(12) UK Patent Application (19) GB (11) 2 103 391 A

(21) Application No **8220841**
(22) Date of filing **19 Jul 1982**
(30) Priority data
(31) **8123517**
(32) **31 Jul 1981**
(33) **United Kingdom (GB)**
(43) Application published
16 Feb 1983
(51) **INT CL³**
F16K 31/08
(52) Domestic classification
G3P 11 1D 24KX 5
F2V S20
(56) Documents cited
GB 1444393
GB 01266237
GB 1207329
GB 0765352
(58) Field of search
F2V
G3P
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(54) **Servo operated fluid flow taps and valves**

(57) A servo operated fluid flow tap or valve including a flexible diaphragm (20) a central portion of which is closable onto a seating (16) surrounding a low pressure outlet and an outer part of which on that side which contacts the seating being subjected to inlet pressure at all times, the inlet pressure being able to communicate with a control chamber (24) on the other side of the diaphragm (20) by way of a restricted opening (26) and a pilot valve member (28) being provided for allowing fluid under pressure to escape from said control chamber (24) to cause the tap or valve to open, said pilot valve member being under the control of a control element (44). The control element is not directly connected to the pilot valve member but has magnetic attraction or repulsion relative thereto by means of magnet 40. The movement may be proportional, as shown, or on/off, Fig 2, (not shown) or flat operated, Fig 5, (not shown).

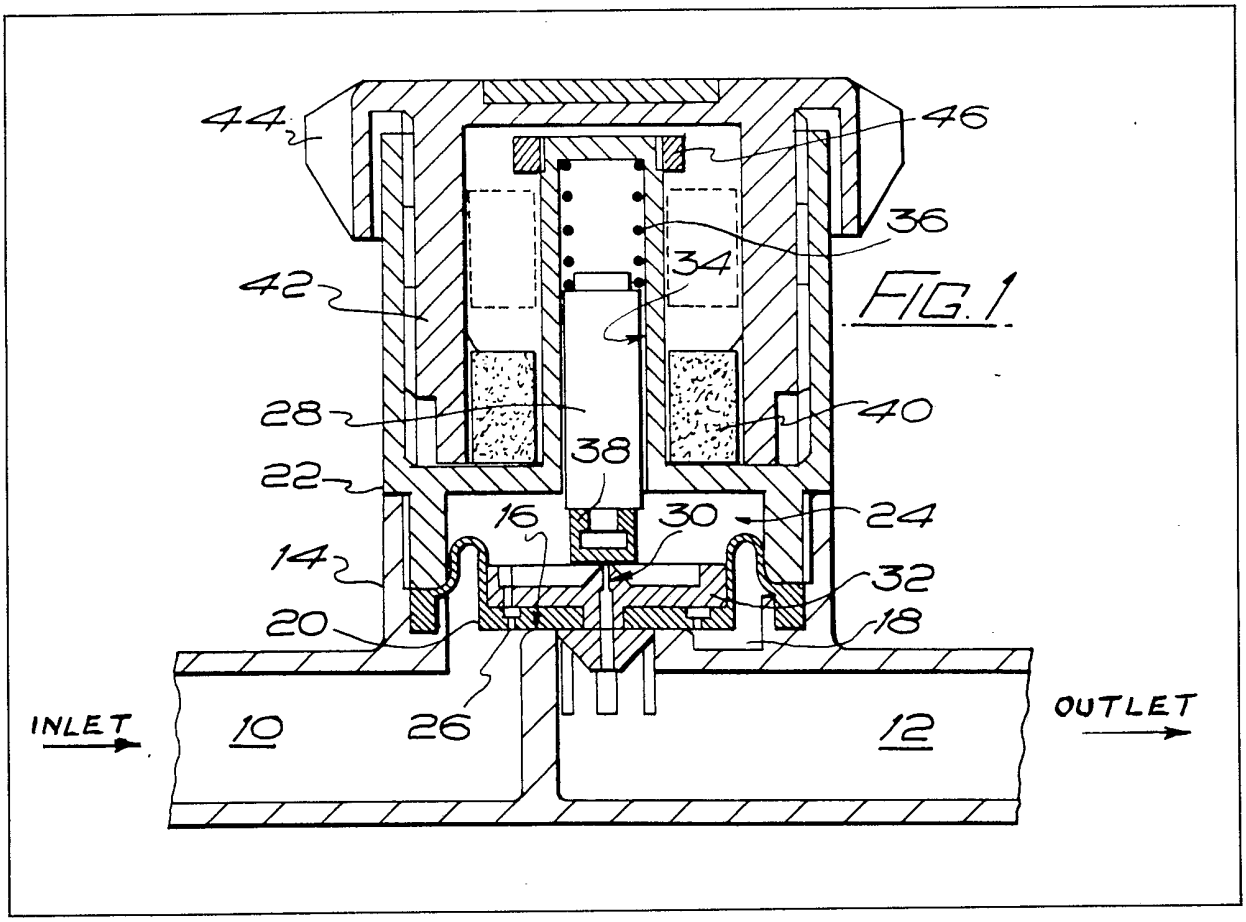

FIG. 1

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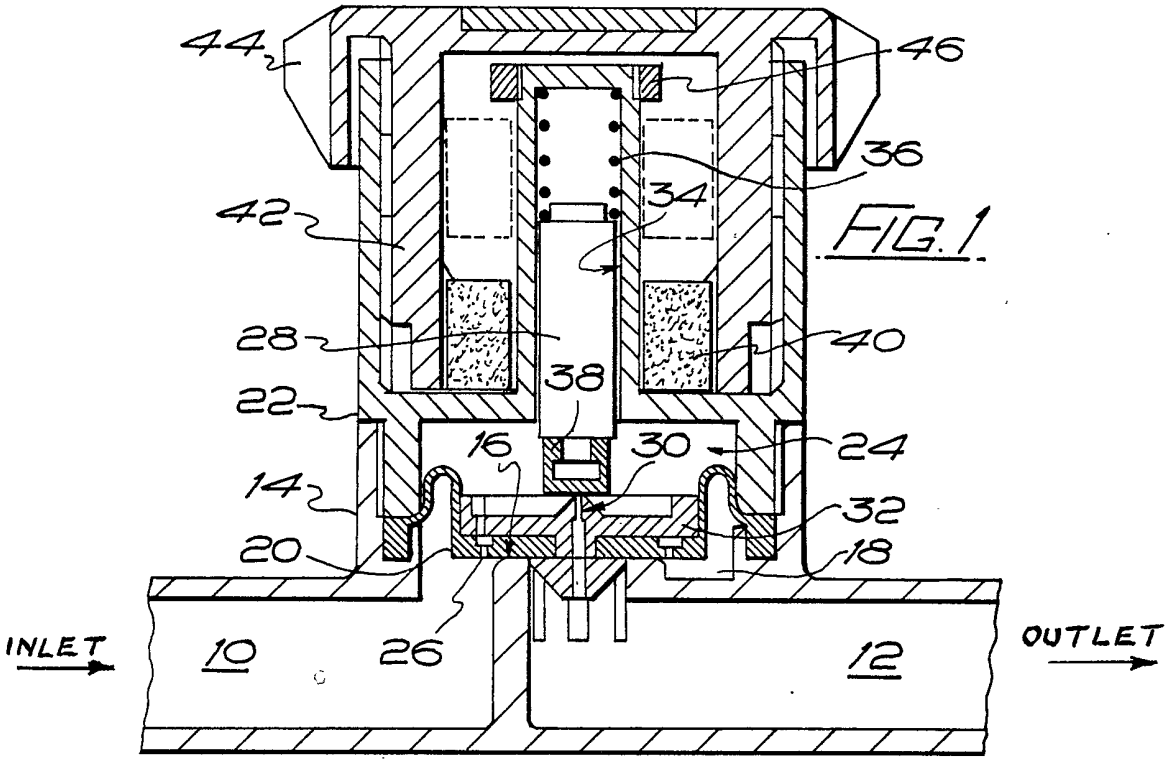
44
46
36
34
42
28
40
38
22
16
30
24
14
32
20
18
INLET
10
26
12
OUTLET

FIG. 1

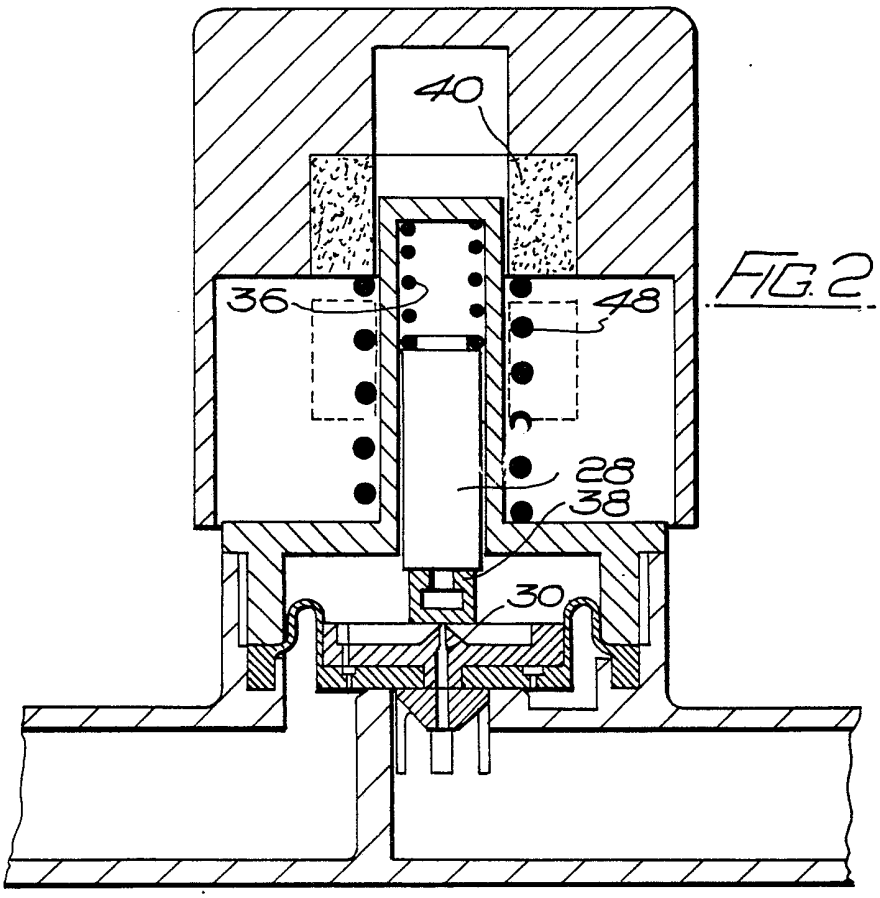
40
36
48
28
38
30

FIG. 2

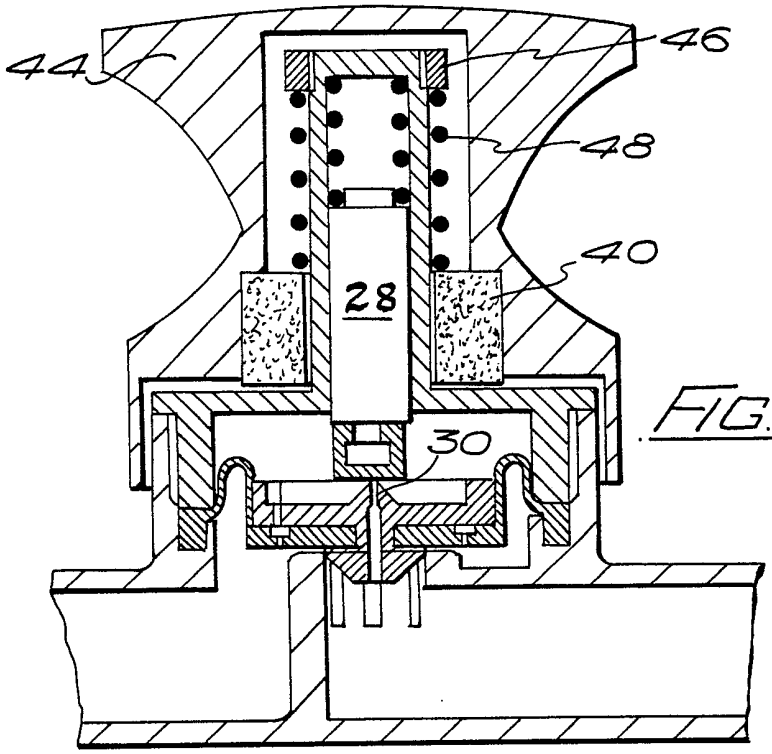

FIG. 3

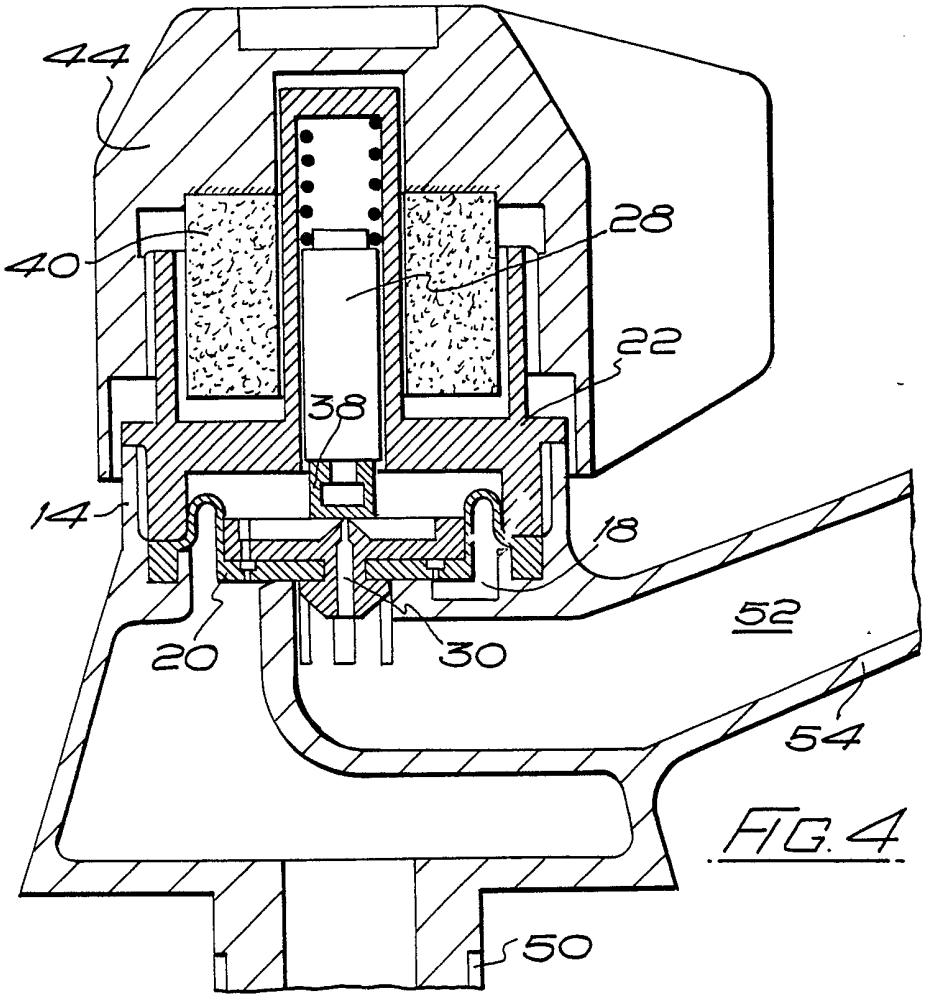

FIG. 4

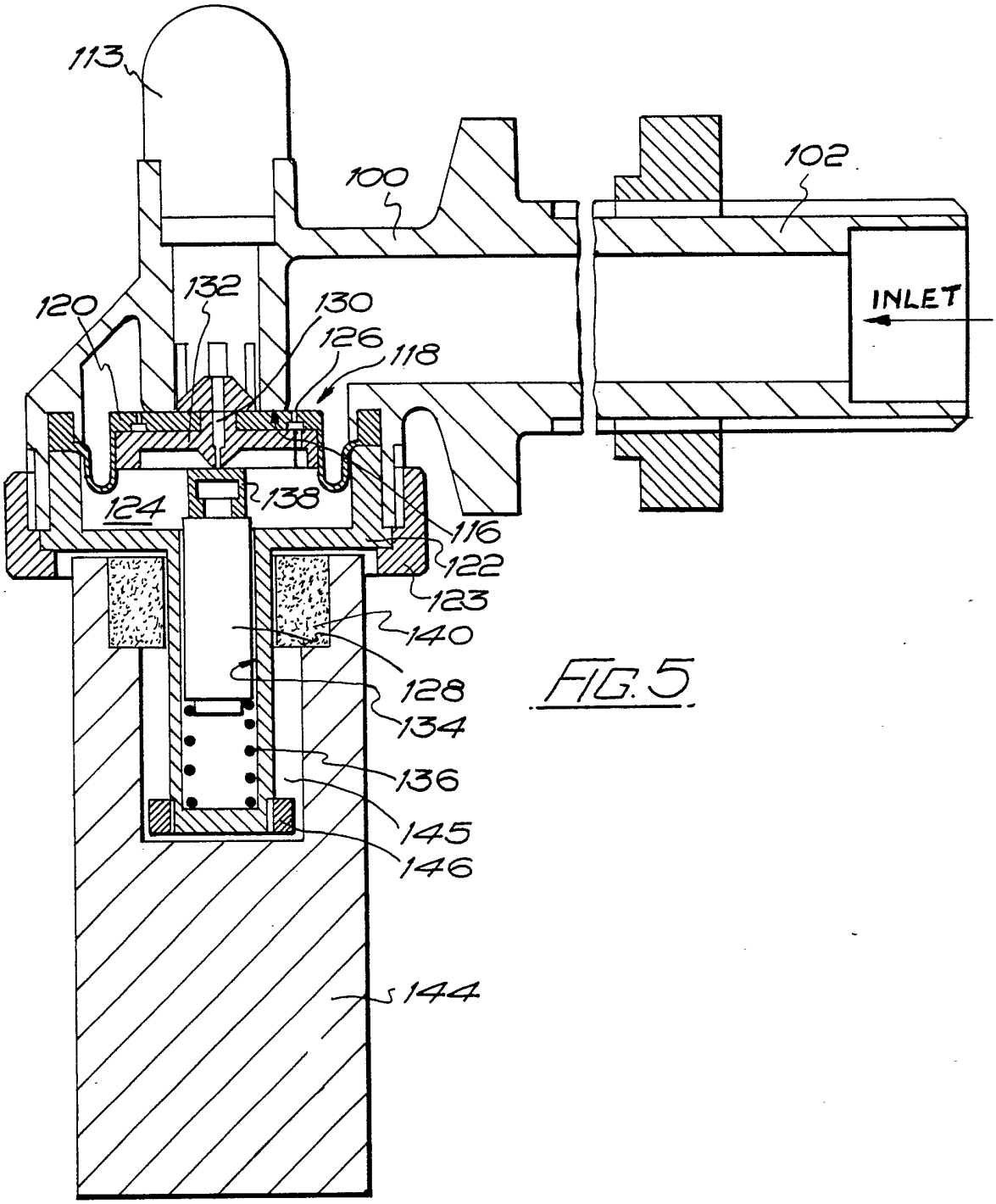
113
100
102
120
132
130
126
118
INLET
124
138
116
122
123
140
128
134
136
145
146
144

FIG. 5

SPECIFICATION

Servo operated fluid flow taps and valves

The invention relates to servo operated fluid flow taps and valves.

Servo operated fluid flow taps and valves are well known and are used both for industrial and domestic application, their great advantage being that the operating force required to open or close such a tap or valve is very small indeed. Certain taps and valves of this kind employ a flexible diaphragm a central portion of which is closable onto a seating surrounding a low pressure outlet. An outer part of the diaphragm on that side which contacts the seating remains subjected to inlet pressure at all times and inlet pressure can communicate with a control chamber on the other side of the diaphragm by way of a restricted opening, conveniently by means of a restricted opening through the diaphragm. The arrangement is such that inlet pressure acting within said control chamber tends to close the flexible diaphragm onto its seating until pressure is allowed to escape from the control chamber at a rate greater than the flow of fluid into the said chamber through the restricted opening. When this happens the flexible diaphragm is able to move away from its seating so that high pressure fluid is able to flow from the inlet to the outlet. It has in one instance previously been arranged for the pressure to be allowed to escape from the control chamber, in effect directly into the outlet; this has then caused the flexible diaphragm to move to its fully open position. In another instance, the pressure has been allowed to escape from the control chamber through a bleed hole in the flexible diaphragm, said bleed hole normally being closed by a pilot valve member movable withian the control chamber. The arrangement in this case is such that the flexible diaphragm is caused to follow the movement of the pilot valve member and to be displaced from its seat through only the distance by which the pilot valve is moved. Consequently, the flow of fluid through the tap or valve is able to be closely controlled by adjustment of the pilot valve member. Such an arrangement, that is to say one which is capable of flow control adjustment, is often to be preferred but in previously known arrangements the manner in which the pilot valve member has been mounted and been made capable of being moved has been unduly complex.

The invention aims to provide a servo operated fluid flow tap or valve of relatively simple construction. In a preferred form of the invention the tap or valve is capable of flow control adjustment.

According to the invention there is provided a servo operated fluid flow tap or valve having a flexible diaphragm a central portion of which is closable onto a seating surrounding a low pressure outlet, an outer part of said diaphragm on that side which contacts the seating remaining subjected to inlet pressure at all times and inlet pressure being able to communicate with a control chamber on the other side of the diaphragm by way of a restricted opening, means being provided for allowing fluid under pressure to escape from said control chamber to cause the tap or valve to open, said means being constituted by a pilot valve member movable within the control chamber and capable of closing a bleed hole in the central portion of the diaphragm, mechanism which is provided for moving said pilot valve member within the control chamber including a control element not directly connected to said pilot valve member but having magnetic attraction or repulsion relative to said valve member or relative to a carrier member therefor, whereby the pilot valve member is caused to move in response to movements of said control element. Preferably, inlet pressure will be able to communicate with the control chamber by way of a small hole in the diaphragm. The pilot valve member may be slidably mounted for movement towards and away from the diaphragm, and may be urged towards the diaphragm by a spring.

The control element will preferably be an annular magnet loosely encircling a portion of the tap or valve within which the pilot valve member is movable. In this case, said annular magnet may be carried by a handle having screwthreaded engagement with a head part of the tap or valve, the arrangement being such that the pilot valve member follows adjustment movements of the handle. On the other hand, the annular magnet may be carried by a handle which is slidably adjustable against the force of a spring. The handle may be capable of being manually depressed to bring the magnet to a position in which it is able to attract the pilot valve member, the latter thereby opening the bleed hole in the diaphragm and causing the tap or valve to open, the arrangement being such that when the handle is released it returns to a raised position under the action of the spring, the magnet thereby being brought to a position in which it is no longer able to attract the pilot valve member, the latter then falling back to a position in which it closes the bleed hole in the diaphragm and causes the tap or valve to close. On the other hand, the handle may be capable of being manually raised so that the pilot valve member follows the movement of the magnet carried by said handle, the pilot valve member thereby opening the bleed hole in the diaphragm and causing the tap or valve to open, the arrangement being such that when the handle is released it falls back to its lower position and the pilot valve member closes the bleed hole in the diaphragm and causes the tap or valve to close.

In an alternative arrangement, the valve may be a valve of the kind used for controlling the level of water in a domestic water tank and in this case the control element having magnetic attraction or repulsion relative to the pilot valve member will be carried by a float element.

In order that the invention may be fully understood and readily carried into effect, the same will now be described, by way of example only, with reference to the accompanying drawings, of which:-

Figure 1 is a semi-diagrammatic sectional view of a fluid flow valve embodying the invention,

Figures 2 and *3* are views similar to Figure 1 and illustrating possible modifications of the valve.

Figure 4 is a sectional view which illustrates the

application of the invention to a pillar tap, and

Figure 5 is a sectional view which shows the application of the invention to a liquid level control valve.

Referring now to Figure 1 of the drawings, the valve there illustrated is provided with aligned flow passages, that is to say a high presure inlet end 10 and a relatively low pressure outlet end 12. The valve includes an upstanding cylindrical main body part 14 in a lower portion of which is formed a relatively small annular seating 16, that is to say small in relation to the diameter of the body part. The seating 16 surrounds a low pressure outlet communicating with the low pressure outlet end of the pipeline. An annular space 18 surrounding the seating 16 is in communication with the high pressure inlet end of the pipeline.

A flexible diaphragm 20 is located in the lower portion of the body part 14, a peripheral edge portion of the diaphragm being clamped in position by a valve head part 22 a screwthreaded lower portion of which has threaded engagement within said body part. A central portion of the diaphragm is closable onto the seating 16, as shown.

A space immediately overlying the flexible diaphragm, and formed by a cavity in the underside of the valve head part 22, constitutes a control chamber 24 with which inlet pressure from the high pressure inlet end 10 of the flow passage can communicate by way of a restricted opening, that is to say by way of a small hole 26 in the diaphragm. The arrangement is such that, when the valve is closed as shown in Figure 1, the diaphragm is held against its seating by differential pressure, that is to say by the fact that the areas of the diaphragm against which high pressure fluid is able to act are substantially different, the area above the diaphragm being substantially the whole area thereof whilst the effective area beneath the diaphragm is the area of the annular space 18 surrounding the seating 16. This will of course continue until fluid under pressure is allowed to escape from the control chamber at a rate greater than can flow into said chamber through the small hole 26.

Means which are provided for allowing the escape of fluid under pressure from the control chamber to cause the valve to open include a pilot valve member 28 made of ferrous metal and movable within the control chamber in such a way that it is capable of closing a bleed hole 30 in the central portion of the diaphragm. (The bleed hole 30 is actually formed in a central stiffening disc element 32 carried by the diaphragm). The pilot valve member is slidably mounted in an upwardly extending blind bore 34 of the valve head part 22. It is urged downwardly by a light coil spring 36 and carries at its lower end a resilient seal element 38 which is arranged to contact an upstanding central portion of the disc element 32 to close the bleed hole 30.

Mechanism which is provided for moving the pilot valve member within the control chamber includes a control element not directly connected to said pilot valve member, that is to say an annular magnet 40 loosely encircling an upstanding central pillar position of the valve head part within which the blind bore 34 is formed. The annular magnet is carried within the lower end of a depending sleeve portion 42 of a handle 44, said sleeve portion having screwthreaded engagement with a screwthread formed within an upstanding outer sleeve portion of the valve head part. The arrangement is such that as the handle is rotated in the appropriate direction the annular magnet is moved up or down as required, upward movement of the magnet being limited by a stop member in the form of a nut 46 which is secured on a screwthreaded upper end of the central pillar portion of the valve head part. Since there is magnetic attraction between the magnet and the pilot valve member, the latter follows the movement of the magnet.

By virtue of the fact that the valve is servo operated, very little force is required to turn the handle in either direction. It will also be understood that since there is no physical connection between the pilot valve member and the mechanism for moving it, leakage of fluid from the valve is very unlikely; the only fluid seal required is that formed at the periphery of the flexible diaphragm and this is a fixed seal and not one which needs to allow relative movement between adjacent parts. Consequently, it can be very tightly clamped and is virtually certain to maintain a leak proof seal throughout the working life of the valve even though very high hydraulic pressures may be involved.

Referring now to Figure 2, in a modification of the valve just described the annular magnet is shown to be located at a somewhat higher position within the handle 44 and the latter is slidably mounted relative to the upstanding central pillar portion of the valve head part. The valve head part is in this case devoid of the outer sleeve portion within which the handle of the first described embodiment was screwthreaded. The handle in this case is capable of being manually depressed against the force of a relatively strong spring 48 to bring the magnet to the position in which it is shown in chain-dotted lines. In this depressed position the magnet is able to attract the pilot valve member 28, against the force of spring 36 which in turn lifts the resilient seal element 38 away from the bleed hole 30 in th disc element 32 of the diaphragm. Consequently, fluid under pressure is able to flow from the control chamber through the bleed hole 30 to unbalance the diaphragm and the valve is caused to open fully.

When the handle is subsequently released, it is returned by the spring 48 to its previously raised position and raises the magnet to the position in which it is shown in full lines in Figure 2. (Means which will be provided for limiting the upward movement of the handle are not shown in the drawing but such means could in fact take various forms). In this raised position, the magnet is unable to continue to attract the pilot valve member 28 and the latter is able to fall under its own weight and aided by the force of spring 36. The resilient seal 38 thereupon closes the bleed hole 30 and the consequent build up of pressure in the control chamber causes the valve to close.

In Figure 3 there is illustrated a valve very similar to that just described in that the handle is manually

slidable. In this case, however, it is normally held in its depressed condition by the force of spring 48 (which in this case reacts against the nut 46 secured at the upper end of the central pillar portion of the valve head part). When the user wishes to open the valve, he manually raises the handle against the force of the spring 48 and the pilot valve member 28 follows the movement of the magnet. It will be understood that in this case, unlike the valve illustrated in Figure 2, there is a degree of volume according to how much lift is imparted to the handle. When the handle is released it immediately returns to its lower position. The pilot valve member then returns to its lower position, under its own weight and assisted by the force of spring 48, closing the bleed hole 39 and thereby causing the valve to close.

In Figure 4 there is illustrated a pillar type tap to which the invention has been applied. The functional parts of the tap are substantially the same as those of the valve illustrated in Figure 1 and the same reference numerals have been used to denote like parts. (The only difference, and one which does not affect the functioning of the tap, is that the handle has screwthreaded connection on the outside of the upstanding sleeve portion rather than on its inside). Consequently, the functioning of the tap does not need to be described. It will be seen that what is the upstream high pressure side of the tap is a cored part of the main body which communicates with an inlet flow passage through a screwthreaded adaptor 50. The downstream low pressure side of the tap communicates with a cored flow passage 52 extending through a spout 54 which is formed integrally with the main body. It will of course be understood that, alternatively, the tap could have been provided with the same functional parts as the valve illustrated in Figure 2 or with the same functional parts as the valve illustrated in Figure 3.

Referring now to Figure 5, the invention is shown applied to a liquid level control valve of the kind which might be used for controlling the level of water in a domestic water tank. The valve, which is shown in vertical section, comprises a body 100 formed integrally at one end with an inlet pipe 102 by means of which it can be secured in normal manner to the side wall of a water tank and connected to a water supply. At its other end, the body is provided with a part defining a valve seating 116 surrounded by an annular space 118 with which the supply water communicates.

A flexible diaphragm 120 is located in position within a downwardly extending cylindrical portion of the body, a peripheral edge portion of the diaphragm being clamped in position by a depending plug element 122 an upper end of which has a part in register with the cylindrical part of the body. A screwthreaded annular nut 123 engages a screwthread on the outer periphery of the cylindrical part of the body and acts against the upper part of the depending plug element to force the latter against the peripheral edge portion of the diaphragm. A central portion of the diaphragm is closable onto the valve seating 116 as shown.

A space immediately beneath the flexible diaphragm, and formed by a cavity in the upper part of the depending plug element 122 constitutes a control chamber 124 with which water supply pressure can communicate by way of a restricted opening, that is to say by way of a small hole 126 in the diaphragm. The arrangement is such that, when the valve is closed as shown in the drawing, the diaphragm is held against its seating by differential pressure, that is to say by the fact that the areas of the diaphragm against which water supply pressure is able to act are substantially different, the area beneath the diaphragm being substantially the whole area thereof whilst the effective area above the diaphragm is the area of the annular space 118 surrounding the seating 116. This will of course continue until water pressure is allowed to escape from the control chamber at a rate greater than can flow into said chamber through the small hole 126.

Means which are provided for allowing the escape of water pressure from the control chamber to cause the valve to open include a pilot valve member 128 made of ferrous metal and movable within the control chamber in such a way that it is capable of closing a bleed hole 130 in the central portion of the diaphragm (or more correctly in a central stiffening disc 132 carried by the diaphragm). The pilot valve member is slidably mounted in a downwardly extending blind bore 134 of the depending plug element 122. It is urged upwardly by a light coil spring 136 and carries at its upper end a resilient element 138 which is arranged to contact a downwardly extending central portion of the disc element 132 to close the bleed hole 130.

Means which are provided for moving the pilot valve member within the control chamber includes a control element not directly connected to said pilot valve member, that is to say an annular magnet 140 loosely encircling a downwardly projecting central shaft portion of the depending plug element 122 within which the blind bore 134 is formed. The annular magnet is carried, as shown, at the upper end of a float element 144 provided with an internal cavity 145 into which the downwardly projecting central shaft portion of the depending plug element 122 extends. The arrangement is such that as the water level in the tank drops the float moves downwards relative to said central shaft portion, the latter carrying a nut 146 at its lower end to limit the downward movement of the float. Since there is magnetic attraction between the magnet and the pilot valve member, the latter follows the movement of the magnet. Downward movement of the pilot valve member away from the diaphragm causes the latter to be unseated and water can flow from the inlet into the tank concerned by way of an anti-syphon delivery tube 113 which is connected into an upper part of the body as shown. (The anti-syphon tube is in the nature of an inverted U-tube provided with any of the known means for "breaking" a syphon). When the pre-determined required level of water in the tank has been re-established, the closure of the bleed hole 130 in the diaphragm by the pilot valve member causes the latter to close upon its seat.

The advantages of a float valve as described are as follows:-

1. It is more compact in size than float valves of conventional construction, this being due mainly to the fact that the float hangs vertically downwards instead of being carried by a pivotally mounted arm.

2. All water delivery to the tank is by way of the anti-syphon delivery tube so that noise created by fine jets of water from other sources is avoided.

3. The valve is held fully open until the required water level has almost been achieved.

Various other modifications may be made. For example, it will be understood that in any of the various constructions described above the pilot valve member could be made of magnetic material and the annular member the movement of which is arranged to move the pilot valve member could then be made of non-magnetised ferrous metal. Alternatively, both of these elements could be magnetic and be arranged so that they mutually attract (or indeed be arranged so that they mutually repel each other, but it will be understood that in this case the valve concerned will only be capable of being either fully open or fully closed).

An important advantage of any valve embodying the invention is that it gives a measure of protection against concussion or water hammer. The speed of reaction when either opening or closing can of course be determined by the sizes of the restricted openings through the diaphragm. The restricted opening from the pressure side of the valve into the control chamber need not necessarily be provided by a small hole in the diaphragm; it could conceivably be provided by a restricted channel in the body of the valve, although this would then probably require additional sealing means to guard against leakage.

CLAIMS

1. A servo operated fluid flow tap or valve having a flexible diaphragm a central portion of which is closable onto a seating surrounding a low pressure outlet, an outer part of said diaphragm on that side which contacts the seating remaining subjected to inlet pressure at all times and inlet pressure being able to communicate with a control chamber on the other side of the diaphragm by way of a restricted opening, means being provided for allowing fluid under pressure to escape from said control chamber to cause the tap or valve to open, said means being constituted by a pilot valve member movable within the control chamber and capable of closing a bleed hole in the central portion of the diaphragm, mechanism which is provided for moving said pilot valve member within the control chamber including a control element not directly connected to said pilot valve member but having magnetic attraction or repulsion relative to said valve member or relative to a carrier member therefor, whereby the pilot valve member is caused to move in response to movements of said control element.

2. A servo operated fluid flow tap or valve according to claim 1, in which inlet pressure is able to communicate with the control chamber by way of a small hole in the diaphragm.

3. A servo operated fluid flow tap or valve according to either one of the preceding claims, in which the pilot valve member is slidably mounted for movement towards and away from the diaphragm.

4. A servo operated fluid flow tap or valve according to any one of the preceding claims, in which the pilot valve member is urged towards the diaphragm by a spring.

5. A servo operated fluid flow tap or valve according to any one of the preceding claims, in which the control element is an annular magnet loosely encircling a portion of the tap or valve within which the pilot valve member is movable.

6. A servo operated fluid flow tap or valve according to claim 5, in which the annular magnet is carried by a handle having screwthreaded engagement with a head part of the tap or valve, the arrangement being such that the pilot valve member follows adjustment movements of the handle.

7. A servo operated fluid flow tap or valve according to any one of claims 1 to 5, in which the annular magnet is carried by a handle which is slidably adjustable against the force of a spring.

8. A servo operated fluid flow tap or valve according to claim 7, in which the handle is capable of being manually depressed to bring the magnet to a position in which it is able to attract the pilot valve member, the latter thereby opening the bleed hole in the diaphragm and causing the tap or valve to open, the arrangement being such that when the handle is released it returns to a raised position under the action of the spring, the magnet thereby being brought to a position in which it is no longer able to attract the pilot valve member, the latter then falling back to a position in which it closes the bleed hole in the diaphragm and causes the tap or valve to close.

9. A servo operated fluid flow tap or valve according to claim 7, in which the handle is capable of being manually raised so that the pilot valve member follows the movement of the magnet carried by said handle, the pilot valve member thereby opening the bleed hole in the diaphragm and causing the tap or valve to open, the arrangement being such that when the handle is released it falls back to its lower position and the pilot valve member closes the bleed hole in the diaphragm and causes the tap or valve to close.

10. A servo operated fluid flow valve according to any one of claims 1 to 5, being a valve of the kind used for controlling the level of water in a domestic water tank, in which the control element having magnetic attraction or repulsion relative to the pilot valve member is carried by a float element.

11. A servo operated fluid flow tap or valve constructed, arranged and adapted to operate substantially as hereinbefore described with reference to and as illustrated by the accompanying drawings.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1983.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.