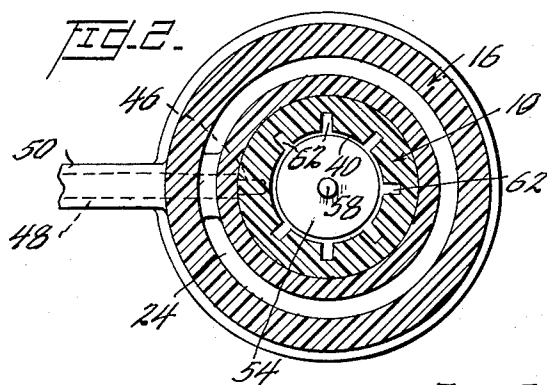
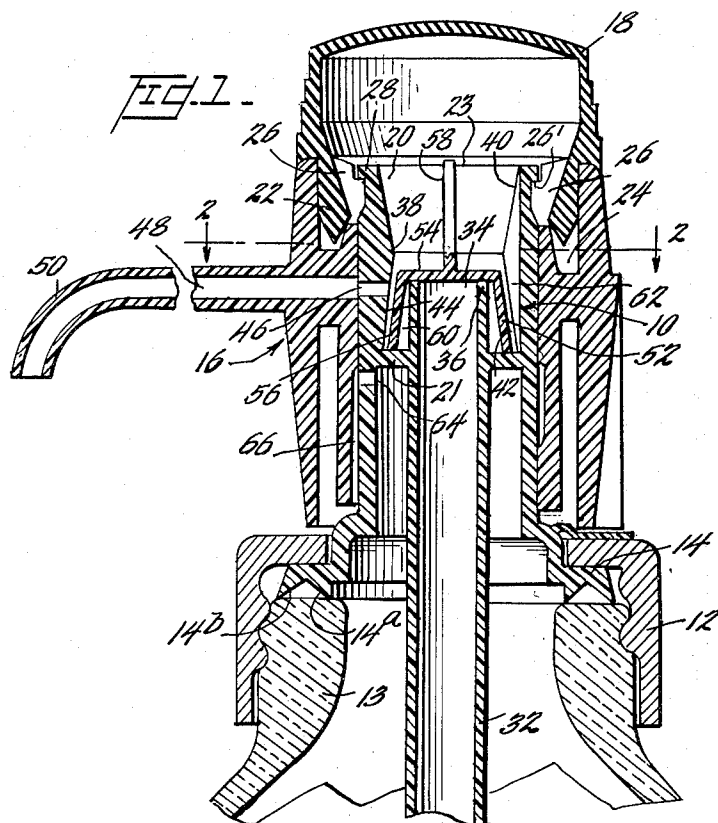


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DISPENSING PUMP VALVE STRUCTURE

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DISPENSING PUMP VALVE STRUCTURE

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This invention relates to an improved pump valve structure for use in pumps of the type in which there is employed a variable volume pump chamber, such as is exemplified in the patents to J. U. Stewart et al., No. 2,853,210, granted September 23, 1958, and No. 2,815,890, granted December 10, 1957.

In pumps of this general type, it has been customary to utilize separate check valves for controlling the intake and discharge ports, respectively, of the pump chamber to insure unidirectional flow of fluid from the intake port into the chamber and thence through the discharge port.

It is a primary object of the invention to provide an improved valve arrangement in which a single, double-acting valve is made to assume the functions of the two separate valves, such as heretofore were employed.

It is a further object to provide such a valve which need comprise but two parts, each being capable of integral unitary formation, as by usual plastic molding processes, and the two parts being adapted for assembly in novel manner by a single assembly step.

The advantages arising from the invention include a definite simplification of the structure involved, as well as of the mode of assembly of the several parts, with resulting economy of production. In addition, there is attainable by virtue of the invention a pump valve structure which is more reliable in operation than heretofore was the case with the separate valves employed in the prior art.

In the accompanying drawing:

FIGURE 1 is an axial section through a pump incorporating the improved valve arrangement, the pump being applied to a container of which only the upper end portion is shown.

FIGURE 2 is a cross section on the line 2-2 of FIGURE 1.

Referring now in detail to the accompanying drawings, the invention is illustrated herein in its preferred mode of use in a pump structure such as disclosed in the U.S. patents above identified. Its use in connection with other types of pumps, including piston pumps, will be obvious.

The pump itself comprises a substantially cylindrical inner body or housing 10, adapted for mounting in sealed relation in the outlet opening of a container. As is illustrated, the housing 10 projects upwardly through a centrally apertured bottle cap 12, of the type which is adapted to be screwed onto the externally threaded neck 13 of a usual bottle. The radial flange 14 of the housing at its lower end projects radially beyond the edges of the aperture and beneath the lower face of the cap 12. This flange 14 is proportioned to rest upon the neck 13 of the bottle and to be clamped against the axially presented end of the neck by means of the cap 12 as the latter is threaded tight to the bottle neck. Preferably the inner body or housing 10 is molded as an integral unit from a plastic material having some ability to be resiliently deformable. For instance, polyethylene plastic has been quite successfully used in actual practice. With such a material, it will be readily apparent that the flange 14, by virtue of its resilient deformability may function efficiently as a seal between the cap and the end of the container neck. To increase its efficiency in this respect, it may be desirable to form the flange with downwardly projecting annular sealing ribs, such as 14a and 14b.

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Snugly disposed about the housing 10 in fluid-tight engagement therewith is an annular outer body 16 which is also formed of polyethylene in the present embodiment. It will be seen that the upper end portion of this outer body or member 16 is defined and closed by a flexible wall portion in the form of a bulbous resilient diaphragm 18, which in the present embodiment is formed of soft rubber. The bulbous diaphragm 18, thus being secured in fluid-tight relation by member 16 over the upwardly opening mouth of the bore within the body 10, cooperates with said bore to define a pump chamber 20 of variable volume. The lower end of this chamber 20 is defined by the annular partition 21 formed integrally with body 10 in the present embodiment.

Although the particular arrangement of the flexible wall portion 18 and its mode of association with the housing 10 constitutes no part of the instant invention, these parts may conveniently be formed and assembled in the manner taught in the U.S. Patent No. 2,815,890, above referred to. Thus, the dome-like flexible wall or diaphragm 18 may have its lower peripheral edge 22 disposed in an annular upwardly opening slot 24 in the outer member 16 and clamped between the radially opposed sides of the slot by radial expansion of the radially deflectable fingers 26 collectively defining the upper end portion of annular inner wall of the slot 24. Expansion of the fingers 26 is caused by insertion upwardly therethrough of the cylindrical inner body 10, the latter being formed to define a retainer flange 28 projecting radially outwardly at its upper end, and beneath which the shouldered free end portions 26' of the respective fingers may resiliently contract to secure the inner and outer bodies 10 and 16, as well as the flexible wall 18 in their assembled relation. The arrangement is such that in accordance with usual practice, downward finger pressure on the upper end surface of the dome-like diaphragm or wall 18 constitutes the compression stroke of the pump structure, while its suction stroke occurs upon release of the pressure, as an incident to return of resilient wall 18 to its normal position or shape. In other words from a broad standpoint the diaphragm 18 may be regarded as equivalent to a usual reciprocating pump piston.

Disposed in fluid-tight relation through the central opening in annular partition 21 is an intake tube 32, the upper or free end of which in the present embodiment projects somewhat above the partition 21 to define an intake port 34 for the pump chamber 20. The tube 32 also may be integrally formed with the elements 10 and 21. With such an arrangement, the free end 34 of the intake tube may function as a raised valve seat. It will be readily apparent that the lower end of the intake tube 32 will normally extend beneath the surface of the fluid or liquid within the container to which the cap 12 is applied, so that the suction stroke of the pump diaphragm 18 will normally tend to draw the fluid upwardly through the tube 32 and intake port 34 into the pump chamber 20. The internal bore through the housing 10 is preferably constricted medially of its length, as at 38, and its upper portion is defined by the conically tapered inner pilot surface 40 of the pump chamber 20, converging downwardly from the mouth 23 of the bore to the constriction 38. Beneath the constriction 38 the wall 44 of the bore 36 also is of frusto-conical configuration. It will be noted that the tapered wall portions 40 and 44 of the bore diverge in opposite axial directions from the constriction 38.

The discharge port 46 of the pump chamber opens radially outwardly through the conical downwardly diverging interior wall 44 of the chamber and communicates at its outer end with the discharge passage 48 of a spout 50 which constitutes part of the outer body 16. It will

be noted that the discharge port 46 opens through the inner wall surface 44 of the pump chamber at a location spaced above its lower end partition 21. Also, it will be noted that the upwardly projecting end of the tube 32 above the blind end or flange 30 is spaced radially inwardly from the interior conical wall 44 of the pump chamber.

Disposed for axial movement within the lower portion of pump chamber 20 is a resiliently deformable frusto-conical valve body 52 of polyethylene, rubber, or the like materials, which is of greater diameter at its diverging lower end than the constriction 38, so that its upward movement is limited by engagement with the conical wall 44 beneath the constriction 38. The exterior frusto-conical surface of the valve body diverges in a direction parallel to the wall 44 to seat thereagainst in fluid-tight manner around the discharge port 46 on upward movement of the valve body 52. Preferably, the upper end of the valve body 52 is defined by an end disc 54, while its frusto-conical diverging surface is defined by an integral skirt 56, which depends from the disc 54 in the space between the upwardly-projecting end of the tube 32 and the inner wall surface 44 of the pump chamber.

Inasmuch as it is desired to be able to form the housing 10 and the valve body 52 each as an integral unitary structure, it is necessary that provision be made for assembling the valve body 52 into the housing by downward insertion of the valve body through the constriction 38. To this end, the valve body itself is preferably molded of a resiliently deformable material, such as polyethylene. In its preferred form, the end disc 54 is preferably of somewhat smaller external diameter than the constriction 38, so as to offer little or no resistance to insertion therethrough. At the same time, the skirt 56 of the valve body, which depends from the disc 54, is preferably formed of relatively thin cross-section, so that it will be flexible, particularly at its lower or diverging end edge remote from the disc 54. The housing 10 around the pump chamber 20 is of comparatively heavier and stiffer construction, than the skirt 56, to withstand insertion of the valve body without material deformation.

It is desirable that the external diameter of the diverging end of the valve body 52 be no greater than that of the upwardly directed mouth 23 of the pump chamber so that in assembling the device, the diverging end of the skirt 56 may be readily received within the mouth 23 in engagement with the wall 40. Thus the skirt will be automatically cammed or deflected radially inwardly by its engagement with such wall as the valve body is thrust toward the constriction 38. After the skirt has passed through the constriction 38 into the downwardly diverging lower end portion of the pump chamber, the skirt 56 will then resiliently return to its original shape and diameter, with its conical exterior surface at the same angle as that of the chamber wall 44. With the particular arrangement of the valve as illustrated in the accompanying drawings, it will be seen that, not only does the valve disc 36 seat against the upwardly projecting end of the tube 32 around the port 34 to close the latter, but that, in addition, the diverging free end edge of the skirt 56 seats against the upper surface of the partition 21, thus effecting a double seal for the port 34 against the compression exerted by the downward finger stroke on the flexible diaphragm 18. It is not essential that such a dual seating of the valve body be provided, and either seating arrangement by itself may suffice.

As an aid in handling the valve body during its insertion into the valve housing, the body 52 may be provided with an upwardly projecting stem, such as 58. In addition to thus facilitating the handling and assembly of the valve body, it is desirable that such a stem 58 project upwardly sufficiently that it may be contacted and depressed by the medial portion of the diaphragm 18 on depression of the latter, in the event the valve body should

become temporarily stuck in its raised position, wherein it is unseated from the port 34.

When the valve body is raised from the intake port 34 and seated against the conical interior surface 44 of the valve chamber to close discharge port 46, it will necessarily tend to obstruct the upward passage of fluid from tube 32 and port 34 into the upper portion of the pump chamber. Since such passage of fluid is essential to operation of the pump structure, there is provided a bypass passage around the valve body 52 from the intake port 34 to the upper portion of pump chamber 20. In the present embodiment, such a bypass passage is afforded when the valve body is raised, by means of the clearance 60 between the skirt 56 and tube 32, between the lower edge of the skirt 56 and the annular partition 21, and thence upwardly through one or more slots, such as 62, in the conical inner wall surfaces 44 and 40 of the valve housing. In the preferred embodiment, such passages or slots 62 extend upwardly through the constriction 38 and thence to the upper end of the housing 10.

In the assembly of the entire structure, the valve body 52 normally will be assembled first within the housing 10, simply by axial insertion of the valve body through the mouth 23, whereupon the interengagement between the lower edge of the valve body skirt 56 and the conically inclined pilot surface 40 will radially compress the skirt to permit its passage through the constriction 38 into the lower chamber portion 44. As above mentioned, after having been received in the lower end of pump chamber 20, the valve body skirt will then expand radially to resume its normal shape and to seat against the inner chamber surface 44 and close the discharge port 46 upon upward or retraction movement.

After assembly of the valve body 52 in housing 10, the housing 10 is inserted upwardly through the central opening in the container cap 12 until its lower flange 14 abuts against the under face of the cap. Then the outer body 16, with the flexible diaphragm 18 having its lower edge loosely received in the annular opening 24 thereof, is moved downwardly over the open upper end of the housing 10. As an incident to this, as is brought forth in the patents earlier identified, the upper end of the valve housing tends to thrust the resilient fingers 26 outwardly into clamping engagement with the lower edge portion of the flexible wall or diaphragm 18 to secure the latter in place. It will be seen that when the parts are seated in their final assembled positions, the radial flange 28 at the upper end edge of the housing has its lower surface abutting against the upwardly presented shouldered portions 26' of the respective fingers 26 to prevent disassembly of the inner and outer bodies 10 and 16 respectively. Thus, the flexible diaphragm 18 is secured in fluid-tight manner over the mouth 23 of the housing 10.

The pump structure operates as follows: Downward pressure on the upper surface of the diaphragm 18 will tend to compress any fluids in the pump chamber 20 and, by so doing, to seat the valve body 52 with respect to the inlet port 34, while at the same time unseating the same valve body from its closing relationship with respect to the discharge opening 46. Thus, the fluid within the pump chamber is caused to be expelled through the port 46 and spout passage 48. When the finger pressure on the diaphragm 18 is released, it will tend to return to its normal shape, thereby creating a suction or reduced pressure in the pump chamber. This, in turn, raises the valve body 52 into seating relation with respect to the inner conical chamber surface 44 and the port 46 to close the latter. This causes fluid to be drawn upwardly through the tube 32, thence downwardly through the space 60 and beneath the lower edge of the skirt 56 for movement upwardly and around the valve body through the passage or passages 62 and thus into the upper portion of the pump chamber. Obviously, such fluid within the pump chamber will then be expelled

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through the discharge port 46 and passage 48 on the next compression or downward stroke of the diaphragm 18. In the event the nature of the fluid being pumped or dispensed is such as might tend to cause sticking of the valve body 52 in its raised position, it will be seen that the valve body may be dislodged simply by downward finger pressure on the diaphragm 18 sufficient to engage the upper end of the stem 53 and transmit there-through a direct downward and positive thrust against the valve body. It will be apparent that the container may be provided with a usual breather bore or vent such as provided by the inter-connected passages 64 and 66, simply to permit passage of air into the container to replace the fluid which is expelled by the pumping action, all in accordance with usual practice.

While the invention has been illustrated and described as applied to a diaphragm-type pump, its use is obviously by no means restricted to this type of pump and it may be equally well adapted for use with any type of pump of a class in which the fluid is drawn into a pump chamber by suction and expelled therefrom by compression through the respective intake and discharge ports communicating with such a chamber. Moreover, it will be readily apparent that the several details of the invention may be altered or modified in various ways, all without departing from the invention. Accordingly, the foregoing drawings and description are to be regarded as illustrative in nature and not as restrictive.

Having thus described our invention, we claim:

1. A dispensing pump comprising a housing of integral construction formed with an internal bore having a mouth opening through one end of said housing, said bore being constricted medially of its length and being defined by a conically tapered inner pilot surface converging inwardly from said mouth to the constriction, and by a relatively oppositely conically tapered inner wall surface diverging from said constriction, said housing being formed with an inlet port opening axially thereinto on the remote side of said constriction from said mouth, together with a valve seat around said port, and a discharge port opening radially through said inner wall surface at a location spaced between said valve seat and the constriction; means defining a variable volume pump chamber in communication with the mouth of the bore; a resiliently deformable frusto-conical valve body of greater diameter at its diverging end than said constriction disposed in said bore between said valve seat and said constriction for alternate axial movement into seating relation with the respective ports; said inner wall surface being formed with a by-pass passage permitting fluid flow from said intake port past the valve body to the pump chamber when the valve body is seated relative to said discharge port; said valve body including an end disc of smaller diameter than said mouth and a resiliently flexible skirt depending from the periphery of said disc, said skirt having an exterior conical taper similar to that of said inner wall surface for seating engagement with said surface around said discharge port; said mouth of the bore being of greater diameter than the free diverging end of said skirt, whereby said pilot surface may slidably engage and cam said skirt radially inwardly for passage through said constriction.

2. A dispensing pump comprising a housing of integral construction formed with an internal bore having a mouth opening through one end of said housing, said bore being constricted medially of its length and being defined by a conically tapered inner pilot surface converging inwardly from said mouth to the constriction, and by a relatively oppositely conically tapered inner wall surface diverging from said constriction, an annular partition at the diverging end of said inner wall surface, an intake tube disposed in fluid tight manner through said partition, and having a free end inwardly of the partition defining an intake port, said free end being spaced radially from said wall surface, and a discharge opening

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radially through said inner wall surface at a location spaced between said valve seat and the constriction; means defining a variable volume pump chamber in communication with the mouth of the bore; a resiliently deformable frusto-conical valve body of greater diameter at its diverging end than said constriction disposed in said bore between said valve seat and said constriction for alternate axial movement into seating relation with the respective ports; said inner wall surface being formed with a bypass passage permitting fluid flow from said intake port past the valve body to the pump chamber when the valve body is seated relative to said discharge port; said valve body including an end disc of smaller diameter than said mouth for seating over said intake port, and a resiliently flexible skirt depending from the periphery of said disc coaxially around said free end of said tube, said skirt having an exterior conical taper similar to that of said inner wall surface for seating engagement with said surface around said discharge port; said mouth of the bore being of greater diameter than the free diverging end of said skirt, whereby said pilot surface may slidably engage and cam said skirt radially inwardly for passage through said constriction.

3. A dispensing pump as defined in claim 2 in which the diverging end edge of the skirt is positioned for seating engagement with said annular partition when said disc is seated over the intake port.

4. A dispensing pump comprising a housing of integral construction formed with an internal bore having a mouth opening through one end of said housing, said bore being constricted medially of its length and being defined by a conically tapered inner pilot surface converging inwardly from said mouth to the constriction, and by a relatively oppositely conically tapered inner wall surface diverging from said constriction, said housing being formed with an inlet port opening axially thereinto on the remote side of said constriction from said mouth, together with a valve seat around said port, and a discharge port opening radially through said inner wall surface at a location spaced between said valve seat and the constriction; means defining a variable volume pump chamber in communication with the mouth of the bore; a resiliently deformable valve body having a conical surface diverging parallel to said wall surface, said valve body being of greater diameter at its diverging end than said constriction and disposed in said bore between said valve seat and said constriction for alternate axial movement into seating relation with the respective ports; said inner wall surface being formed with a by-pass passage permitting fluid flow from said intake port past the valve body to the pump chamber when the valve body is seated relative to said discharge port; said mouth of the bore being of greater diameter than the free diverging end of said valve body whereby said pilot surface may slidably engage and cam said valve body radially inwardly for passage through said constriction.

5. In a dispensing pump comprising a housing of integral construction formed with an internal bore having a mouth opening through one end of said housing, said bore being constricted medially of its length and being defined by a conically tapered inner pilot surface converging inwardly from said mouth to the constriction, and by a relatively oppositely conically tapered inner wall surface diverging from said constriction, said housing being formed with an inlet port opening axially thereinto on the remote side of said constriction from said mouth, together with a valve seat around said port, and a discharge port opening radially through said inner wall surface at a location spaced between said valve seat and the constriction; a resiliently deformable valve body having a conical exterior surface diverging parallel to said inner wall surface and of greater diameter at its diverging end than said constriction, said valve body being disposed in said bore between said valve seat and said

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constriction for alternate axial movement into seating relation with the respective ports; means being provided to define a bypass passage permitting fluid flow from said intake port past the valve body and through said constriction when the valve body is seated relative to said discharge port; said mouth of the bore being of greater diameter than the free diverging end of said valve body, whereby said pilot surface may slidably engage and compress said valve body radially inwardly for passage through said constriction.

6. A dispensing pump comprising a housing of integral construction formed with an internal bore having a mouth opening through one end of said housing, said bore being constricted medially of its length and being defined by a conically tapered inner pilot surface converging inwardly from said mouth to the constriction, and by a relatively oppositely conically tapered inner wall surface diverging from said constriction, said housing being formed with an inlet port opening axially thereinto on the remote side of said constriction from said mouth, together with a valve seat around said port, and a discharge port opening radially through said inner wall surface at a location spaced between said valve seat and the constriction; a resiliently demorable valve body having a conical outer surface portion diverging parallel to said inner wall surface and of greater diameter at its diverging end than said constriction, said valve body being disposed in said bore between said valve seat and said constriction for alternate axial movement into seating relation with the respective ports; means defining a bypass passage from said intake port and through said constriction; a resiliently deformable valve body having said discharge port; said mouth of the bore being of greater diameter than the free diverging end of said valve body, whereby said pilot surface may slidably engage and compress said valve body radially inwardly for passage through said constriction, a flexible diaphragm disposed over and enclosing the said mouth to coact with said bore in defining a variable volume pump chamber, a portion of said valve body projecting upwardly through said mouth in the seated position of said valve body relative to the discharge port, for engagement by the diaphragm to dislodge the valve body in the event said valve body should tend to stick in its said seated position relative to the discharge port.

7. In a pump comprising a variable volume pump chamber, a housing having a frusto-conical bore communicating through its smaller axial end with and defining the lower end portion of said pump chamber, a partition extending across said bore and having an intake port therethrough at the lower diverging end of said bore, said housing being formed with a discharge port opening radially therethrough into said bore at a location above said partition, a conically tapered valve body disposed in said bore for bodily axial movement, the conical angle of said valve body being similar to that of said bore, the diameter of the lower diverging end of said valve body being intermediate of the diameters of said bore at its lower end and at the axial location of said discharge port, said valve body at the upper extremity of its axial movement having a portion of its conical surface in seating engagement with the inner conical wall of said bore around said discharge port and being spaced axially from said intake port, said valve body at the lower extremity of its movement seating over and closing said intake port, with its conical surface spaced from the conical inner wall of the valve chamber to provide a passage for flow of fluid from said bore into said discharge port, and means defining a bypass passage around the valve body between the intake port and the pump chamber when the valve body is seated with respect to the discharge port.

8. A valve structure comprising a housing defining a frusto-conical chamber, and formed with an intake port

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opening axially into said chamber through its diverging end, and with a discharge port opening into said chamber through the frusto-conical wall of said chamber, the converging end of said chamber being adapted for communication with a variable volume pump chamber, a valve body disposed for axial bodily movement in said chamber into alternate seating relation with the respective ports, and having an exterior surface conically tapered similarly to said inner chamber wall for seating thereagainst around said discharge port, and means defining a bypass passage around said valve body from the intake port to said converging end of the chamber when the valve body is seated with respect to the discharge port.

9. The valve structure defined in claim 8, in which said valve body is of greater maximum diameter than said smaller axial end of the frusto-conical bore, and its maximum diameter portion is resiliently radially compressible for insertion of the valve body into said bore through the said smaller axial end of the bore.

10. In a dispensing pump comprising a housing of integral construction formed with an internal bore having a mouth opening through one end of said housing, said bore being constricted medially of its length and being defined by a conically tapered pilot surface converging inwardly from said mouth to the constriction, said housing being formed with an inlet port opening axially thereinto on the remote side of said constriction from said mouth, together with a valve seat around said port, and a discharge port opening radially through said inner wall surface at a location between said valve seat and the constriction, a resiliently deformable valve body of greater diameter than said constriction disposed in said bore between said valve seat and said constriction for alternating axial movement into seating relation with the respective ports, means being provided to define a bypass passage permitting fluid flow from said intake port past the valve body and through said constriction when the valve body is seated relative to said discharge port, said mouth of the bore being of greater diameter than said valve body, whereby said pilot surface may slidably engage and compress said valve body for passage through said constriction during assembly of said valve body and said housing.

11. A valve structure comprising a housing defining a downwardly diverging frusto-conical valve chamber open at its upper end, and formed with an intake port opening axially into said chamber through its lower diverging end, a discharge port opening from said chamber through its conical inner wall at a location spaced axially from said lower end, a frusto-conical valve body movement, the conical angle of said valve body being similar to that of the valve chamber, and the lower diverging end of said valve body having a diameter intermediate of the diameters of said valve chamber respectively at its lower end and at the axial location of said discharge port, said valve body at the upper extremity of its axial movement having a portion of its conical surface in seating engagement with the inner conical wall of said chamber around said discharge port, and being spaced axially from said intake port, means defining a by-pass passage through the valve structure to establish communication between said intake port and said open upper end when the valve body is at its said upper extremity, said valve body at the lower extremity of its movement seating over and closing said intake port, with its conical surface spaced radially from the conical inner wall of the valve chamber to place said open upper end in communication with said discharge port.

12. A valve structure as defined in claim 11 wherein said housing and said valve body are each of integral unitary construction, the open upper end of said valve chamber being of smaller diameter than the valve body, means defining a pilot surface having an open mouth of larger diameter than said valve body and converging

from said mouth, said pilot surface having its converging end communicating with said open upper end of the valve chamber, said valve body being of resiliently deformable material to be radially compressed by engagement with said pilot surface as it is urged toward and through said mouth and into the valve chamber incident to assembly of the housing and valve body.

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