Dec. 10, 1968 R. HORNLEIN ET AL 3,415,159

FLUID-OPERATED EXTENDABLE AND CONTRACTABLE ARRANGEMENT

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Fig. 1

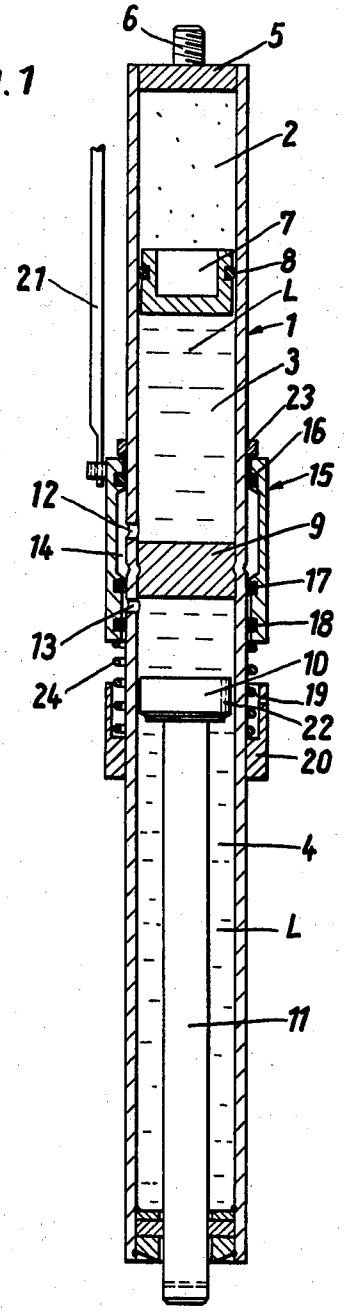
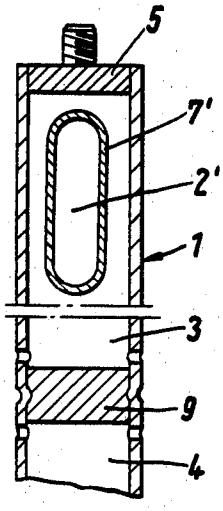


Fig. 1a



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FLUID-OPERATED EXTENDABLE AND CONTRACTABLE ARRANGEMENT

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Fig. 2

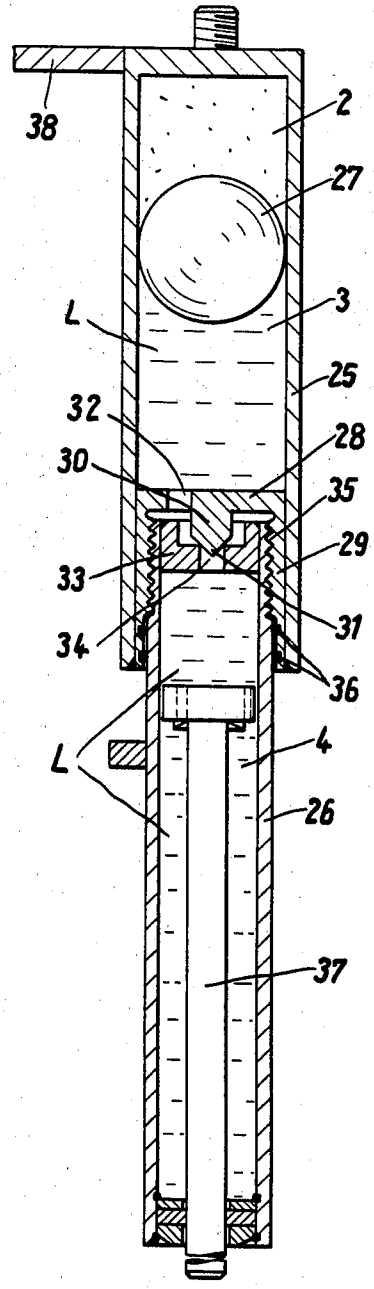
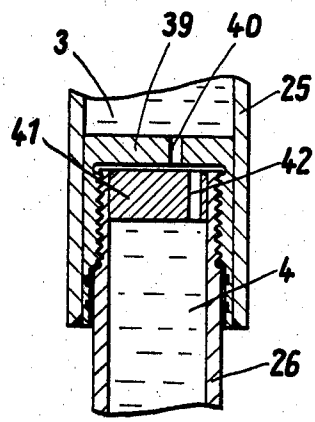


Fig. 3



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FLUID-OPERATED EXTENDABLE AND CONTRACTABLE ARRANGEMENT

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Fig. 4

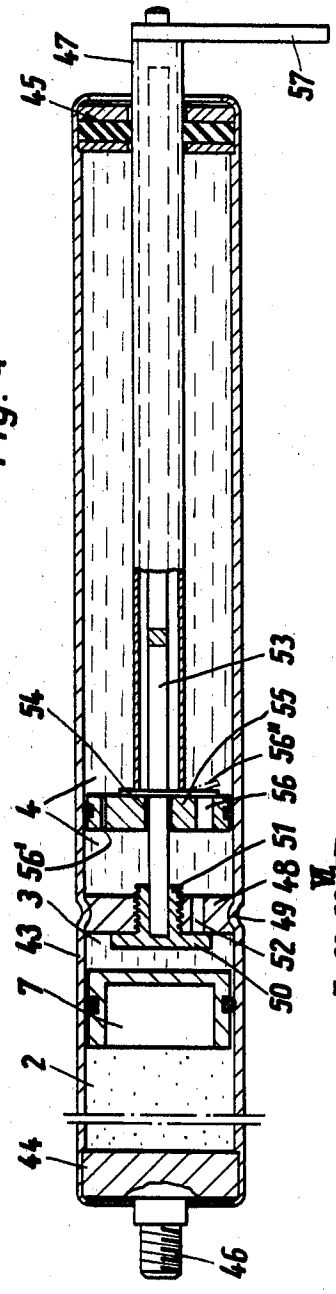


Fig. 5

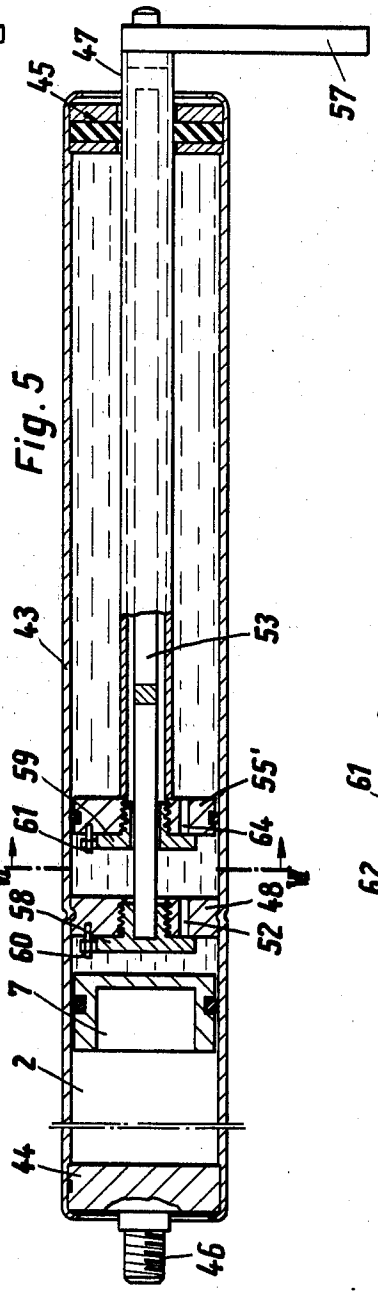
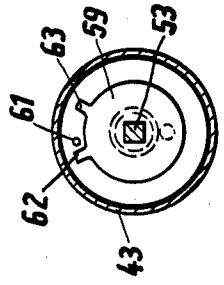


Fig. 6



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FLUID-OPERATED EXTENDABLE AND CONTRACTABLE ARRANGEMENT

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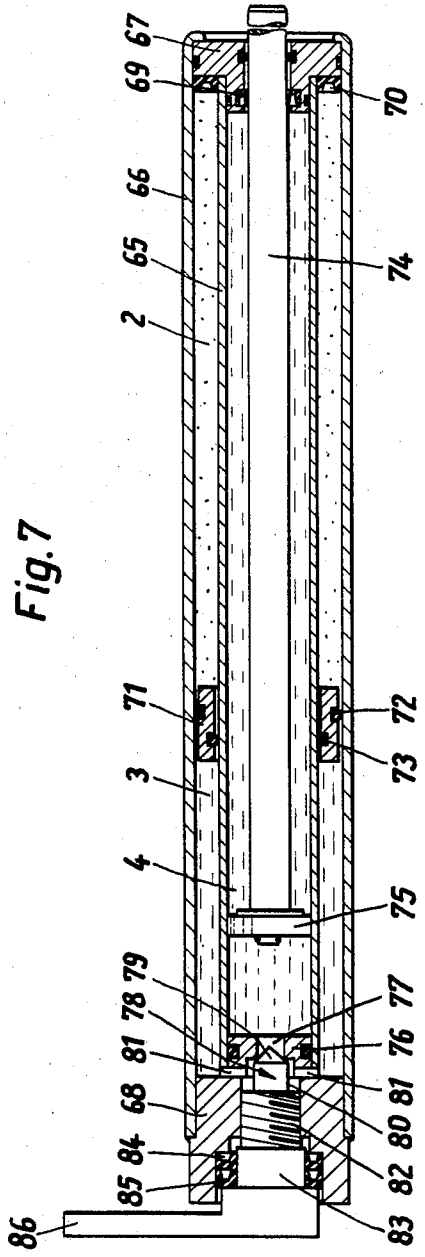
Fig. 7



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FLUID-OPERATED EXTENDABLE AND CONTRACTABLE ARRANGEMENT

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Fig 8

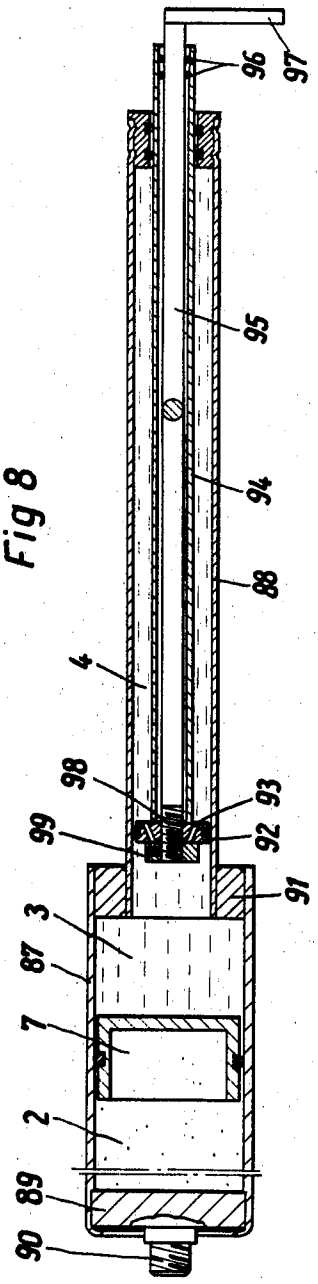
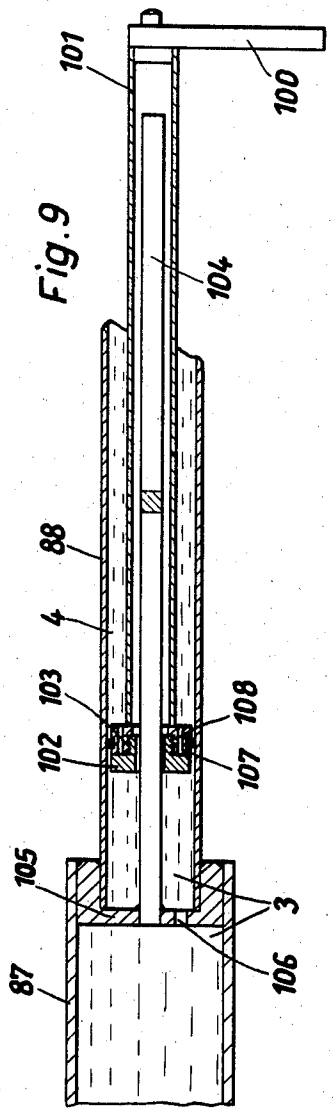


Fig. 9



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FLUID-OPERATED EXTENDABLE AND CONTRACTABLE ARRANGEMENT

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31 Claims. (Cl. 91—5)

ABSTRACT OF THE DISCLOSURE

A fluid-operated extendable and contractable arrangement in which a movable partition divides cylinder means into a gas chamber means filled with compressed gas and a liquid chamber means filled with liquid in which an elongated displacement member extends into the liquid chamber means and project fluid-tightly sealed through and beyond one end of the cylinder means while a second partition is located between the displacement member and the movable partition and dividing the liquid chamber into a first liquid chamber and a second liquid chamber placed by passage means in communication with each other, which passage means may be opened and closed by control means so that when the passage means are closed, the arrangement will be locked in any position it had been brought to while the passage means were open.

The present invention relates to a fluid-operated extendable and contractable arrangement especially suited for height adjustable tables or the like and which includes a cylinder and an elongated displacement member extending into the cylinder and beyond one end thereof. adjustable in longitudinal direction with respect to the cylinder and arrestable in any adjusted position relative thereto. The arrangement according to the present invention may be used also for adjusting the position of any two members relative to each other which are respectively connected to one end of the cylinder and to the end of the displacement member projecting beyond the other end of the cylinder.

It is an object of the present invention to provide for a fluid-operated arrangement of the aforementioned kind which permits a hydraulic blocking and resilient adjustment and which is constructed of relatively few and simple parts so that the arrangement can be manufactured at reasonable cost and will stand up perfectly under extended use.

It is an additional object of the present invention to provide for an arrangement of the aforementioned kind in which the possible length of the adjustment obtainable by the arrangement is relatively great.

With these objects in view, the fluid-operated arrangement according to the present invention mainly comprises cylinder means having opposite closed ends, movable partition means dividing the cylinder means into a gas chamber means and a liquid chamber means, wherein the volume of the gas chamber means increases and that of the liquid chamber means decreases when the movable partition means move in a first direction and vice versa when the movable partition means move in the second direction opposite to the first direction. A compressed gas fills the gas chamber means and an elongated displacement member extends into the liquid chamber member and has an inner end spaced from the movable partition means and an opposite end portion projecting fluid-tightly sealed through and beyond one end of the cylinder means. A liquid fills the space in the liquid chamber means

about the displacement member and this liquid is in pressure transmitting contact with the movable partition means. The displacement member is movable in inward direction upon application of a predetermined pressure on the outer end portion thereof so as to contract the arrangement and so as to displace liquid in the liquid chamber means, forcing thereby the movable partition means to move in the second direction to thereby compress the gas in the gas chamber means to an increasing extent, and upon reduction of the predetermined pressure on the opposite end portion of the displacement member, the increasingly compressed gas will act on the movable partition means to move the latter in the first direction reducing thereby the volume of the liquid chamber means and forcing the displacement member in outward direction so as to expand the arrangement. The arrangement includes further second partition means between the inner end of the displacement member and the movable partition means and dividing the liquid chamber means into a first liquid chamber bordering on the movable partition means and a second liquid chamber into which the displacement member extends, passage means providing communication between the first and the second liquid chamber, and control means cooperating with the passage means for opening and closing the latter, whereby when the passage means are closed, the liquid trapped in the first and the second liquid chamber will prevent movement of the displacement member in inward direction and movement of said movable partition means in the first direction so that the arrangement will be locked in any position as it has been brought to while said passage means were open.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a longitudinal cross section through a first embodiment of an arrangement according to the present invention;

FIG. 1*a* is a longitudinal cross section through a partially illustrated modification of the arrangement shown in FIG. 1;

FIG. 2 is a longitudinal cross section through a second embodiment of an arrangement according to the present invention;

FIG. 3 is a partial longitudinal cross section through a further modification;

FIGS. 4 and 5 are longitudinal cross sections through additional modifications according to the present invention;

FIG. 6 is a transverse cross section taken along the line VI—VI of FIG. 5;

FIG. 7 is a longitudinal cross section through an additional modification; and

FIGS. 8 and 9 are partial longitudinal cross sections through additional modifications of arrangements according to the present invention.

Referring now to the drawings, and more specifically to FIG. 1, it will be seen that the arrangement illustrated in this figure mainly comprises elongated cylinder means shown in FIG. 1 as a single elongated cylinder **1** of substantially uniform diameter. A movable partition means, in the form of a floating piston **7**, is located in the interior of the cylinder **1** and an O-ring **8** located in an annular groove of the floating piston **7** provides a fluid-tight seal between the piston **7** and the inner surface of the cylinder **1**. The piston **7** forming the movable partition

means divides the interior of the cylinder **1** into a gas chamber means **2** located between the piston **7** and the upper end of the cylinder **1** closed by the transverse wall **5** and a liquid chamber means **3, 4**. A compressed gas fills the gas chamber **2**. An elongated displacement member in the form of a piston rod **11** extends fluid-tightly sealed through and beyond the bottom end of the cylinder **1**. A piston **10** is fixedly connected to the inner end of the piston rod **11** and the piston is formed with an axial bore **22** therethrough located laterally of the axis of the piston. A liquid L fills the space in the liquid chamber means **3, 4** about the displacement member **11** and the piston **10** fixed thereto. The arrangement shown in FIG. 1 includes further second partition means in the form of a plate **9** extending transversely through and fixed to the cylinder **1** in any convenient manner. The plate **9** is located between the floating piston **7** and the piston **10** fixed to the inner end of the piston rod **11**, thus dividing the liquid chamber means into a first liquid chamber **3** bordering the movable partition **7** and a second liquid chamber **4** into which the displacement member or piston rod **11** extends. Passage means provide communication between the first liquid chamber **3** and the second liquid chamber **4** and these passage means comprise at least one pair of bores **12** and **13** through the wall of the cylinder **1** spaced in axial direction of the cylinder from each other and respectively located at opposite sides of the plate **9** forming the second partition means. Control means are provided for controlling flow of liquid through the bores **12** and **13**. The control means including an elongated sleeve **15** surrounding the cylinder **1** and a pair of annular fluid-tight seals in the form of O-rings **16** and **18** located in inner grooves at opposite ends of the sleeve **15** and a third annular seal in the form of an O-ring **17** spaced from the upper O-ring **16** a distance greater than the axial distance between the bores **12** and **13** and spaced from the lower O-ring **18** a distance smaller than thea forementioned axial distance, and the inner surface of the sleeve **15** is spaced between the sealing rings **16** and **17** from the outer surface of the cylinder so as to form an annular passage **14** therebetween. The sleeve **15** is shown in FIG. 1 in one of its end positions in which the third seal, that is the sealing ring **17**, is located between the bores **12** and **13** so that no liquid can flow between the first liquid chamber **3** and the second liquid chamber **4**. From this end position shown in FIG. 1 the sleeve is movable in downward direction to a second end portion against the resilient pressure of a coil spring **24** in which the third sealing ring **17** will be downwardly displaced beyond the bore **13** whereas the upper sealing ring **16** will still stay upwardly of the bore **12**. In this second end position liquid may flow from the first liquid chamber **3** through the bore **12**, the annular passage **14** and the bore **13** into the second liquid chamber **4** and vice-versa. The coil spring **24** engages with the lower end thereof a stop **20** fixed to the outer surface of the cylinder and this stop has an upwardly extending annular portion **19** which engages the lower end of the sleeve **15** when the latter is displaced to its lower end position. An additional stop **23** fixed to the outer surface of the cylinder **1** limits upward movement of the sleeve **15** under the force of the coil spring **24**. An operating member in the form of an elongated rod **21** is connected to the sleeve **15** for moving the latter between the end positions thereof. A threaded stud **6** is preferably provided projecting centrally from the plate **5** closing the upper end of the cylinder and, if the above described arrangement is used for adjusting the height of a table this central stud may for instance be connected to the table plate, whereas the lower end of the piston rod **11** projecting downwardly beyond the cylinder may be connected in any convenient manner to a cross member forming the base of the table. Obviously, the above described arrangement shown in FIG. 1 may also be connected at opposite ends thereof to any two members which have to be relatively moved with respect to each other and be locked in any adjusted position.

The arrangement above described will operate as follows:

In the position of the sleeve **15** as shown in FIG. 1 no fluid can pass from the first fluid chamber **3** into the second fluid chamber **4**. Therefore, the compressed gas in the gas chamber **2** cannot move the floating piston **7** in downward direction, nor can the piston rod **11** and the piston **10** move inwardly since the space in the second fluid chambers **3** and **4** is completely filled with liquid. When the sleeve **15** is moved by the operating member **21** in downward direction against the pressure of the spring **24** until the lower end of the sleeve **15** engages the upper end **19** of the lower stop **20**, communication will be provided between the first fluid chamber **3** and the second fluid chamber **4** through the bore **12**, the annular passage **14** and the bore **13** whereupon the compressed gas in the gas chamber **2** will move the floating piston **7** in downward direction, displacing thereby liquid from the first liquid chamber **3** into the lower liquid chamber **4** above the piston **10** forcing thereby the piston **10** and the piston rod **11** in downward direction so that the piston rod will project at the lower end thereof to a greater extent outwardly from the lower end of the cylinder **1**. During such displacement of cylinder **10** and piston **11**, the liquid in the liquid chamber **4** beneath the piston **10** may pass through the bore **22** through the piston and since this bore has a relatively small diameter a throttling of the downward movement of piston **10** and piston rod **11** will be provided. After the piston rod **11** has been displaced in downward direction to a desired extent, the operator releases the operating member **21** so that the sleeve **15** will return under the action of the coil spring **24** to the position shown in FIG. 1, whereby the piston rod will be locked in the position to which it has been moved. If the arrangement has to be collapsed again, outside pressure has to be provided either to the lower end of the piston rod **11** in upward direction or to the upper end of the cylinder **11** in downward direction while the sleeve **15** is moved to the lower end position thereof engaging with the lower end the stop **20** and liquid will thereby be displaced as the piston rod **11** moves inwardly into the cylinder **1** from the second liquid chamber **4** into the first liquid chamber **3** moving thereby the floating piston **7** in upward direction and compressing thereby the gas in the gas chamber **2** to an increasing extent. When the arrangement is thus collapsed to a desired position, the operator releases the operating rod again so that the sleeve **15** is returned under the action of the coil spring **24** to the position shown in FIG. 1.

FIG. 1*a* shows in a partial sectional view, a slight modification of the arrangement illustrated in FIG. 1. The arrangement partially shown in FIG. 1*a* differs from the arrangement above described in that the first partition means is constituted by an enclosure **7'** formed of flexible material and located in the first fluid chamber **3** surrounded by the liquid therein. The flexible enclosure **7'** is filled with compressed gas and the interior of the flexible enclosure **7'** constitutes therefore the gas chamber means **2'**. The arrangement is only partially illustrated in FIG. 1*a* and it is to be understood that the arrangement includes otherwise all components shown in FIG. 1 and described above.

The arrangement illustrated in FIG. 1*a* will operate substantially as above described in connection with FIG. 1 the only difference being that during inward movement of cylinder **10** and piston rod **11** and displacement of liquid from the second liquid chamber **4** into the first liquid chamber **3** the flexible wall **7'** of the first partition means will be partly collapsed and the gas located therein thereby compressed.

FIG. 2 shows a further arrangement according to the present invention. The arrangement shown in FIG. 2 differs from the above described arrangement shown in FIG. 1 in that the cylinder means comprise an upper cylinder **25** and a lower cylinder **26** coaxially arranged with the

upper cylinder 25 and having an upper end extending into the lower end of the upper cylinder. The movable partition means in the arrangement shown in FIG. 2 is constituted by a ball 27 of elastic material located in the upper cylinder 25 and sealingly engaging the inner surface thereof. The ball 27 forming the movable partition means divides the cylinder means 25, 26 into an upper gas chamber 2 and lower liquid chamber means 3, 4. An elongated piston rod 37 carrying at the upper inner end thereof a piston formed with at least one bore therethrough extends with its lower end fluid-tightly sealed through and beyond the lower end of the cylinder 26. The second partition means comprises in the arrangement of FIG. 2 a plate member 33 fixed to and extending transverse through the upper end of the lower cylinder 26 so as to divide the liquid chamber means into a first liquid chamber 3 above the plate 33 and a second liquid chamber 4 below the plate 33. The passage means forming communication between the liquid chambers 3 and 4 are constituted in this embodiment by a central bore 34 through the plate 33. The upper end of the cylinder 26 extending into the lower end of the cylinder 25 is provided with an outer screw thread 35 with which a corresponding inner screw thread of a cup-shaped member 29 is threadingly engaged. The transverse end wall of the cup-shaped member 29 is formed with an opening 32 therethrough, whereas the peripheral wall 29 of the cup-shaped member tightly engages with the outer surface thereof the inner surface of the cylinder 25 and the peripheral wall 29 is welded at the bottom end thereof fluid-tightly to the bottom end of the cylinder 25. A pair of annular seals 36 in the form of O-rings or the like are located in annular grooves at the inner surface of the peripheral wall 29 and these seals 36 provide a fluid-tight seal between the inner surface of the peripheral wall 29 of the cup-shaped member 28 and the outer surface of the cylinder 26. Integrally connected to the transverse wall of the cup-shaped member 28 and projecting downwardly therefrom is a projection 30 having a substantially conical bottom end 31 engaging in the position shown in FIG. 2 into the bore 34 so as to close the latter. The projection 30 forms therefore a control means for opening and closing the passage means 34 between the liquid chambers 3 and 4. A handle 38 projects laterally from the upper end of the cylinder 25 fixed thereto for turning the upper cylinder 25 about its axis relative to the lower cylinder 26 which is held in any convenient manner in fixed non-rotatable position.

The embodiment shown in FIG. 2 will operate substantially in the same manner as the embodiment shown in FIG. 1, however opening and closing of the passage means of the bore 34 through the plate 33 will be provided in the arrangement illustrated in FIG. 2 by turning the upper cylinder 25 by means of the handle relative to the lower fixed cylinder 26. Due to the thread connection between the lower cylinder 26 and the cup-shaped member 28 fixed to the upper cylinder 25, such turning of the upper cylinder relative to the lower cylinder will cause axial shifting of the projection 30 in one or the other direction, depending on the direction of rotation of the upper cylinder, so that during such turning the passage 34 will be opened or closed.

FIG. 3 shows part of an arrangement similar to that shown in FIG. 2 and it is to be understood that the portions of the arrangement not shown in FIG. 3 are substantially identical to those shown in FIG. 2. The arrangement illustrated in FIG. 3 differs from that shown in FIG. 2 only by the specific construction of the means for closing and opening the passage which provides communication between the upper liquid chamber 3 and the lower liquid chamber 4. The lower cylinder 26 in which the lower liquid chamber 4 is provided is again formed at the upper end thereof with the screw thread with which the screw thread on a cup-shaped member 39 fixed to the lower end of the upper cylinder 25 engages. The upper end of the lower cylinder 26 is again closed by a plate 41 which is formed with a bore 42 therethrough and the transverse wall portion of the cup-shaped member 39 which closes the lower end of the upper cylinder 25 is likewise formed with a bore 40 therethrough which is transversely displaced with regard to the bore 42 in the plate 41. By tuning the upper cylinder 25 about its axis relative to the lower stationary cylinder 26, in the manner as described before in connection with FIG. 2, the transverse wall portion of the cup-shaped member 39 may be moved towards or away from the plate 41 which closes the lower cylinder 26 and when the bottom surface of the transverse wall portion of the cup-shaped member 39 engages the top surface of the plate 41 no liquid can pass between the liquid chambers 3 and 4, whereas when these surfaces are spaced from each other, liquid may pass through the bore 40, the space between the two surfaces, and the bore 42 between the two liquid chambers.

FIGS. 4–6 illustrate further modifications of the arrangement according to the present invention. In the arrangement shown in FIG. 4 as well as in that shown in FIG. 5, the cylinder means comprise a single elongated cylinder 43 divided by movable partition means in the form of a floating piston 7 in a gas chamber 2 and liquid chamber means 3, 4. The liquid chamber means 3, 4 is divided by second partiition means in the form of a fixed plate 48 securely fastened to the cylinder wall by a corrugation 49 into a first liquid chamber 3 adjacent the floating piston 7 and a second liquid chamber 4. The cylinder 43 is closed at opposite ends thereof by end caps 44 and 45, respectively, and the lower end cap 44 carries fixedly connected thereto a threaded stud 46 serving to connect the cylinder 43 at one end thereof to a member to be moved by the arrangement illustrated. An elongated displacement member 47 in the form of a hollow piston rod is located in the liquid chamber 4 and projects with its upper end through and beyond the closure cap 45 fluid-tightly sealed with respect thereto. A handle 47 extends transversely from the upper end of the piston rod 47 for a purpose as will be described later on. The upper end of the piston rod 47 may be connected in any convenient manner to the other member to be adjusted by the arrangement.

The passage means which provides communication between the liquid chamber 3 and the liquid chamber 4 is constituted in the arrangement shown in FIG. 4 by a bore 52 through the plate 48. The control means for opening and closing the bore 52 comprise in the arrangement shown in FIG. 4 a bushing 51 provided with an outer screw thread and threadingly engaged in a correspondingly threaded central bore through the plate 49. The bushing 51 carries at its lower end fixedly connected thereto a disk 50 which extends in radial direction beyond the bore 52 through the plate 48. The upper surface of this disk 50 engages the bottom face of the plate 49 and in the position as shown in FIG. 4 no liquid can pass between the liquid chambers 3 and 4. When the bushing 51 is turned about its axis it will thereby be displaced in axial direction and when the bushing is turned in opening direction the disk 50 will become disengaged from the plate 48 so that the passage means between the liquid chambers 3 and 4 are opened. The piston rod 47 carries fixedly connected thereto at the inner end thereof a piston 55 which is in sealing engagement with the inner surface of the cylinder 43 and which is formed with a bore 56 and a second bore 56' of smaller diameter than that of the bore 56 therethrough. An elongated rod 53 of polygonal, for instance square, cross section is telescopically arranged in the interior of the hollow piston rod 47, and rod 53 extends through a central bore 54 in the piston 55 having a cross section substantially identical to that of the rod 53. The rod 53 is fixedly connected in any convenient manner at the bottom end thereof in the bushing 51. When the piston rod 47 is turned by means of the handle 57 about its axis, the piston 55 fixedly connected thereto will likewise be turned

and to take thereby the rod 53 along so that turning of the piston rod 47 will cause turning of the bushing 51 in one or the other direction depending on the direction of turning of the piston rod, so that the disk 50 may be brought in a position opening or closing the passage 52. When the passage 52 is thus opened, the piston rod 47 may be pushed downwardly by application of pressure onto the upper end thereof and during such downward movement, in which the piston rod 47 moves to a greater extent into the liquid chamber 4, liquid therein will be displaced into the liquid chamber 3, moving thereby the floating piston 7 in downward direction and compressing the gas in the gas chamber 2. During such inward movement of the piston rod 47 and the piston 55 connected thereto liquid will pass also from the portion of the liquid chamber 4 beneath the piston to the portion thereof above the piston through the bores 56 and 56' through the piston. When the passage 52 is closed again, the piston rod 47 and the cylinder 3 will be held in locked position relative to each other. Subsequent reopening of the passage 52 will cause the compressed gas in the gas chamber 2 to move the floating piston 7 in upward direction displacing thereby liquid from the liquid chamber 3 into the liquid chamber 4 which will result in outward movement of the piston 55 and the piston rod 47 connected thereto. The speed of this outward movement will be throttled by the flap valve 56'' which closes during outward movement the large diameter bore 56 through the piston 55 and during such outward movement liquid from the portion of the liquid chamber 4 between the plate 48 and the piston 55 can pass only through the small diameter bore 56' into the portion of the liquid chamber 4 between the piston 56 and the cylinder cap 45.

The arrangement illustrated in FIGS. 5 and 6 differs from the above described arrangement shown in FIG. 4 by a slightly different construction of the closure means for closing the passage 52 through the plate 48 and for closing the passage 64 through the piston 55'. The piston 55' as well as the plate 48 in the arrangement shown in FIG. 5 are both formed with a threaded central bore therethrough and a valve member 59 having a threaded bushing portion and a disk portion integrally connected thereto is threadingly engaged in the threaded central bore through the piston 55' whereby the disk portion of the valve member 59 extends radially over the bore 64. A corresponding valve member 58 is threadingly engaged with the threaded central bore through the plate 48 and the disk portion of the valve member 58 extends radially over the bore 52 through the plate 48. A rod member 53 of polygonal, for instance square, cross section is telescopically arranged in the hollow piston rod 47 and the rod member 53 extends through a central bore of a cross section substantially identical to that of the rod in the valve member 59, whereas the lower end of the rod 53 extends into the valve member 58 and is fixedly connected thereto. The disk portions of the valve members 58 and 59 are provided with a pair of circumferentially spaced projections 62 and 63, as best shown in FIG. 6, cooperating with a pin 60 or 61 respectively fixed to the plate 48 and the piston 55'.

Turning of the piston rod 47 about its axis by means of the handle 57 will cause turning of the piston 55' connected thereto and during the first part of the turning movement the rod 53 will not rotate and therefore the valve member 59 will be prevented likewise from rotation so that due to the screw connection between valve member 59 and piston 55' the piston 55' will move relative to the valve member 59 in axial direction opening thereby the passage 64 through the piston. Further turning of the piston 55' will lead to engagement of the pin 61 with one of the projections on the disk portion of the valve member 59, turning thereby the valve member together with the piston, which in turn will cause turning of the rod 53 and the valve member 58 connected to the inner end of the rod 53, opening thereby the passage 52. This turning may be continued until one of the projections on the valve member 58 engages the pin 60. After the passages 52 and 64 are opened the piston rod 47 and the cylinder 43 may be moved longitudinally with respect to each other either due to application of pressure on the outer end of the piston rod or due to expansion of the compressed gas in the gas chamber 2 and after cylinder 43 and piston rod 47 are brought to the desired adjusted position, the valves are again closed by turning the piston rod in the opposite direction so that piston rod and cylinder are locked in the adjusted position.

In the arrangement shown in FIG. 5 the piston rod is positively locked against inward or outward movement.

FIG. 7 shows a further modification of the arrangement according to the present invention. The cylinder means shown in FIG. 7 comprise an outer cylinder 66 and an inner cylinder 65 coaxially arranged in the outer cylinder. The outer cylinder 66 is closed at one end by an end cap 67 and at the other end thereof by an end cap 68. The end cap 67 has a projecting portion 69 extending into one end of the inner cylinder 65 and closes the inner cylinder at this end. A floating piston 71 is arranged in the annular space between the inner and the outer cylinder and sealing rings 72 and 73 are provided in this floating piston respectively engaging the inner surface of the outer cylinder 66 and the outer surface of the inner cylinder 65 to form a perfect seal with these cylinder surfaces. The floating piston 71 constitutes movable partition means dividing the cylinder means constituted by the inner and outer cylinders into a gas chamber 2 and a liquid chamber means 3, 4. The gas chamber 2 is sealed at the end distance from the floating piston 71 by a gasket 70. A second partition means divide the liquid chamber means into a first liquid chamber 3 adjacent the gas chamber 2 and a second liquid chamber 4. The second partition means is constituted in the arrangement shown in FIG. 7 by a plate 76 fixed in a fluid-tight manner to the end of the inner cylinder 65 adjacent the end cap 68 of the outer cylinder. Plate 76 may also be integral with the end cap 68. An elongated displacement member in the form of a piston rod 74 is located in the second liquid chamber 4 projecting with an end portion thereof fluid-tightly sealed through and beyond the end cap 67 to the outside of the outer cylinder 66. The inner end of the piston rod 74 carries fixedly connected thereto a piston 75 slidingly guided in the inner cylinder 65 and formed with at least one bore therethrough. The passage means providing communication between the liquid chamber 3 and the liquid chamber 4 are constituted in this arrangement by a central bore 77 through the plate 76 which communicates with a bore of enlarged diameter 80 and through a pair of transverse bores 81 with the liquid chamber 3. A valve member 78 serves for opening and closing the aforementioned passage between the liquid chamber 3 and the liquid chamber 4. The valve member 78 has a threaded portion 82 threadingly engaged in a threaded bore in the end cap 68 and an inner projection 79 of preferably conical configuration of the valve member is adapted to engage into the bore 77 to close the latter in the position as shown in FIG. 7. The valve member 78 has at the outer end an enlarged diameter portion 83 which together with an enlarged bore 84 in the end cap 68 provides an annular chamber in which sealing rings 85 are located to properly seal the valve member 78. A handle 86 connected to the outer end of the valve member 78 serves to turn the latter about its axis so that the valve member may be moved during turning thereof between a valve closing and a valve opening position. In the open position of the valve 78, the piston rod 74 and the cylinder means 65, 66 may be moved relative to each other in the manner as described before, whereas when the valve is closed the piston rod 74 will be held in locked position relative to the cylinder means.

FIGS. 8 and 9 show further embodiments of the arrangement according to the present invention. In both embodiments the cylinder means are constituted by the cylinders 87 and 88 axially aligned with each other and the cyl-

inder **87** has a larger diameter than the cylinder **88**. In the arrangement shown in FIG. 8 the cylinders are connected at adjacent ends thereof by the annular member **91**. Movable partition means in the form of a floating piston **7** divide the cylinder means into a gas chamber **2** filled with compressed gas and liquid chamber means **3**, **4** filled with liquid, for instance oil. At the end opposite from the floating piston **7** the gas chamber **2** is closed by the end cap **89** fixed to the outer end of the large cylinder **87** and the end cap **89** fixedly carries a threaded stud **90** projecting outwardly therefrom which may serve to connect the arrangement at one end thereof to one of the components to be moved and be held in adjusted position by the arrangement. An elongated displacement member in the form of a hollow piston rod **94** extends into the cylinder **88** and projects with one end thereof fluid-tightly sealed through and beyond the end cap at the right end of the cylinder **88**, as viewed in FIG. 8. The second partition means which divides the liquid chamber means into a first liquid chamber **3** adjacent the gas chamber **2** and a second liquid chamber **4** is constituted in the arrangement shown in FIG. 8 by a piston **92** fixed to the inner end of the piston rod **94**. The passage means which provide communication between the liquid chambers **3** and **4** are constituted in this case by bores **93** extending through the piston **92**. The control means for opening and closing the passage means **93** comprise a disc **99** extending radially beyond the bores **93** through the piston. In order to move the disc **99** from the position shown in FIG. 8 in axial direction away from the piston **92** a rod member **95** is provided which may have a circular cross section and which extends with a threaded portion **98** thereof through a correspondingly threaded central bore in the piston **92** and the rod member **95** is fixedly connected, for instance by a set screw, at the inner end thereof to the disc member **99**. The outer end of the rod **95** extends sealed by means of seals **96** through and beyond the outer end of the piston rod **94** and a handle or transverse bar **97** is connected to the outer end of the rod **95**. Turning of the rod **95** by means of the handle **97** in one or the other direction will cause axial movement of the disc **99** towards or away from the piston **92** to thereby open or close the passages **93** therethrough. When the passages are opened, the piston rod **94** and the piston **92** connected thereto may be moved relative to the cylinder means in the manner as described before, while when the passages **93** are closed, the piston rod and the cylinder means are locked with respect to each other in any adjusted position.

The arrangement only partly illustrated in FIG. 9 differs from that described above in connection with FIG. 8 only by the specific construction for opening and closing the passages **108** through the piston **107** which is fixedly connected to the inner end of the hollow piston rod **101**. In the construction shown in FIG. 9, the piston **107** is provided with a central threaded bore in which a correspondingly threaded bushing **103** threadingly engages, which is integral with a disc portion **102** extending radially over the bores **108** through the piston. Telescopically arranged within the hollow piston rod **101** is a rod member **104** of polygonal, for instance square, cross section and this rod **104** extends through an opening in the bushing **103** having a cross section corresponding to that of the rod **104**, whereas the inner end of the rod **104** is fixedly connected, for instance by welding, to a member **105** connecting adjacent ends of the cylinders **87** and **88** to each other. The transverse portion of the member **85** is formed with the opening **106** therethrough. A transverse lever or handle **100** is connected to the outer end of the piston rod **107** for turning the latter about its axis. When the piston rod **101** is turned about its axis while the valve member **102**, **103** is prevented from rotation by the engagement with the fixed rod **104**, the valve member and the piston **107** will be axially displaced with respect to each other so that, depending on the direction of rotation of the piston rod **102**, the disc portion **102** of the valve member will be moved toward or away from the piston **107** to open or close the passages **108** therethrough.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of fluid-operated extendable and contractable arrangements differing from the types described above.

While the invention has been illustrated and described as embodied in a fluid operated extendable and contractable arrangement, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A fluid-operated extendable and contractable arrangement comprising, in combination, cylinder means having opposite closed ends; movable partition means dividing said cylinder means into a gas chamber means and a liquid chamber means, the volume of said gas chamber means increasing and that of said liquid chamber means decreasing when said movable partition means moves in a first direction, and vice versa when said movable partition means moves in a second direction opposite to said first direction; a compressed gas filling said gas chamber means; an elongated displacement member extending into said liquid chamber means and having an inner end in said cylinder means and an opposite end portion projecting fluid tightly sealed through and beyond one end of said cylinder means; means connected to said elongated displacement member for preventing said inner end thereof to move beyond said one end of said cylinder means; a liquid filling the space in said liquid chamber means about said displacement member, said liquid being in pressure transmitting contact with said movable partition means, said displacement member being upon application of a predetermined pressure on said opposite end portion thereof movable in inward direction so as to contract said arrangement and so as to displace liquid in said liquid chamber means forcing thereby said movable partition to move in said second direction to thereby compress said gas in said gas chamber means to an increasing extent, and upon reduction of said predetermined pressure on said opposite end portion of said displacement member said increasingly compressed gas will act on said movable partition to move the latter in said first direction reducing thereby the volume of said liquid chamber means and forcing said displacement member in outward direction so as to extend said arrangement; second partition means between said inner end of said displacement member and said movable partition means and dividing said liquid chamber means into a first liquid chamber bordering on said movable partition means and a second liquid chamber into which said displacement member extends; passage means providing communication between said first and said second liquid chamber; and control means cooperating with said passage means for opening and closing the latter, whereby when said passage means are closed the liquid trapped in said first and said second liquid chamber will prevent movement of said displacement member in inward direction and movement of said movable partition means in said first direction so that the arrangement will be locked in any position it has been brought to while said passage means were open.

2. An arrangement as set forth in claim **1**, wherein said second partition means comprises a plate member fixed

to and extending transversely through said cylinder means.

3. An arrangement as set forth in claim 2, wherein said cylinder means is in the form of a single elongated cylinder, said second partition means is in the form of a plate member fixed to and extending transversely through said cylinder intermediate said opposite ends thereof and wherein said passage means includes at least a pair of bores through the wall of said cylinder spaced in axial direction thereof and respectively located at opposite sides of said plate member.

4. An arrangement as set forth in claim 3, wherein said control means includes a sleeve surrounding said cylinder in the region of said bores spaced from the outer surface of said cylinder and having at opposite ends thereof a pair of fluid tight seals engaging the outer surface of said cylinder and a third fluid tight seal spaced from one of said pair of seals a distance greater and from the other a distance smaller than the axial distance between said bores, said sleeve being axially movable between a first end position in which said third seal is located between said bores closing thereby said passage means and a second end position in which said bores are located between said one seal and said third seal so that said passage means are open.

5. An arrangement as set forth in claim 4, and including a pair of stop means on said cylinder and respectively engaging said sleeve in either of said end positions thereof.

6. An arrangement as set forth in claim 5, and including resilient means engaging said sleeve and biased to resiliently maintain the latter in said first end position.

7. An arrangement as set forth in claim 6, and including an operating member connected to said sleeve for moving the latter against said resilient means from said first to said second end position.

8. An arrangement as set forth in claim 2 wherein said passage means includes one bore extending in axial direction through said plate member and wherein said control means includes a closure movable in axial direction and cooperating with said bore for opening and closing the latter.

9. An arrangement as set forth in claim 8, wherein said cylinder means includes a pair of cylinders axially aligned with each other and movable in axial direction relative to each other, and wherein said plate member is fixed to one of said cylinders and said closure member to the other of said cylinders.

10. An arrangement as set forth in claim 9, wherein said closure member comprises a second plate member fixed to the other of said cylinders and formed with an opening therethrough laterally spaced from said bore, said second plate member being movable in axial direction with said other cylinder between a closed position engaging said plate member fixed to said one cylinder and an open position spaced therefrom.

11. An arrangement as set forth in claim 9, wherein said pair of cylinders are threadingly connected at adjacent ends thereof so that by turning one of said cylinders relative to the other said cylinders are moved in axial direction relative to each other.

12. An arrangement as set forth in claim 11, wherein said closure member includes a second plate member fixed to the other of said cylinders and formed with an opening therethrough transversely spaced from said bore and a conical projection fixed to said second plate member and movable with said other cylinder in and out of said bore.

13. An arrangement as set forth in claim 11, and including a transverse lever fixed to one of said cylinders for turning the same about its axis.

14. An arrangement as set forth in claim 1, wherein said movable partition means is in the form of a ball of elastic material fluid-tightly engaging the inner surface of said cylinder means.

15. An arrangement as set forth in claim 1, wherein said movable partition means is in the form of a flexible enclosure located in said first liquid chamber.

16. An arrangement as set forth in claim 8, wherein said elongated displacement member is hollow and including a rod member telescopically arranged in said hollow displacement member and operatively connected to said closure member for moving the latter.

17. An arrangement as set forth in claim 16, wherein said bore through said plate member is arranged laterally of the axis of said cylinder means and wherein said closure member includes a bushing threadingly engaged in a threaded central opening in said plate member and carrying at one end thereof integrally connected thereto a disc extending over said bore, said rod member being connected at an inner end thereof projecting beyond said hollow displacement member to said bushing.

18. An arrangement as set forth in claim 17, wherein said rod member and said displacement member are nonrotatably connected to each other and including a transverse lever fixed to said opposite end portion of said displacement member.

19. An arrangement as set forth in claim 1, wherein said means connected to said elongated displacement member comprises a piston fixed to said inner end of said elongated displacement member in sealing engagement with said cylinder means and being formed with a bore therethrough located laterally of the axis thereof.

20. An arrangement as set forth in claim 1, wherein said passage means includes one bore extending in axial direction through said plate member, wherein said control means includes a closure member movable in axial direction and cooperating with said bore for opening and closing the latter, wherein said elongated displacement member is hollow, and including a rod member telescopically arranged in said hollow displacement member and operatively connected to said closure member for moving the latter, and further including an additional closure member for closing said bore through said piston, and means coupling said closure members to each other.

21. An arrangement as set forth in claim 20, wherein said bores through said plate member and said piston are located laterally of the axis of said cylinder means and wherein each of said closure members includes a bushing threadingly engaged in a threaded central opening respectively provided in said plate member and said piston and each carrying at one end thereof integrally connected a disc extending over the respective bore, said rod member being connected at an inner end portion thereof projecting beyond said hollow displacement member to said bushings, and including stop means limiting turning of said bushings in opening and closing direction relative to said piston and said plate member.

22. An arrangement as set forth in claim 21, said stop means including a pair of projections projecting angularly spaced from each other in a radial direction from each of said discs, and a pin member fixed to and projecting in axial direction from said plate member and said piston respectively, and cooperating with said projections.

23. An arrangement as set forth in claim 22, wherein said rod member has a polygonal cross section and wherein said bushing in said piston is formed with a central opening of corresponding cross section through which said rod member extends.

24. An arrangement as set forth in claim 1, wherein said cylinder means comprises an outer cylinder and an inner cylinder coaxially arranged in said outer clyinder radially spaced therefrom, said movable partition means being formed by an annular piston located between and sealingly engaging said inner and said outer cylinder, and said displacement member extending into said inner cylinder through one end of said cylinder means.

25. An arrangement as set forth in claim 24, and including a cap closing the end of said outer cylinder opposite said one end of said cylinder means, said second partition means comprising a plate extending transversely

through the end of said inner cylinder facing said cap, said passage means including a central bore through said plate, and said control means including a valve member cooperating with the bore for opening and closing the latter.

26. An arrangement as set forth in claim **25**, wherein said cap is formed with a central stepped bore therethrough having an inner threaded portion of smaller diameter and wherein said valve member has a threaded portion threadingly engaged with said threaded inner portion of said bore and an outer portion of larger diameter axially spaced from said threaded portion thereof, and including sealing means about said valve member between said outer and said threaded portion thereof.

27. An arrangement as set forth in claim **26**, wherein said passage means includes at least one transverse bore through said plate member communicating at the inner end thereof with said central bore.

28. An arrangement as set forth in claim **1**, wherein said elongated displacement member is hollow, wherein said second partition means comprises a piston fixed to said one end of said displacement member, said passage means comprising at least one bore through said piston, said control means including a closure member cooperating with said bore for opening and closing the latter and an elongated rod member extending through said hollow displacement member and connected to said closure member for operating the latter.

29. An arrangement as set forth in claim **28**, wherein said bore is located laterally of the axis of said piston, said piston being formed with an additional threaded central opening therethrough, said rod member having adjacent one end thereof a threaded portion threadingly engaged in said threaded opening and extending with the other end thereof beyond said other end portion of said hollow elongated displacement member, said closure member comprising a disc fixed to said one end of member and extending radially over said bore, and including a transverse lever fixed to said other end of said rod member.

30. An arrangement as set forth in claim **28**, wherein said piston is formed with a threaded central opening, said closure member comprising a threaded bushing threadingly engaged in said threaded opening and a disc coaxially fixed to said bushing and extending over said bore, said rod member being fixed at the inner end thereof to said cylinder means and said bushing being non-rotatably connected to said rod member but slidably in longitudinal direction thereof.

31. An arrangement as set forth in claim **28**, wherein said cylinder means includes a cylinder portion of larger diameter and another cylinder portion of smaller diameter, said movable partition means being arranged in said large diameter cylinder portion and said piston slidingly engaging said other cylinder portion of smaller diameter.

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