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[54] ELECTROMAGNETICALLY OPERATED VALVE WITH TWO SEATS

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **137/625.65,** 251/50

[51] **Int. Cl.** **F16k 31/06**

[58] **Field of Search** 137/625.65, 625.64, 625.67, 137/625.66; 251/138, 129, 50

[56] **References Cited**

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[57] **ABSTRACT**

An electromagnetically operated valve wherein a spherical valve member normally engages one of two seats to thereby connect a port for spent fluid with a port which is connected with a consumer of pressurized fluid. The valve member is held in such position by the plunger of an armature which is accommodated in a fluid-filled chamber provided in the valve housing and communicating with a fluid-admitting port. When the winding of the electromagnet is energized, the plunger is retracted to permit movement of the valve member into engagement with the other seat whereby the port which is connected to the consumer communicates with the fluid-admitting port. The plunger can be held in a position in which the valve member engages the one seat by fluid pressure in the chamber and/or by a spring.

7 Claims, 2 Drawing Figures

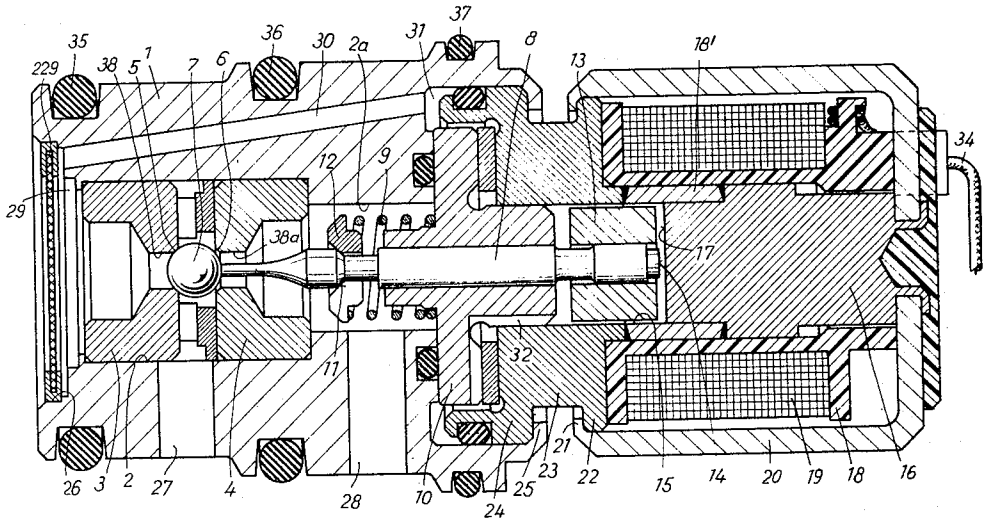

Fig. 1

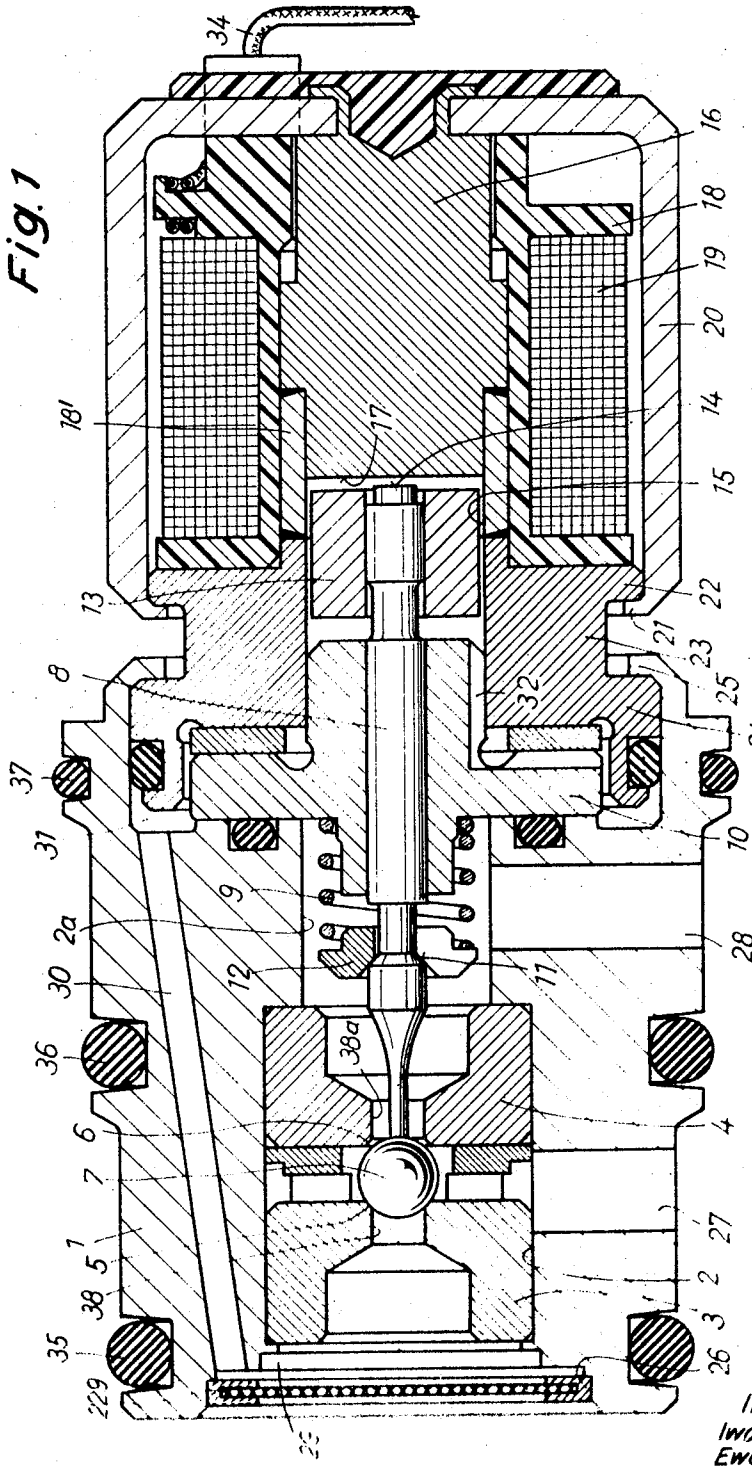

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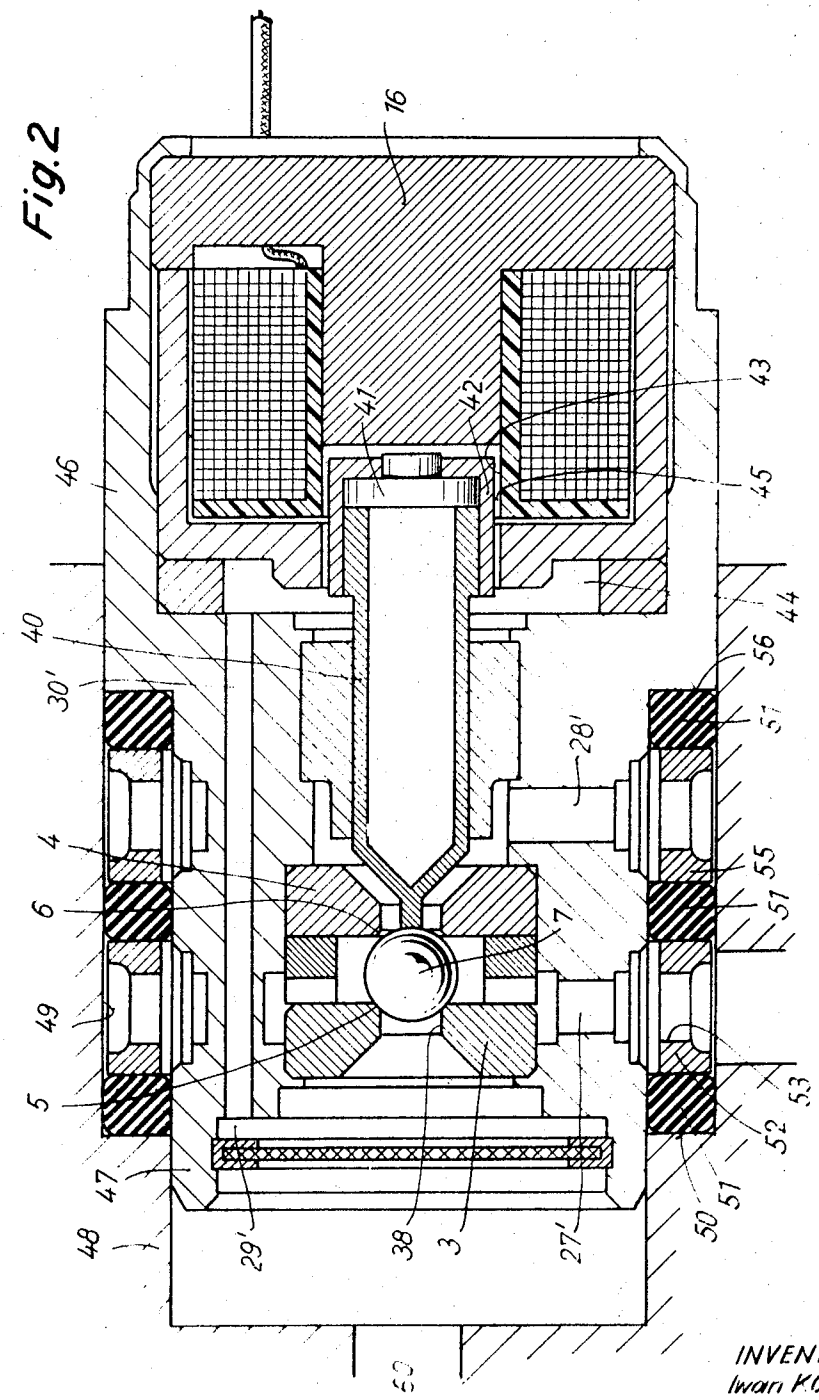
Fig. 2



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ELECTROMAGNETICALLY OPERATED VALVE WITH TWO SEATS

BACKGROUND OF THE INVENTION

The present invention relates to valves in general, and more particularly to improvements in electromagnetically operated valves of the type wherein the valve member is movable between two seats.

An electromagnetically operated valve with two seats is disclosed in Swiss patent No. 416,252. The patented valve comprises a valve member which is movable between the two seats and a polarized electromagnet which is outwardly adjacent to the housing of the valve and is energizable to move the valve member to one of its positions. A drawback of such valves is that the plunger which effects movements of the valve member must be machined with a high degree of precision and that the housing of the valve must be provided with accurately machined guide surfaces for the plunger in order to avoid jamming. Such precise finish of the plunger and of guide surfaces involves considerable expenses. Moreover, the plunger is rather bulky and has a relatively large surface for action of pressurized fluid; therefore, the frequency at which the valve member can move between its positions is rather low.

SUMMARY OF THE INVENTION

An object of the invention is to provide an electromagnetically operated valve with two seats wherein the valve member is movable at a high frequency, wherein the means for effecting movements of the valve member between its positions need not be machined or finished with a high degree of precision but are still capable of operating without jamming, and wherein the parts which are used to effect movements of the valve member are properly lubricated at all times.

Another object of the invention is to provide a novel and improved construction and mounting for an electromagnet which is used to effect movements of the valve member between two valve seats.

A further object of the invention is to provide a valve wherein the ports of the valve housing are sealed in a novel and improved way.

The improved electromagnetically operated valve comprises a housing including two seats and having first, second and third ports one of which is connected with a source of pressurized fluid, a fluid-filled internal chamber provided in the housing and communicating with the one port, a valve member disposed intermediate the seats and movable between a first position in which it engages one of the seats to thereby connect the first and second ports (e.g., to connect the port which supplies pressurized fluid to a consumer with the port which returns spent fluid from the consumer to a tank) and a second position in which the valve member engages the other seat to thereby connect the first or second port with the third port (e.g., to connect the port which is connected with the source of pressurized fluid with the port which conveys such fluid to the consumer), and an electromagnet including an armature which is reciprocable, preferably with at least some clearance, in the fluid filled chamber of the housing and normally holds the valve member in engagement with the one seat. The electromagnet further comprises winding means which is energizable at frequent or less frequent intervals to thereby effect movement of the armature so that the valve member can move into engagement with the other seat, e.g., in response to fluid pressure.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved valve itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an axial sectional view of an electromagnetically operated valve with two seats which embodies one form of the invention; and

FIG. 2 is a similar sectional view of a second valve.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1, there is shown an electromagnetically operated valve which comprises a housing including a valve body 1 and two coaxial seats 3, 4 mounted in an axial bore 2 of the body 1. The seats 3 and 4 are spaced from each other in the axial direction of the body 1 and are provided with concave sealing surfaces 5, 6 disposed at the axial ends of two bores 38, 38*a*. A spherical valve member or stopper 7 is disposed between the seats 3, 4 and is normally biased against the sealing surface 5 to thereby permit communication between a first radial port 27 of the housing and a second radial port 28 as well as to seal the ports 27, 28 from an axial fluid-admitting third port 29. The latter is connected with a pump (not shown) or another suitable source of pressurized fluid, e.g., oil. The valve member 7 is held in the illustrated first position by the plunger 8 of a reciprocable armature which forms part of an electromagnet and is movable axially of the housing 1. The plunger 8 is slidable in an annular guide member or bearing 10 which is fixedly mounted in the housing and serves as a retainer for one end of a helical spring 9 which bears against a collar 12 abutting against a conical shoulder 11 on the plunger. The spring 9 reacts against the guide member 10 and urges the plunger 8 axially toward the port 29 whereby the left-hand end face of the plunger maintains the valve member 7 in sealing engagement with the surface 5 of the left-hand seat 3. The guide member 10 consists of nonmagnetic material and the spring 9 is accommodated in a smaller diameter portion 2*a* of the axial bore in the body 1.

The armature further comprises a ring-shaped element 13 of magnetizable material which is fixedly secured to the right-hand portion of the plunger 8 and is received with clearance in an axially extending fluid-filled chamber 15 of the valve housing. The right-hand end face 14 of the plunger 8 extends slightly beyond the element 13 and abuts against the adjacent face 17 of a core 16 when the armature is moved axially from the illustrated extended position to a retracted position in which the plunger 8 is slightly spaced from the valve member 7 even if the latter abuts against the sealing surface 6 of the right-hand seat 4. The electromagnet further comprises a yoke 18 for windings 19. The yoke 18 surrounds the core 16. A portion of the core 16 is surrounded by a sleeve 18′ of nonmagnetic material which serves as a means for preventing escape of fluid from the chamber 15, namely, along the right-hand end face of the guide member 10. The housing of the valve further includes a cupped shell 20 which surrounds the parts 16, 18 and 19 of the electromagnet. The shell 20 has an inturned collar 21 which overlies a shoulder 22 provided on an annular coupling member 23 which forms part of the housing and has a second annular shoulder 24 overlapped by an inturned collar 25 of the body 1.

An enlarged portion 26 of the port 29 accommodates a filter 229 for the fluid which is delivered to the housing from the source. The port 27 is connected with one or more consumers of pressurized fluid and the port 28 is connected with a tank or another receptacle for spent fluid. The chamber 15 receives pressurized fluid from the port 29 by way of a channel 30 in the body 1, a ring-shaped space 31 which surrounds the guide member 10, and an axially parallel groove 32 machined into the guide member. The windings 19 of the electromagnet in the shell 20 are connected with an energy source by way of conductors 34.

The body 1 is provided with circumferential grooves for elastic sealing rings 35, 36, 37 and is sealingly received in a valve block, not shown. The diameter of the bore 38 in the seat 3 equals the diameter of the plunger 8.

The fluid which enters the body 1 by way of the port 29 fills the bore 38 and exerts pressure against the valve member 7 which engages the surface 5 of the seat 3. Such fluid also fills the channel 30, space 31, groove 32 and chamber 15 to exert pressure against the right-hand end face 14 of the plunger 8. This insures a complete balance of hydraulic forces which act on the valve member 7 and plunger 8. Consequently, a relatively weak spring 9 suffices to maintain the valve member 7 in the illustrated position.

When the winding 19 of the electromagnet is energized, the ring-shaped element 13 is attracted by the core 16 so that the end face 14 of the plunger 8 abuts against the face 17. The fluid pressure in the bore 38 of the seat 3 then causes the valve member 7 to engage the surface 6 of the seat 4 and to permit communication between the ports 27, 29 which are then sealed from the port 28. Since the face 17 of the core is engaged only by the end face 14 of the plunger 14, the armature is not likely to stick in its retracted position so that the spring 9 can immediately expand as soon as the circuit of the windings 19 is interrupted. The axial length of the plunger 8 is such that, when the end face 14 abuts against the face 17 of the core 16, the left-hand end face of the plunger is slightly spaced from the valve member 7 even when the latter engages the surface 6 of the seat 4. The armature 8, 13 is of lightweight construction so that it can be moved back and forth at a high frequency. Such high-frequency operation is further enhanced by the fact that, when the electromagnet is deenergized, the hydraulic forces acting on the valve member 7 are balanced by hydraulic forces acting on the plunger 8. Consequently, a relatively weak electromagnet and a relatively weak spring 9 will suffice to effect movements of the valve member 7 between the seats 3 and 4. The stroke of the plunger 8 is preferably short, i.e., the valve member 7 must cover a short distance to move from engagement with the surface 5 into engagement with the surface 6 or vice versa.

FIG. 2 shows a second valve which employs a hollow plunger 40 having a diameter which exceeds substantially the diameter of the bore 38 in the seat 3. A hollow plunger is preferred in order to reduce the mass of the armature. The right-hand end of the plunger 40 is sealed by a disk 1 received in a cap 42 of magnetizable material. This cap is received in a fluid-filled chamber 43 of the valve housing 46. The annular clearance between the peripheral surface of the cap 42 and the surface surrounding the chamber 43 is shown at 45. The clearance 45 connects the chamber 43 with an annular space 44 which communicates with the fluid-admitting port 29' by way of the channel 30' in the valve housing 46. The latter includes a cylindrical extension 47 received in a compartment 49 defined by an enclosure 48, e.g., a valve block. The enclosure 48 has an internal shoulder 50 engaging an elastically deformable sealing ring 51. Two additional sealing rings 51 are installed in the compartment 49 and one thereof engages a shoulder 56 of the housing 46. The leftmost sealing ring 51 is adjacent to a steel ring 52 having passages 53 in communication with the port 27' in the extension 47. A second steel ring 55 is disposed between the two right-hand sealing rings 51 and is provided with passages communicating with the port 28'. The rings 51 are subjected to at least some deforming stresses to insure a satisfactory sealing action. Since the effective area of the right-hand end face of the armature exceeds the diameter of the bore 38 in the seat 3, the plunger 40 normally maintains the valve member 7 in engagement with the surface 5. When the windings of the electromagnet are energized, the core 16 attracts the cap 42 and the fluid pressure in the bore 38 causes the valve member 7 to move against the surface 6 of the right-hand seat 4. Thus, the armature acts not unlike a differential piston and automatically holds the valve member 7 in the illustrated lefthand end position when the windings of the electromagnet are deenergized. Therefore, the valve spring 9 of FIG. 1 can be dispensed with. The port 29' of the extension 47 communicates with a conduit 60 in the enclosure 48; the conduit 60 is connected with the source of pressurized fluid.

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 which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

We claim:

1. An electromagnetically operated valve, comprising a housing including two seats and having first, second and third ports, one of said ports being connected with a source of pressurized fluid and said housing further having a fluid-filled chamber communicating with said one port; a valve-member disposed intermediate said seats and movable between a first position in which it engages one of said seats to thereby connect said first and second ports and a second position in which it engages the other seat to thereby connect one of said first and second ports with said third port; and an electromagnet including an armature reciprocable with clearance in said fluid-filled chamber and normally holding said valve member in engagement with said one seat, and winding means energizable to effect movement of said armature so that said valve member can move into engagement with said other seat.

2. A valve as defined in claim 1, wherein said one port is said third port, wherein said first port is connected with a consumer of pressurized fluid and said second port is connected with a return line for spent fluid.

3. A valve as defined in claim 1, wherein said armature comprises a plunger which normally holds said valve member in said first position and further comprising annular guide means provided in said housing for said plunger and spring means for biasing said plunger against said valve member.

4. A valve as defined in claim 1, wherein said armature comprises a differential piston arranged to normally maintain said valve member in said first position under the action of fluid pressure in said chamber.

5. A valve as defined in claim 1, wherein said armature is movable axially in response to energization of said winding means from an extended position in which it holds said valve member in said first position to a retracted position in which said armature is out of contact with said valve member in the latter's second position.

6. A valve as defined in claim 5, wherein said electromagnet further includes a core fixedly mounted in said housing and said armature comprises a plunger having an end face which abuts against the core in said retracted position.

7. A valve as defined in claim 1, wherein said valve member is a sphere and said seats have coaxial bores one of which connects said first and second ports and the other of which connects said third port with one of said first and second ports.

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