions are in parallel planes.

6. A check-valve as claimed in any one of the preceding claims, in which the surface of said base member is a substantially flat surface.

7. A check-valve as claimed in any one of the preceding claims, in which said edge of the or each partition is a sloping plane with respect to said surface, the sloping plane and the partition itself both defining acute angles into the same compartment.

8. A check-valve as claimed in claim 6 or 7, in which the hypothetical intersections between the or each partition and hypothetical planes parallel with said surface are curved, the centres of curvature of said intersections lying on the same side of the or each partition as the or each compartment in which the angle between the or each partition and said surface is obtuse.

9. A check-valve as claimed in claim 2 or any one of claims 3 to 7 as appendant directly or indirectly to claim 2, in which said edges of said first and second partitions are parallel straight lines.

10. A check-valve as claimed in claim 2 or any one of claims 3 to 8 as appendant directly or indirectly to claim 2, in which said edges of said first and second partitions are congruent curvilinear lines.

11. A check-valve as claimed in any one of the preceding claims, in which said peripheral rim has an integral outward flange by which the elastomeric member is secured against said base member.

12. A check-valve as claimed in claim 11, in which the outward flange has an integral bead protruding downwardly from beneath the flange. 25
- 5 13. A check-valve as claimed in any one of the preceding claims, in which the recessed portion is substantially hemispherical. 30
- 10 14. A check-valve as claimed in claim 2 or any one of claims 3 to 13 as appendant directly or indirectly to claim 2, in which the first-mentioned acute angle and the second-mentioned acute angle are each substantially 75°. 35
- 15 15. A check-valve as claimed in claim 2 or any one of claims 3 to 14 as appendant directly or indirectly to claim 2, and also comprising a finger pump for use with a container having an open top, and in which said base member comprises a coupling for engagement with the open top of the container, and a tabular member extending from said coupling, the tabular member having a surface through which open the first and second 40
- 20 ports, a first passage communicating said first port with a nozzle, and a second passage communicating said second port with a tube adapted to extend into said container.
16. A check-valve as claimed in claim 15, in which the surface of the tabular member protrudes partly into the third compartment in order to reduce the volume thereof. 30
17. A check-valve as claimed in any one of the preceding claims, in which the elastomeric member is made of a material chosen from the group: plasticised PVC, ethyl vinyl acetate, styrene-butadiene rubber, butyl rubber, natural rubber, and silicone rubber. 35
18. A check-valve substantially as hereinbefore described with reference to Figures 1 and 2, or Figures 3, 4, 5 and 6, or Figure 7 or Figures 8, 9 and 10 of the accompanying drawings. 40

HASELTINE, LAKE & CO.,
Chartered Patent Agents,
28 Southampton Buildings, Chancery Lane,
London, W.C.2.
Agents for the Applicant.

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