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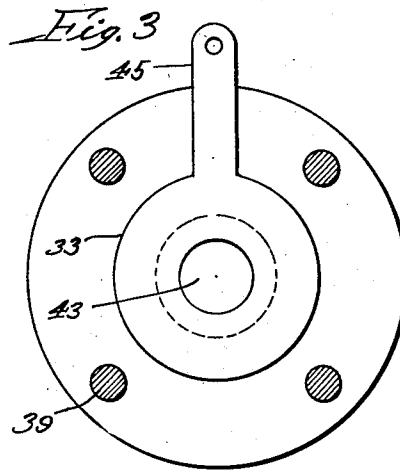
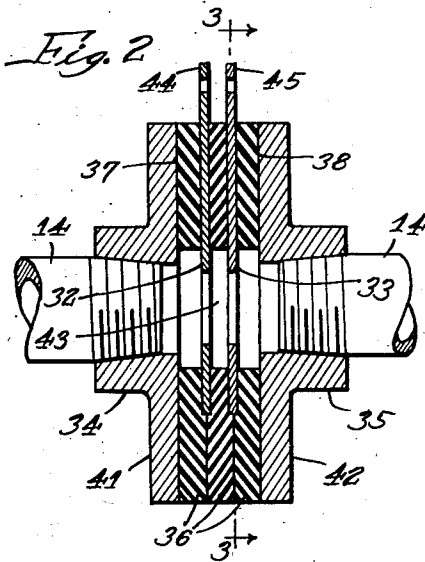
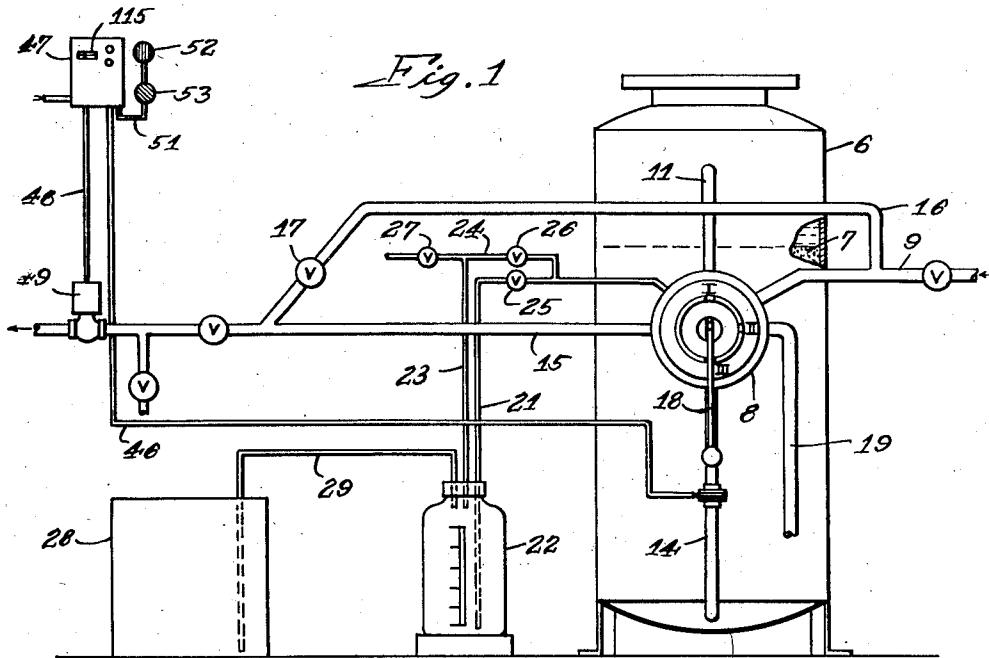
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2,351,648

HYDROGEN ION EXCHANGE APPARATUS

Filed Aug. 1, 1940

2 Sheets-Sheet 1



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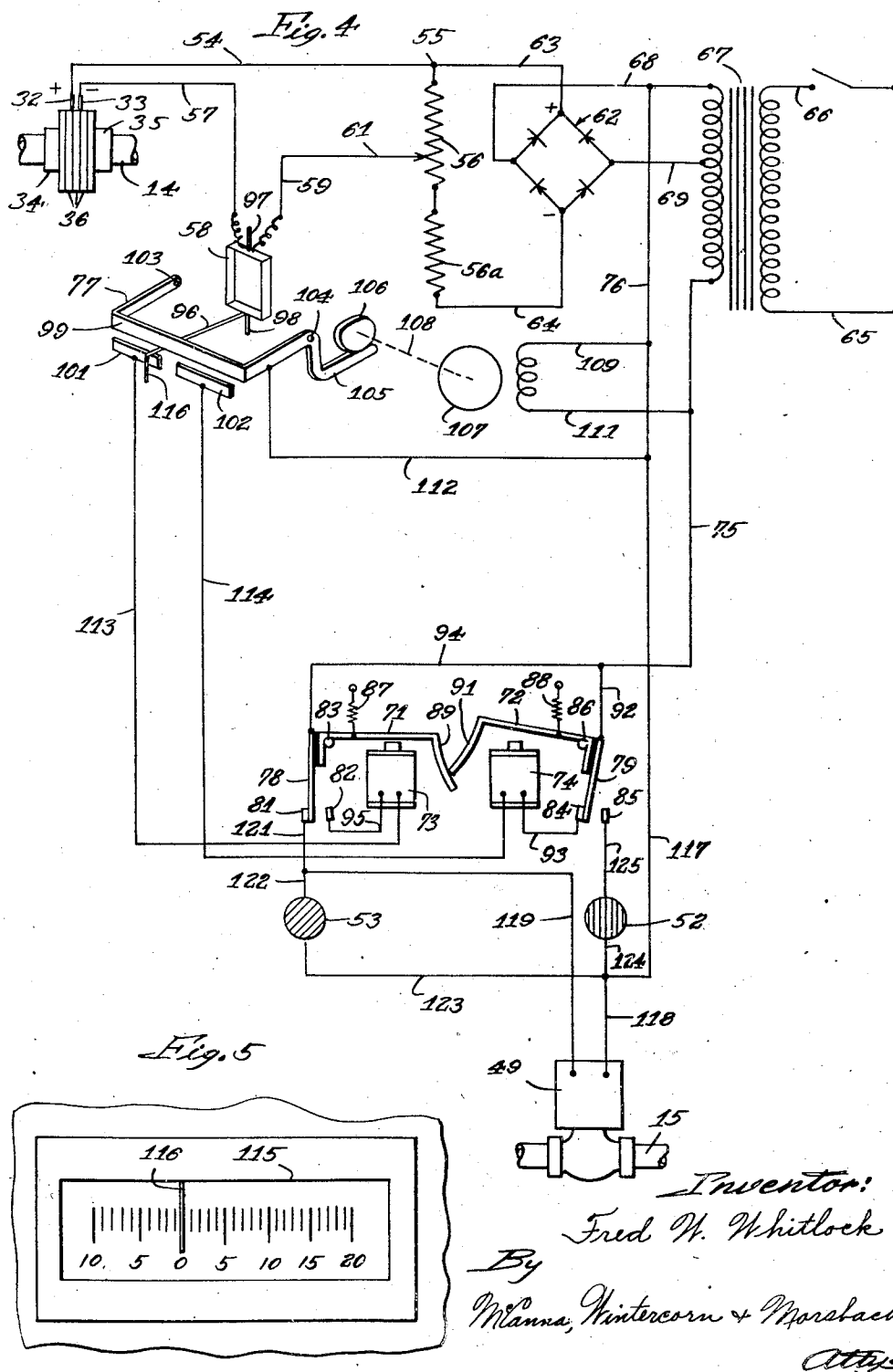
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UNITED STATES PATENT OFFICE

2,351,648

HYDROGEN ION EXCHANGE APPARATUS

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Application August 1, 1940, Serial No. 349,351

15 Claims. (Cl. 210—24)

My invention relates to improvements in water treatment devices wherein means are provided for preventing the device from being prematurely returned to service. Means are also provided for indicating the condition of the effluent of the device.

A serious problem is encountered in the treatment of water through a device employing a tank and a bed of so-called "carbonaceous zeolite," such as the hydrogen exchange type. Devices of this type are frequently used as a source of treated water for use in bottling soft drinks. If the regenerating steps of such a device are not carefully watched and checked, there is great likelihood of prematurely returning the device to service. The common practice in such softeners is to introduce an acid solution through the bed of zeolite to regenerate it by an exchange of hydrogen for the metals retained by the zeolite during the treating process, the spent acid being conducted to a drain. The next phase of regeneration is a rinse step in which water is introduced to rid the softener of the salts of the metals given up by the zeolite and any excess acid. It is apparent that if the softener is returned to service prior to a complete rinsing, acid may be carried into the service line where it may do irreparable personal damage if the treated water is used for the bottling of soft drinks intended for human consumption, as well as damage to physical equipment such as a boiler through its corrosive action. It is therefore the principal object of my invention to provide a device for detecting the presence of a predetermined amount of acid or other electrolyte in the effluent and automatically open or close a valve on the service line in accordance with the type of solution present, so that regardless of the operator's errors, no undesired electrolytic solution will pass through the service line.

Another object of my invention is to provide a device of relatively great sensitivity for detecting a predetermined electrolytic solution and for operating valves and signals in response to the presence or absence of such a solution. To obtain the sensitivity required for detecting undesired acid solutions, for example, it is necessary that such a device tolerate weaker acid or other electrolytic solutions without a positive response thereto. This object is accomplished in my invention by providing a cell through electrodes immersed in the liquid to be tested, together with a circuit balanced so that no current will flow through the circuit when an electrolytic solution less than the predetermined one is present in the

cell and a galvanometer responsive to unbalancing of the bridge in one direction to actuate a valve for controlling the flow through the service line.

Other objects and advantages will appear from the following description and the accompanying drawings, in which—

Fig. 1 is a side elevation of a zeolite water softener showing the magnetic valve, cell, control box, signal lights, and conduits of my invention connected therewith;

Fig. 2 is a cross-section of a cell used in my invention showing the electrodes and electrolytic compartment;

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

Fig. 4 is a wiring diagram showing the parts performing the electrical phases of my invention, and

Fig. 5 is a face view of the galvanometer dial.

Referring to the drawings, 6 represents a treatment tank containing a bed of hydrogen exchange zeolite 7 at the level indicated. Raw water is passed into a multi-port rotary valve 8 of a conventional design, such as that shown in Daniels Patent 2,093,692, through an inlet pipe 9. When the valve is in the service position III, as indicated in Fig. 1, raw water enters the tank 6 through a vertical pipe 11. The water then passes downward through a zeolite bed 7 to enter the lower end of a vertical pipe 14 from which it is returned to the rotary valve 8 and directed into a service line 15.

Where it is desired to proportion the amount of treated water to raw water, a by-pass arrangement is employed, consisting of a pipe 16 which connects into the raw water inlet pipe 9 at one end circumventing the treatment tank to connect with the service line 15 through which the treated water passes, a valve 17 being provided to regulate the proportion of raw water to treated water.

During the backwash phase commonly provided in such devices, the valve handle 18 is moved from the service position III to the opposite position I. This causes water from the inlet pipe 9 to enter vertical pipe 14 and pass out through its lower end located in the bottom of the tank 6. The introduction of this water acts to displace the water thereabove in the tank 6, causing it to flow out through a drain pipe 19 whose upper end also terminates in the valve 8 and provides an open passage for the direction of the water through the drain 19 when the valve lever 18 is at I or the backwash position.

To regenerate the zeolite bed 7 upon its ex-

haustion, acid, most commonly sulphuric acid, is introduced into the treatment tank 6 through a pipe 21 having one end located in the bottom end of a hermetically sealed measuring bottle 22, the other end terminating in a valve port with which an injector is brought into registration when the valve 8 is brought into position II. A pipe 23 also enters the top of measuring bottle 22, its other end terminating in a T on pipe 24 which connects with the pipe 21, control valves 25, 26, and 27 being provided on this system. Thus, when the valve lever 18 is placed in the regenerating position II, raw water from the inlet pipe 9 will be caused to flow through the injector past the valve end of the pipe 21 reducing the pressure in pipe 21 through which acid in the measuring bottle 22 will be caused to enter the raw water stream and mix therewith. This acid mixture then flows upwardly through the vertical pipe 11 and downwardly through the zeolite bed 7 where the hydrogen of the acid is exchanged for the metallic ions absorbed from the raw water by the zeolite. This spent acid solution which includes the sulphates such as calcium, magnesium and sodium and excess acid enters the lower opening of pipe 14 in the bottom of the zeolite bed 7 passing upwardly therein to the valve 8 and thence out the drain pipe 19.

After the required amount of acid is introduced into the tank 6, the device goes into the rinse step. This is accomplished by closing valves 25 and 27, thereby shutting off the source of acid from the measuring bottle 22, but permitting water to continue to pass through the zeolite 7 and out the drain 19. While in the rinse step, the injector permits the refilling of the measuring bottle 22 from a carboy 28, since by opening valve 26, a reduced pressure is formed in bottle 22 causing acid to flow from the carboy 28 through a pipe 29 to the bottle 22.

From the above description it will be seen that the valve 8 is so constructed that when it is in the service position III the effluent will leave the tank 6 through the pipe 14 to enter the valve 8 where it is directed into the service line 15.

Electrodes 32 and 33 of two dissimilar metals such as "Everdur" (an alloy which consists of about 95% or more copper and in the region of 1 to 3% of silicon together with small amounts of other alloying agents) and stainless steel are positioned in a parallel spaced relationship within opposed couplings 34 and 35 secured to the pipe 14 of the softening tank 6 to form the electrodes of a voltaic cell. The electrodes 32 and 33 are spaced and positioned one from the other by means of three insulating disks 36 which are interposed between the inner faces 37 and 38 of the couplings 34 and 35 and between the electrodes 32 and 33, bolts 39 being entered through the flange portions 41 and 42 of the couplings to secure them together and seal an electrolyte compartment 43 at the center of the insulating disk 36. Integral arms 44 and 45 of the electrodes 32 and 33 extend outwardly beyond the radius of the coupling flanges 41 and 42 to provide terminal means for the said electrodes.

The two leads from respective terminals of the electrodes 32 and 33 are contained within a conduit 46 which enters a control box 47. A conduit 48 containing electrical leads for a motorized valve 49 which is mounted on the service line 15 also enters the control box 47, as is illustrated in Fig. 1. Fig. 1 likewise shows the

conduit 51 containing leads for red and green signal bulbs 52 and 53.

The diagram of the circuits and other means controlling the operation of the motorized valve 49 is contained in Fig. 4. One lead 54 from the electrode 32 goes to one terminal 55 of an adjustable resistance 56 while the lead 57 from the electrode 33 goes to a moving coil galvanometer 58, the cell circuit being completed by a lead 59 which goes to the slider 61 of the resistance 56. Direct current is supplied to the adjustable resistance 56 and a fixed resistance 56a connected therewith through a rectifier 62 having leads 63 and 64 going to the ends of the resistances 56 and 56a. Alternating current from power lines 65 and 66 is directed, as reduced to approximately two volts by the tapping of a transformer 67, to the rectifier 62 through leads 68 and 69, supplying in this manner the direct current required for the resistances 56 and 56a.

The balancing of this cell circuit is accomplished by placing the two sources of potential in opposition to one another so that no current will flow in the cell circuit unless the electrolytic solution in the cell compartment 43 reaches a predetermined strength. Upon reaching this strength, the potential of the cell will increase and unbalance the circuit, causing sufficient current to flow through the cell circuit to actuate the galvanometer 58 notwithstanding the opposed source of potential. When resistance 56 is adjusted to balance the potential output of the cell having an electrolytic solution, such as the small acid concentration contained in treated water, no current will flow in the cell circuit. On the other hand, when the electrolytic solution reaches the predetermined threshold, such as an undesired acid concentration, a current will flow in the circuit of the galvanometer 58 and cause it to shift.

The valve 49 and the signal lights 52 and 53 are immediately controlled by circuits completed or broken through rocker switches 71 and 72 which are actuated by electromagnetic energy supplied by corresponding electromagnets 73 and 74, this relay device being controlled by the movement of galvanometer 58, as will be later described. Power of approximately twenty-four volts is supplied to the circuits of the electromagnets 73 and 74 by the transformer 67 from which leads 75 and 76 extend.

The circuit to each of the electromagnets 73 and 74 is designed to be completed and broken at different places, one through the switch provided by a chopper bar 77 of a conventional type chopper bar galvanometer such as that shown in McMaster and Van Gulder Patent No. 2,144,105 and the other through arms 78 and 79 of the rockers 71 and 72, respectively. Opposed terminals 81 and 82 of the rocker switch are in a spaced relation so that the arm 78 of rocker 71 which is pivotally mounted on pin 83 will reciprocate therebetween. Likewise, terminals 84 and 85 are positioned with respect to the arm 79 of rocker 72 which is pivotally mounted on pin 86. Tension springs 87 and 88 are fastened to the rockers 71 and 72 to constantly urge them in an upward direction, respective inwardly located terminals 82 and 84 acting as stops against unrestricted upward urging of the springs 87 and 88. Through the provision of downwardly inclined integral end portions 89 and 91 on rockers 71 and 72, a coacting relationship is effected in which one rocker always assumes an upward position with respect to the other, the one in

the lower position being attracted thereto by the force exerted by its electromagnet while the one in the upper position is simultaneously released. Because of the reciprocable hold-down action of end portions 89 and 91, the rockers 71 and 72 will maintain their respective lower and upper positions notwithstanding the release of the magnetic attraction exerted by the electromagnet beneath the rocker in the lower position, the energization of the opposite electromagnet being required to reverse the positions of the rockers.

It is clear that the breaking means provided by rockers 71 and 72 in the circuits of electromagnets 73 and 74 is in an unbroken position when a rocker is in its upward or released position. Thus, referring to Fig. 4, the circuit breaking means consisting of rocker 72 is unbroken, this portion of the circuit of electromagnet 74 consisting of lead 75, a lead 92, rocker arm 79, terminal 84 and lead 93. Correspondingly, the unbroken portion of rocker circuit of electromagnet 73 would consist of lead 75, a lead 94, rocker arm 78, terminal 82 and a lead 95.

Aside from the circuit breaking means consisting of the rockers 71 and 72, the circuit to the electromagnets 73 and 74 is controlled by the lateral position of a needle 96 that is secured at one end to the galvanometer 58. As the galvanometer 58 pivots on its bearing pins 97 and 98, it causes the needle 96 to move in a radial arc in a horizontal plane between the bottom edge of a cross-piece 99 of the chopper bar 77 and the top edge of horizontal contact bars 101 and 102. The chopper bar 77 is hinged at 103 and 104 and contains a drive arm 105 adapted to engage with a motor-driven cam 106. A continuously running electric motor 107 having a rotary driving shaft 108 rotates the cam 106 causing the chopper bar 77 to reciprocate in a limited arc on its pivots 103 and 104. The motor 107 is supplied with power through the leads 109 and 111 which tap into leads 76 and 75 from the transformer 67. As the chopper bar 77 moves in response to the turning of the cam 106, it will periodically clamp down upon needle 96 which in turn will abut the top edge of one or the other of bars 101 and 102 making an electrical contact between chopper bar 77, needle 96, and end bar 101 or 102. A lead 112 from transformer lead 76 terminates at the chopper bar 77. Thus, when the needle 96 is in the position illustrated in Fig. 4, and when cross-piece 99 is in its downward clamping position, one portion of the circuit to electromagnet 73 will be completed through the lead 76, 112, the chopper bar 77, rod 96, bar 101 and a lead 113, this circuit portion being broken upon the return of the cross-piece 99 to its upward position. Correspondingly, one portion of the circuit to electromagnet 74 is completed when rod 96 is in its opposite position above the top edge of bar 102 and when the chopper bar is in its downward clamping position. This circuit will consist of transformer lead 76, the lead 112, chopper bar 77, needle 96, the bar 102 and a lead 114.

The galvanometer 58 is so tensioned that when no current is flowing, the needle 96 is at one side of center. The position of the galvanometer 58 is indicated on a calibrated dial 115 having an offset zero marking conforming to the zero position of the galvanometer. A right-angled end 116 of needle 96 moves in registration with these dial calibrations to indicate the strength of the electrolytic solution within the cell compartment 43.

The valve 49 may be one of a well known type containing a solenoid which when energized opens the valve ports. When the circuit to the solenoid is broken, the valve automatically closes.

In Fig. 4, the rockers 71 and 72 which immediately control the opening and closing of the valve 49 are shown in the open-valve position, that is, one in which the solenoid within the valve is energized. This closed circuit consists of the lead 76, a lead 117, a lead 118, a lead 119, lead 121, terminal 81, rocker arm 76, lead 94 and the lead 75. When the rockers 71 and 72 are moved to reversed positions through the lateral shifting of bar 96 in response to the unbalancing of the cell circuit, the circuit to the valve 49 is broken at the terminal 81, thereby causing the valve to close.

The green signal light 53 is tapped by leads 122 and 123 in parallel into the valve circuit, so that when this circuit is closed the bulb will light and indicate to the operator that the service line 15 is open and that no undesired electrolytic solution is in the cell compartment 43. Though the valve 49 is closed by the breaking of the valve solenoid circuit, a circuit to the red signal bulb 52 is completed and remains so until the solenoid valve circuit is reclosed. The circuit of red bulb 52 consists of the leads 76, 117, 124, 125, terminal 85, rocker arm 79, leads 92 and 75. Thus, when this red bulb 52 is lighted, the operator is informed that the valve 49 on service line 15 is closed and that there is an undesired solution of electrolyte emerging from the tank 6.

Operation

When the softener is in the service position, raw water from the inlet pipe 9 enters the top of the softener to pipe 11, passes downwardly through the zeolite bed 7, upwardly through the pipe 14 and out the service line 15. During this stage, the treated water will contain a slight amount of acid obtained in its passage through the zeolite bed 7 and it may also contain some dissolved salts. These will form an electrolyte which will react with the electrodes 32 and 33. No current, however, will flow in the external circuit of this cell because of the second source of potential from resistance 56 which is opposed to the cell output in this circuit. Since the resulting balanced circuit has no current, the galvanometer 58 will seek its zero position which is indicated by the offset zero on the dial 115.

The continuously operating motor 107 rotates the cam 106 to move the chopper bar 77 in regular upward and downward movements. This periodically completes a portion of the circuit going to the electromagnet 73. The rocker 71, however, which responds to this magnet 73 maintains its lower position as long as the needle 96 remains at the zero position or left of zero and possibly at a tolerated position one or two points at the right of zero. This setting of the rockers 71 and 72 completes the circuit to the solenoid in the valve 49 maintaining it in open position and lighting the green signal bulb 53.

When the operator chooses to regenerate the softener, he moves the lever 18 of the rotary valve 8, 180° to position I. This is the backwash step in which the accumulated dirt within the softening tank 6 is removed by running raw water down through the pipe 14, up through the zeolite bed 7, and out through the drain 19.

To regenerate the zeolite, the operator now turns the valve lever 18, 90° to valve position II,

and also opens valve 25 on the line 21 running from the measuring bottle 22 to the valve 8. Through the injector provided, a solution of water and acid is passed up through the pipe 11, down through the zeolite bed 7 to regenerate the same, and up through the pipe 14 and out the drain 19. When the calculated amount of acid has been introduced, the valve 25 is closed and the regeneration enters the rinsing stage through which the sulphates and excess acid are rinsed from the tank 6 by displacing the regenerating solution of acid and water with water. When once the predetermined electrolytic solution is present in the cell compartment 43, during either the acid introducing or rinse stage, or at any other time, the valve 49 on the service line 15 will close, since the circuit to galvanometer 58 is unbalanced by the increased potential of the cell, causing a lateral shift in needle 96 and the completion of a circuit to electromagnet 74 which pulls rocker 72 to its downward position breaking the circuit to the solenoid in valve 49, and completing the circuit to the red signal bulb 52. As the rinse continues, excess acid and the sulphate will be eliminated from the softening tank 6 so that eventually the solution passing through the cell compartment 43 will be less than the undesired strength. This in turn will rebalance the circuit of galvanometer 58, causing it to approach the zero position, through which it reverses the rockers 71 and 72 causing valve 49 to open by the energization of its solenoid and green signal bulb 53 to light.

It is clear then that if the rinse step is terminated by the return of lever 18 to service position before an electrolyte of undesired strength is eliminated from the tank 6, the valve 49 will remain closed and prevent any such solution from going into the service lines. The operator will then be required to return the lever 18 to II to continue the rinsing until the strength of the electrolyte corresponding to an excess regenerating solution is reduced, whereupon the valve 49 is caused to open.

I claim:

1. The combination of a zeolite water treatment apparatus for producing a service effluent, conduits for raw water, service water, reagent and waste, a source of reagent, valve means for controlling the flow through said conduits to effect the steps of regeneration of said apparatus including the flow through said service conduit, and a safety control including an electrical cell comprising a pair of electrodes of dissimilar metal disposed in the service effluent from said apparatus ahead of said valve means, a motorized valve in said service conduit behind said valve means including a motor, means for supplying electrical energy to said motor for operating the same, and circuit means for controlling the supply of electrical energy to said motor in response to the change in electrical output of said cell with change in said effluent for closing and opening said motorized valve.

2. The combination of a zeolite water treatment apparatus for producing a service effluent, a service line for conducting said effluent to a point of use, conduits for raw water, reagent and waste, a source of reagent, valve means for controlling the steps of regeneration of said apparatus including the flow through said service line, an electrical cell comprising a pair of electrodes of dissimilar metal disposed in the effluent from said apparatus ahead of said valve means, a mo-

torized valve in the service line behind said valve means including a motor, means for supplying electrical energy to said motor for operating the same, and circuit means for controlling the supply of electrical energy to said motor in response to the output of said cell in the presence or absence of a predetermined electrolyte within the service line for closing and opening said motorized valve.

3. In a water treatment device, a tank containing a base exchange material for producing a treated effluent, conduits for raw water, service water, reagent and waste, a source of reagent, a service valve for controlling the regeneration of said base exchange material, said conduits including a line between said tank and said service valve, a service pipe, the said service valve having means for directing effluent through said line to drain during the wash step and through said service conduit during the service run, a voltaic cell disposed in said line ahead of said service valve, a motorized valve behind said service valve including a motor, means for supplying electrical energy to said motor for operating the same, and circuit means for energizing said motor in response to the output of said cell in the presence of excess regenerating solution to shut off the service conduit in the presence of excess regenerating solution in said cell notwithstanding the position of said service valve.

4. The combination in a water treatment device of a treatment tank for producing a treated effluent, a service line, conduits for raw water, reagent and waste, a source of reagent, valve means for controlling the steps of regeneration including flow through said service line, an electrolytic cell immersed in said effluent ahead of said valve means having an output responsive to the presence of regenerating material in said effluent, a motorized valve in said service line including a motor, and means including a circuit and a chopper bar galvanometer electrically connected therein between said motor and said cell and responsive to the output of said cell for controlling the opening and closing of said valve in response to the condition of the effluent in said cell.

5. The combination in a water treatment device having a service line, conduits for raw water, reagent and waste, a source of reagent, and means for controlling the flow therethrough to regenerate the water treatment device, of a voltaic cell in said service line having the effluent flowing from said water treating device as its electrolyte, an external circuit to said cell, circuit balancing means on said cell circuit consisting of a source of potential placed in opposition to the potential from said cell, a relay, means responsive to a predetermined current in said external circuit upon unbalancing of said circuit by change in the output of said cell corresponding to change in the effluent to operate said relay, a valve located in the service line behind said cell through which the effluent passes, electrical means for controlling said valve, and a circuit between said relay and said electrical means controlled by said relay for opening and closing said valve.

6. The combination in a flow control device for water treating apparatus for producing a desired effluent of normal composition but capable of producing an undesirable effluent of abnormal composition, of a voltaic cell having an effluent flowing from said apparatus as its electrolyte, an ex-

ternal circuit to the said cell, circuit balancing means for applying to said circuit a potential equal and opposite to that normally generated by said cell during the passage of effluent of normal composition, a relay, means responsive to the presence of a current from said cell corresponding to effluent of abnormal composition in the external circuit to operate said relay, a valve located in the line through which the effluent passes to a point of use, a motor for said valve, and a circuit between the said relay and motor controlled by said relay for closing said valve upon the appearance in said cell of effluent of abnormal composition.

7. The combination in a liquid treatment apparatus for producing a desired effluent of normal composition but capable of producing an undesirable effluent of abnormal composition, of a voltaic cell having an effluent flowing from said apparatus as its electrolyte, a circuit external to said cell and including said cell, circuit balancing means in said cell circuit for balancing the output of said cell in the presence of an effluent of normal composition, electrical signal means for indicating the condition of said apparatus, a relay for controlling said signal means, and means energized in response to unbalanced condition of said circuit and a predetermined current from said cell in said external circuit corresponding to the presence of an effluent of abnormal composition to operate said relay to indicate the presence in said cell of effluent of normal and of abnormal composition.

8. The combination in a flow control device for liquid treatment apparatus of a voltaic cell having an effluent flowing from said apparatus as its electrolyte, a circuit external to said cell and including said cell, circuit balancing means in said cell circuit including a source of potential placed in opposition to the potential of said cell, the potential of said circuit balancing means being adapted to be overcome by the potential of said cell when effluent of a predetermined composition is in said cell, a relay, a galvanometer, means electrically connecting said galvanometer to said relay and responsive to the presence of a current from said cell in said cell circuit to actuate said relay, a valve located in the line through which the effluent passes to a point of use, electrical means for operating said valve, and circuits disposed between said relay and said electrical means for actuating the same to close the valve in response to the potential of said cell corresponding to the presence of said effluent of predetermined composition in said cell and opening the same in response to the potential of said cell corresponding to the absence thereof.

9. The combination in a water treatment apparatus of a tank, a zeolite bed contained therein, conduits for the introduction of raw water into the zeolite bed, a service line for the conveyance of treated water from the said tank, means for passing a regenerating solution through the zeolite bed, conduits for draining off the spent solution existing after the introduction of the regenerating solution to the said zeolite bed, valve means controlling the steps of regeneration and return to service of the said apparatus, a cell having dissimilar electrodes, the said cell being so positioned with respect to the service line that liquid coming from the said tank to the service line will immerse the electrodes of the said cell, a valve located in the service line of the said softener between said valve means and a point of use, a motor for operating said valve, and elec-

trical means including circuits disposed between said cell and said motor for closing said valve upon the presence of an electrolytic solution in said cell of greater than a predetermined concentration corresponding to the presence of an excess of regenerating solution and for opening said valve upon the presence of a solution in said cell of less than said concentration corresponding substantially to normal treated water.

10. The combination in a flow control device for liquid treatment apparatus of a voltaic cell having an effluent flowing from said apparatus as its electrolyte, an external circuit to said cell, circuit balancing means on said cell circuit consisting of a source of potential placed in opposition to the potential from said cell, said circuit balancing means being adapted to be overcome by the potential of said cell when effluent of a predetermined composition is in said cell, a galvanometer responsive to the presence of a current from said cell in said cell circuit, electrical signal means for indicating the presence or absence of said predetermined solution in said cell, a relay for controlling said signal means, circuit means connecting said relay with said galvanometer to complete or break circuits to said relay, circuits between the relay and electrical signal means for controlling said signal means.

11. The combination in a flow control device for liquid treatment apparatus having a line for conducting effluent flowing therefrom to a point of use, a motorized valve in said line for controlling the flow therethrough including a motor, an energizing circuit therefor, a relay adapted in one position to energize said motor to close the valve and in another position to energize said motor to open the valve, a voltaic cell having said effluent as its electrolyte, a circuit external to said cell and including the same, circuit balancing means in said cell circuit including a source of potential in opposition to the potential from said cell, means for balancing said circuit to cause the potential of said cell to overbalance the potential of said balancing means when effluent of a predetermined composition is in said cell to cause a flow of current in said circuit, a chopper bar galvanometer having a conductive needle and motorized spaced switch means connected to said relay and positioned to be selectively closed at intervals dependent upon the position of said needle to energize said relay whereby to close said valve in response to the flow of current in said cell circuit and open said valve in response to substantial absence of current to prevent the flow of effluent to the point of use when said effluent comprises said predetermined composition.

12. The combination in a water treatment apparatus of a tank containing a bed of zeolite, conduits for the introduction of raw water into the zeolite, a service line for the conveyance of treated water from said tank, means for passing a regenerating solution through said zeolite bed, conduits for draining off the spent solution after the introduction of regenerating solution to said bed, valve means controlling the steps of regeneration and return to service of said apparatus, a valve located in the line through which the treated water of the tank passes, means for driving said valve between open and closed positions, an electrolytic cell having dissimilar electrodes, said cell being so positioned with respect to the service line that liquid coming from said tank to the service line will immerse said electrodes, a circuit external to said cell and including said cell, a

relay for controlling said valve driving means, and means responsive to a predetermined current from said cell in said external circuit for operating said relay to move said valve to one of said positions and responsive to a different current in said circuit to move the valve to the other of said positions.

13. The combination in a water treatment apparatus of a tank containing a zeolite bed, conduits for the introduction of raw water into said tank, a service line for the conveyance of treated water from said tank, means for passing a regenerating solution through said bed, conduits for conducting the spent regenerating solution to drain, valve means controlling the steps of regeneration and return to service of said apparatus, a valve located in the line through which the treated water from the tank passes, means for driving said valve between open and closed positions, an electrolytic cell having dissimilar electrodes, said cell being so positioned with respect to the service line that liquid coming from said tank to the service line will immerse said electrodes, a circuit external to said cell and including the cell and circuit balancing means comprising a source of potential placed in opposition to the potential from said cell, a relay for controlling said valve driving means, and means responsive to an unbalanced condition of said external circuit resulting in a cell current in said external circuit corresponding to a changed output of said cell in the presence of an excess regenerating solution in said cell to energize said relay to move said valve to said closed position to prevent flow through said service line regardless of the position of said valve means.

14. The combination in a water treatment apparatus of a tank containing a zeolite bed, conduits for the introduction of raw water into said tank, a service line for the conveyance of treated

water from said tank, means for passing a regenerating solution through said bed, conduits for conducting the spent regenerating solution to drain, valve means controlling the steps of regeneration and return to service of said apparatus, a valve located in the line through which the treated water from the tank passes, means for driving said valve between open and closed positions, an electrolytic cell interposed in the liquid between said tank and said service line and responsive to the presence of regenerating material in said liquid, a circuit external to said cell and including the cell and circuit balancing means comprising a source of potential placed in opposition to the potential from said cell, a relay for controlling said valve driving means, and means responsive to an unbalanced condition of said external circuit resulting in a cell current in said external circuit corresponding to a changed output of said cell in the presence of an excess regenerating solution in said cell to energize said relay to move said valve to one of said positions and responsive to a different current in said circuit to move the valve to the other of said positions whereby to prevent the flow of liquid through said service line in the presence of an excess regenerating solution at said electrodes regardless of the position of said valve means and to permit said flow in the presence of said treated water in said cell.

15. The combination recited in claim 14 wherein the last mentioned means comprises a chopper bar galvanometer having spaced contacts electrically connected to said relay for selectively actuating said relay to either of two positions corresponding to the open and closed positions of said valve, responsive to the cell current in said external circuit to thereby control the position of said valve.

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