Jan. 5, 1954 A. MENDENHALL 2,665,251

WATER SOFTENER

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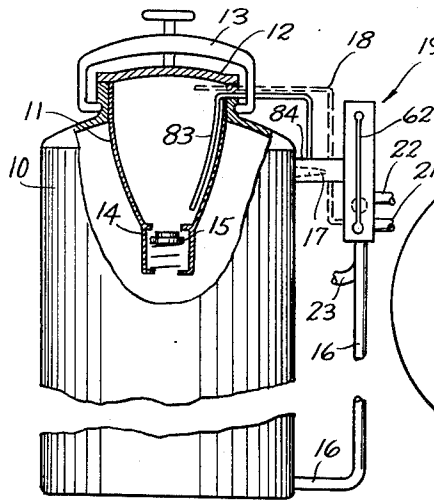


Fig.-1

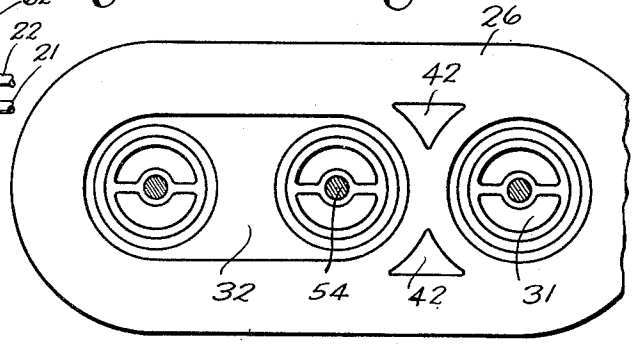


Fig.-3

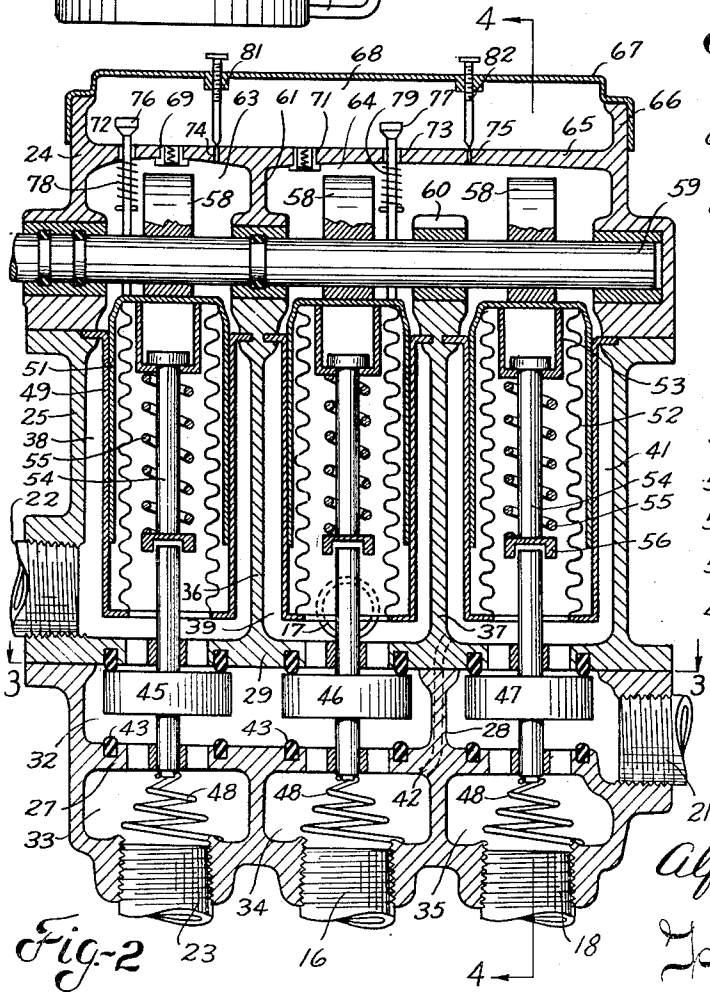


Fig.-2

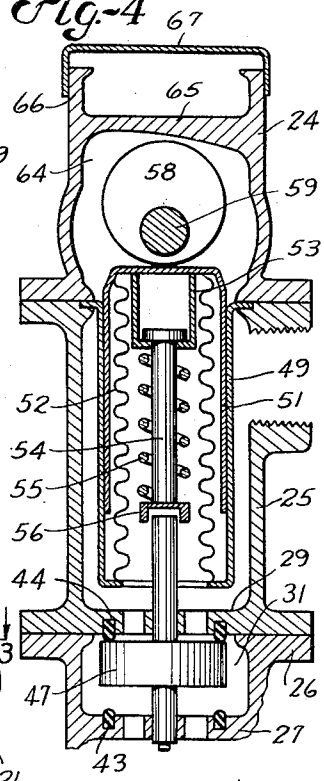


Fig.-4

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WATER SOFTENER

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5 Claims. (Cl. 210—24)

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This invention relates to water softeners and more particularly to control apparatus for the regeneration thereof.

As is well known, water softening devices comprise essentially a bed of minerals having the property of a special kind of filter in that it is capable of removing from water passed therethrough the substances and characteristics which make for "hard" water. After a period of use the mineral bed will lose its ability to remove such substances and must be regenerated or reactivated. This is done by passing a brine solution through the bed. Ordinarily the brine flow is preceded by a backwashing of the mineral bed to remove foreign matter therefrom and is followed by a rinse of the mineral bed to wash out the brine. Inasmuch as water softeners are very widely used in the so-called hard water areas, both in homes and places of business, considerable design effort has been directed toward simplifying the regenerating apparatus and process to make the operation substantially automatic. It is highly desirable to relieve the operator of the necessity of timing the several phases of the operation and of the necessity of making a plurality of control adjustments.

Automatic softeners have heretofore been known requiring but a single manual operation in regenerating as, for example, the pushing of a button or turning of a lever. To achieve such automatic control, however, the prior art softeners have had to rely upon complicated and extensive control devices which have so raised the price of the automatic softeners as to place them beyond the reach of most home owners. Moreover, some of the known control devices are unreliable. Those employing clock mechanisms are likely to get out of order. Those utilizing principles of balanced water pressure are subject to misoperation should the available water pressure vary, as it frequently does.

The instant invention proposes a softener which is as fully automatic in its regeneration as those considered above but which is more simple in structure, less expensive of manufacture and more reliable in operation. To produce a softener so characterized is a principal object of the invention.

Thus, the object of the invention is to simplify the construction as well as the means and mode of operation of a device as disclosed herein, whereby such units may not only be economically manufactured, but will be more efficient, dependable and accurate in use, having relatively few parts and be unlikely to get out of repair.

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Another object of the invention is to present a valve control device for water softener systems in which the number of moving parts is reduced to a minimum, the valves employed being simply and cheaply constructed and control of the water flow being accomplished with relatively few adjustments of the valves.

A further object of the invention is to incorporate time delay apparatus in the valve control device which avoids the difficulties and expensive construction of the clock and water pressure balanced mechanisms heretofore known and used.

Still another object of the invention is to utilize a principle of self-contained hydraulic pressure to interpose time delays in the operation of the valves.

A still further object is to enable the hydraulic fluid to be regulated with respect to individual valves for predetermined timed movement of the valves.

A still further object of the invention, as applied to water softeners of the single tank type, is to provide for automatic exhaustion of water from the salt pot.

A further object of the invention is to provide a device possessing the advantageous structural features, the inherent meritorious characteristics and the mode of operation herein mentioned.

With the above primary and other incidental objects in view as will more fully appear in the specification, the invention intended to be protected by Letters Patent consists of the features of construction, the parts and combinations thereof, and the mode of operation, as hereinafter described or illustrated in the accompanying drawings, or their equivalents.

Referring to the accompanying drawing, wherein is found the preferred but obviously not necessarily the only form of embodiment of the invention,

Fig. 1 is a small scale, partly diagrammatic view, of a water softener system in accordance with the instant invention;

Fig. 2 is a view in longitudinal section of the water flow valve control device of Fig. 1;

Fig. 3 is a section on line 3—3 of Fig. 2; and

Fig. 4 is a section taken on line 4—4 of Fig. 2.

Like parts are indicated by similar characters of reference throughout the several views.

Referring to the drawings, the invention is disclosed in connection with a water softener of the single tank type, that is, one utilizing a salt pot at the top of the mineral tank which is filled prior to each regeneration of the system.

Thus, as shown in Fig. 1, a tank 10 is provided containing a bed of minerals and open at its top to receive a salt pot 11. A lid 12, held in place by a clamp 13, normally closes the top of tank 10 and the top of the salt pot. The bottom of the salt pot is open into the tank and defines a seat 14 facing the tank for a check valve 15 spring urged upon the seat. Accordingly flow may take place from the salt pot into the tank but reverse flow is denied. Plumbing connections to the tank 10 and salt pot 11 include a pipe 16 communicating with the bottom of the tank, a pipe line 17 communicating with the top of the tank, and a pipe line 18 communicating with the top of the salt pot.

The opposite ends of the pipe lines 16, 17 and 18 terminate in a fluid flow valve control device 19 to which is further connected pipe lines 21, 22 and 23 communicating respectively with a source of water supply, a plate of drain and a line of water utilization, as, for example, the household distributing system. The device 19 is mounted adjacent to the tank 10 either upon the tank or independently thereof.

Referring to Fig. 2, the device 10 is made up of a plurality of cast frame members 24, 25 and 26 stacked one upon another and bolted or otherwise secured together to form a unitary body. The lower body member 26 presents a horizontal wall 27 and a vertical wall 28, the latter making a sealing contact with a horizontal wall 29 at the base of intermediate body member 25. Vertical wall 28, together with horizontal walls 27 and 29, defines a chamber 31 on one side thereof and another chamber 32 on the opposite side thereof. Chamber 31 has an opening receiving pipe 21 and so serves as the inlet of the valve device. Beneath the horizontal wall 27, the body member 26 is formed with separated chambers 33, 34 and 35 respectively receiving pipes 23, 16 and 18. Thus, chamber 33 represents the outlet to the household system, chamber 34 communicates with the bottom of tank 10 and chamber 35 communicates with the top of the salt pot 11.

Intermediate body member 25 is formed, in addition to horizontal wall 29, with spaced apart vertical walls 36 and 37 defining with the end walls of the body member cylindrical chambers 38, 39 and 41. Chamber 38 overlies chamber 32 in member 26 and registers with chamber 33 therein. Chamber 39 overlies chamber 32 and registers with chamber 34. Chamber 41 overlies and registers with chambers 31 and 35. Chamber 38 receives pipe 22 and so is in communication with a place of drain. Chamber 39 receives pipe 17 and so is in communication with the top of tank 10. Chamber 41 is connected to chamber 34 by way of a passage 42 and so is in communication with the bottom of tank 10.

The horizontal walls 27 and 29 are ported at places of alignment with chambers 33 and 38, chambers 34 and 39 and chambers 35 and 41. Surrounding such ported areas in the wall 27 and facing upward in the chambers 31 and 32 are rings seals 43 defining individual valve seats upon the wall 27. Surrounding such ported areas in the wall 29 and facing downwardly in the chambers 31 and 32 are ring seals 44 defining individual valve seats upon the wall 29. The seats 43 and 44 are thus aligned and oppositely disposed with respect to one another. Reciprocable between the pairs of oppositely facing valve seats are respective valves 45, 46 and 47, provided with oppositely extending stem portions having respective bearings in the walls 27 and 29. The valves thus are duofunctional, valve 45, for example, acting in a first or upper position of adjustment to close communication between chambers 32 and 38 and to open communication between chambers 32 and 33 and acting in a second and lower position of adjustment to close communication between chambers 32 and 33 and to open communication between chambers 32 and 38. Valve 47 performs similar functions in alternately connecting chamber 31 to chamber 35 or chamber 41. Coil springs 48 are arranged to bear against the downwardly extending stems of the valves to urge them upward upon the seats 43.

Disposed in each chamber 38, 39 and 41 is means for effecting and controlling motion of the valves 45, 46 and 47 between their seats 43 and 44. Inasmuch as such means are in each case identical, a description of one will suffice for all. Vertically arranged in the chamber 38, 39 or 41 is a cylindrical hanger bracket 49 having at its upper end an outturned flange clamped between the upper end of body member 25 and the lower end of body member 24 and having at its lower end an inturned flange surrounding the upwardly projecting stem of the valve. Slidably mounted in the bracket 49 is a tubular sleeve 51 closed at its upper end. Within sleeve 51 is a Sylphon bellows 52 connected at its upper end to the closed end of sleeve 51 and at its lower end to the inturned flange on hanger 49. Surrounded by the bellows 52 is a smaller sleeve 53 secured at its upper end to the closed end of sleeve 51 and formed with an inturned flange on its lower end in closely surrounding relation to a piston rod 54. Within sleeve 53 is the piston rod 54 having a head portion abutting the lower end of the sleeve and a stem portion extending axially downward toward the valve stem and in alignment therewith. A compression spring 55 is interposed between the sleeve 53 and a cup or head 56 on the opposite end of the piston rod 54 tending to maintain the rod and cup in the positions indicated.

The bellows 52, in conjunction with hanger 49 and sleeve 51 seals the upper end of the chamber 38, 39 or 41. According to the operation of each bellows assembly, the depression or axial downward movement of the sleeve 51 serves to contract the bellows 52 and tends to carry sleeve 53, rod 54, spring 55 and cup 56 also downward as a unit. As the cup 56 engages the end of the valve stem, the force of spring 55 is sufficiently greater than the opposing force of spring 48 as to cause the valve to move downward with the bellows assembly from its seat on seal 43 to a seat on seal 44. Continued motion of the bellows assembly is accomplished relatively to the valve and to the piston rod 54, compressing the spring 55 which thus exerts a strong thrust in a direction to seat the valve on seal 44 and in a direction to raise the bellows assembly. When the bellows assembly is permitted to rise, the early part of such travel takes place relatively to the valve and piston rod 54. As the sleeve 53 engages and lifts piston rod 54, however, the ensuing motion is followed by the valve which rises under the influence of its spring 48 and returns to a seat on seal 43.

Operation of the several bellows assemblies is accomplished by individual overlying cams 58 secured to a rotatable shaft 59 passed transversely through the upper body element 24. The shaft 59 has bearings in the end walls of body

member 24 and intermediate bearings in a rib 60 and a vertical wall 61. One end of the shaft extends outside the body of the valve device and has fastened thereto a lever 62 for manual turning of the shaft. The cams 58, as seen in Fig. 4, bear directly upon the sleeves 51 of the bellows assemblies and have, each, a high point which, when presented to the sleeves by rotation of the shaft 59 depresses the bellows assembly.

A vertical wall 61 divides the interior of body member 24 into a first chamber 63 overlying chamber 38 in member 25 and a second chamber 64 overlying chambers 39 and 41. Communication between the chambers 63 and 64 and the underlying chambers in body member 25 is prevented by the sealing action of the intermediate bellows assemblies. The tops of the chambers 63 and 64 are defined by a horizontal wall 65 around the periphery of which is an upstanding rim 66. A closure cap 67 is seated on the rib 66 and defines in conjunction therewith, and with the wall 65, a well or reservoir 68. The reservoir 68 is filled or substantially filled with a hydraulic liquid, such as oil. Similarly, the chambers 63 and 64 are completely filled with oil, which may flow thereto from the reservoir by way of respective check valves 69 and 71 mounted in wall 65. Other means of communication between the reservoir 68 and the chambers 63 and 64 are represented by respective relatively large openings 72 and 73 in wall 65 and relatively small openings or orifices 74 and 75 therein. Flow through the openings 72 and 73 is controlled by poppet type valves 76 and 77 located in the reservoir and having stems passed downward into contact with the sleeve 51 of an associated bellows assembly. In the case of valve 76, this contact is made with the bellows assembly in chamber 38 while valve 77 is arranged to contact the bellows assembly in chamber 39. Springs 78 and 79 are arranged to urge the valves 76 and 77 downward in a direction to close openings 72 and 73, which action is resisted by the underlying bellows assemblies when these devices are in the elevated position illustrated. The orifices 74 and 75 may themselves represent the only control of flow therethrough, or such control may be supplemented or varied by respective metering pins 81 and 82 as shown. These pins may be set in the inner surface of cap 67 and extend downward into or substantially into the respective orifices.

Under extreme temperature conditions it may be necessary to employ some means of compensating for excessive temperatures. In such cases the metering pins 81 and 82 may be made of brass, which expands proportionately to the increase in temperature and consequent thinning of the oil. Thus, as the oil viscosity decreases the pins expand in length to thereby reduce to flow area through the orifices 74 and 75.

By adjustment of the metering pins the rate of flow through the orifices may be increased and reduced, or the rate of flow through one orifice may be increased or reduced relatively to the other. The orifices 74 and 75 provide for continuous communication of the reservoir 68 with the chambers 63 and 64 and permit a restricted flow of fluid from the chambers to the reservoir in response to the presence of an appropriate pressure differential, as caused, for example, by the spring 55 attempting to elevate the bellows assemblies.

In the operation of the system, the parts normally assume the positions illustrated, with the hand operated lever 62 in a vertical hanging position and the cams 58 on shaft 59 presenting low points to the sleeves 51 of the bellows assemblies. Thus, the bellows assemblies are in elevated position, the valves 45, 46 and 47 are in their upper positions on seats 43 and the poppet valves 76 and 77 are held in open position with respect to the ports 72 and 73 which they control. At this time, therefore, water entering inlet chamber 31 passes to chamber 35 whence it is conducted by pipe 18 to the top of salt pot 11, which is normally empty of salt. Flowing through the salt pot and past check valve 15 therein, the water filters through the mineral bed in tank 10 and leaves the bottom of the tank by way of pipe 16. Conducted by pipe 16, the water returns to the valve control device, entering chamber 34 and flowing by way of chamber 32 and chamber 33 to the outlet pipe 23.

When it is desired to regenerate or reactivate the mineral bed the lever 62 is swung through 180° of motion and then returned to its normal position. The lid 12 on top of the tank 10 is then removed and a quantity of salt is poured into the salt pot 11, after which the lid is replaced. The cams 58 on the shaft are thereby turned through one-half revolution during which they act on the bellows assemblies, depressing them, and return to a position presenting low points to the bellows assemblies. Depression of the bellows assemblies effects, as previously described, a shifting of the valves 45, 46 and 47 from positions seating on seals 43 to positions seating on seals 44. As a result of such motion, inlet 31 now is disconnected from chamber 35 and is connected to chamber 41, communicating through passage 42, chamber 34 and pipe 16 with the bottom of the tank 10. Also, chamber 32 is closed from communication with chambers 33 and 34 and is opened to communication with chambers 38 and 39, the former being drained through pipe 22 and the latter being connected to the top of tank 10 by way of pipe 17. Accordingly water from the inlet 31 is, in this position of the ports, directed through pipe 16 to the bottom of the tank 10 wherein it rises upward, backwashing the mineral bed. Flow out of the tank occurs through pipe connection 17, the water reentering the valve device by way of chamber 39 whence it passes through chambers 32 and 38 to drain pipe 22.

When the bellows assemblies are depressed to initiate the operations above described, the chambers 63 and 64 above them are enlarged with the result that additional oil is drawn therein through the check valves 69 and 71. Inasmuch as downward motion of the bellows assemblies permits poppet valves 76 and 77 to close, the oil supplied chambers 63 and 64 is trapped therein, the only escape therefor being through the restricted orifices 74 and 75. Entrapment of the oil serves to hold the bellows assemblies in depressed position from which they may rise, only gradually, at a rate predetermined by the rate of flow through the orifices 74 and 75. Orifice 74 and its metering pin 81 are constructed and arranged to permit a relatively slow rise of the bellows assembly associated with valve 45 since this valve must keep the system open to drain through all of the successive steps of backwash, brine flow, regeneration and rinse. Orifice 75 and its metering pin 82 are constructed and arranged to permit a relatively fast rise of the bellows assemblies associated with valves 46 and 47 since it is necessary that these valves be held in shifted position only during the backwash phase of the operation.

The initial rising motion of the bellows assem-

blies is, as before seen, accomplished relatively to the valves 45, 46 and 47. When, in the course of such movement, however, the bellows in chamber 39, for example, engages and lifts its poppet valve 77 to open substantially free flow into the reservoir 68, the bellows assembly, and the valve controlled thereby, rise quickly to their normal position.

Accordingly, and returning to a description of the operation of the system, while the backwashing step of the regenerating process is taking place, the bellows assemblies are slowly rising, those in chambers 39 and 41 considerably more rapidly than that in chamber 38. As the bellows in chamber 39 engages and lifts poppet valve 77, the hydraulic holding pressure in chamber 64 is released, whereupon the valves 46 and 47 move upward under the influence of springs 48, returning to their respective seats on seals 43. Valve 45 remains in shifted position, closing the outlet and opening flow to the drain. The flow of water entering inlet 31 now is diverted through chamber 35 and pipe 18 to the top of the salt pot 11. Entering the salt pot, the water dissolves the salt therein, forming a brine which flows past the check valve 15 into the tank 10 and descends therein through the mineral bed. Flow out of the tank is by way of pipe 16 which directs the water back to chamber 34, whence it follows a path through chambers 32 and 38 to drain pipe 22. This route of flow remains open while the bellows in chamber 38 continues to rise, and, in the course of such flow, all the salt in pot 11 is dissolved and the continued supply of water to the pot effects a rinsing of the mineral bed to remove the brine therefrom. The rise of the bellows in chamber 38 being at a rate predetermined to allow time for completion of the brine flow and rinsing phases of the operation, the contact of poppet valve 76 thereby occurs after the rinsing operation has been in progress for a determined time interval. When such contact and lifting of valve 76 takes place, the hydraulic pressure in chamber 63 is released and valve 45 rises to close the drain opening and open the outlet opening. The ports now are all restored to the normal positions illustrated and flow through the system is as first described.

In the regenerating process, it will be observed that when valve 47 descends to close chamber 35, the flow passage extending from this chamber to check valve 15 and including pipe 18 and salt pot 11 is filled with water with no pressure available for the removal thereof. Since the presence of water in the salt pot 11 may interfere with the filling of the pot with salt, automatic means in contemplated for emptying the water from the salt pot. Referring to Fig. 1, this means is represented by a pipe line 83 having one end extending into the salt pot adjacent the bottom thereof and its other end connected to pipe 17 ahead of a Venturi jet 84 located therein. Accordingly, during the backwashing phase of the regenerating operation, at which time the water is flowing from tank 10 through pipe 17 back to the control valve device, the venturi 84 induces flow through the pipe 83 from the salt pot 11. In utilizing this feature of the invention, salt is not added to the pot 11 until after the lever 62 has been turned to start the regenerating operation. The backwashing step is the first phase of the operation so that the salt pot is quickly emptied of water, and, as this first phase continues, salt may be added to the pot 11 and the lid 12 replaced, conditioning the system for the brine flow and rinsing steps to follow. The lid 12 must, of course, be removed after backwashing starts so that evacuation of the water therefrom will not be opposed by creation of a vacuum.

From the above description it will be apparent that there is thus provided a device of the character described possessing the particular features of advantage before enumerated as desirable, but which obviously is susceptible of modification in its form, proportions, detail construction and arrangement of parts without departing from the principle involved or sacrificing any of its advantages.

While in order to comply with the statute the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the means and construction herein disclosed comprise but one of several modes of putting the invention into effect.

Having thus described my invention, I claim:

1. A water softening system including a tank containing a mineral bed, a salt pot in the top of said tank, a check valve in the bottom of said salt pot closing in a direction opposed to the direction of flow out of said salt pot into the tank, water connections at the top and at the bottom of said tank and at the top of said salt pot, a water flow valve control device operable to initiate the successive regenerating steps of backwashing, brine flow and rinsing, the direction of backwashing flow being in the water connection at the bottom of the tank, upward in the tank and out the connection at the top of the tank, a flow passage leading from within said salt pot to the water connection at the top of the tank, and a jet device in said water connection at the top of the tank so arranged with respect to the adjacent end of said flow passage to induce an evacuation of water from said salt pot during the backwashing step.

2. A valve device for use in connection with water softening apparatus, including a body presenting ports and passages for the flow of water therethrough, valves in said body controlling flow through said ports and passages and movable from and to a normal position, yielding means urging said valves toward normal position, means for moving said valves simultaneously from normal position, means responsive to the operation of said last named means for establishing hydraulic locks holding said valves away from normal position, escape means for the fluid of said hydraulic locks whereby said valves may return to normal position, and individual means for regulating the rate of flow through said escape means whereby the return of said valves may occur at predetermined intervals and in predetermined timed succession.

3. A valve device for use in connection with water softening apparatus, including a body presenting a hydraulic reservoir, a plurality of chambers in said body, check valve controlled passages between said reservoir and said chambers, means including an expansible bellows partitioning each of said chambers into an upper compartment to receive fluid from said reservoir and a lower compartment sealed by said means from said upper compartment, a water flow control valve beneath each of said expansible bellows and having a stem extending through said lower compartment into

cooperative relation with the end of said bellows, said body having passages controlled by said central valves, a spring urging each of said control valves into cooperative relation with its associated bellows, a rotatable shaft extending transversely through said chambers, cams on said shaft overlying the ends of said bellows and constructed and arranged to depress said bellows and to move out of cooperative relation therewith in response to rotation of said shaft in opposite directions, depression of said bellows serving to shift said control valves and further serving to draw hydraulic fluid through said check valves into said upper compartments from said reservoir, such fluid being trapped in said upper compartment for holding said bellows in depressed position when said cams are withdrawn, escape ports for the fluid from said chambers back to said reservoir, and individual means for regulating the rate of flow through said escape ports to predetermine the time delay in the return of said bellows and said control valves from depressed or shifted position.

4. A valve device for use in connection with water softening apparatus, including a body presenting a hydraulic reservoir, a plurality of chambers in said body, check valve controlled passages between said reservoir and said chambers, an expansible bellows in each of said chambers having one end anchored to the walls of said chamber and an expansion end extensible and retractable within said chamber, said bellows defining upper and lower compartments in the chamber, the lower of which is sealed by said bellows from communication with the reservoir, a sleeve in said bellows and having its upper end secured to the expansion end of said bellows, a piston rod supported within the lower end of said sleeve, a water flow control valve arranged beneath each of said bellows and having a stem extending through the lower compartment of said chamber into cooperative relation with said piston rod, said body having passages controlled by said control valves, a spring urging each of said control valves into cooperative relation with said piston rod, a compression spring in each of said bellows interposed between the expansion end of said bellows and said piston rod, a rotatable shaft passed transversely through the upper compartments of said chambers in overlying relation to the expansion ends of said bellows, cams on said shaft to depress said bellows in response to rotation of said shaft, the depression of said bellows acting through said compression springs and said piston rods to shift said control valves and acting further to draw fluid through said check valves into said chambers, said fluid being trapped in said chambers to hold said bellows depressed when said cams are withdrawn, restricted fluid escape ports from said chambers to said reservoir whereby said bellows may gradually return from depressed position under the influence of said compression springs while said control valves remain in shifted position, and release valves operated by said bellows at a predetermined point in the return motion thereof to release the pressure in said chambers and permit return movement of said control valves.

5. A valve device according to claim 4, characterized by means for varying the rate of flow through said restricted escape ports to effect return movements of said valves at predetermined intervals and in predetermined order.

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