Nov. 13, 1928. 1,691,862

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Filed March 15, 1928

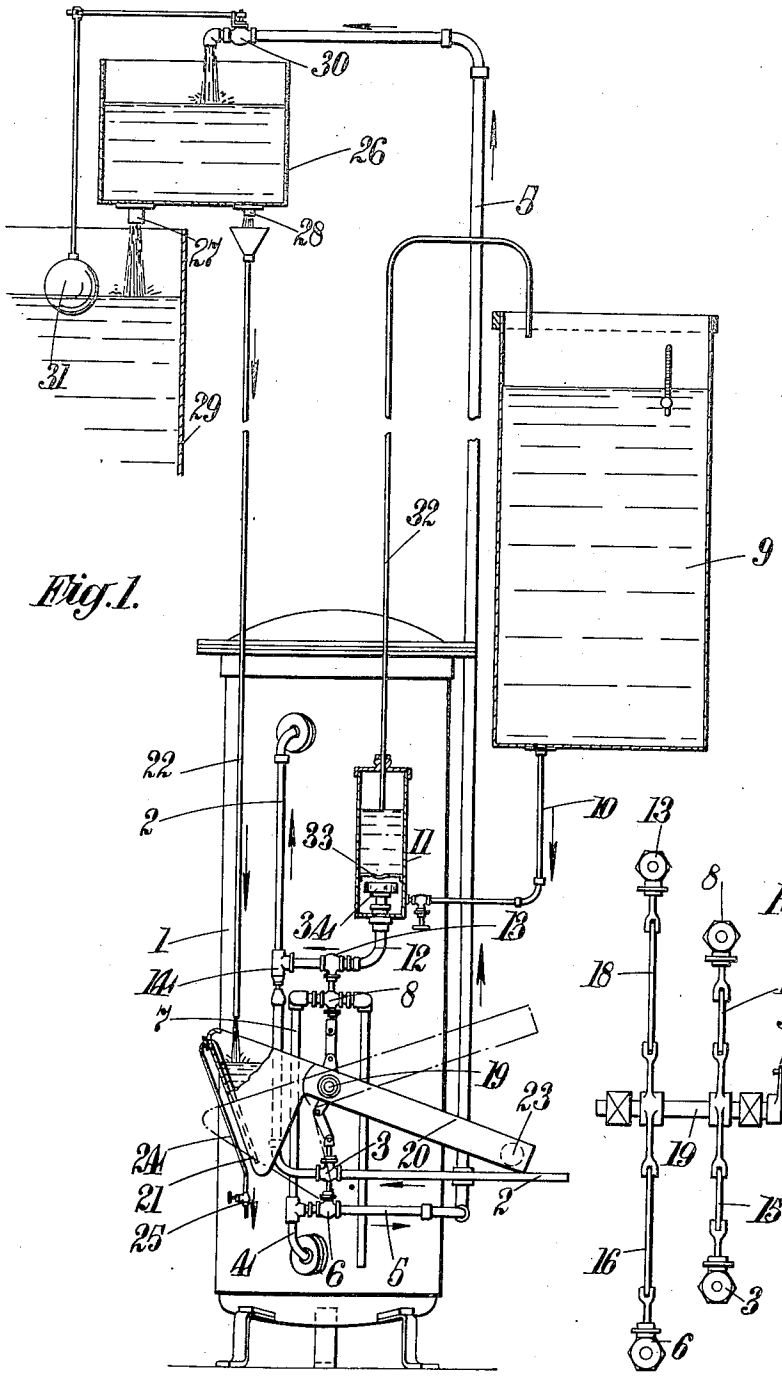

Fig. 1.

Fig. 2.

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Patented Nov. 13, 1928. 1,691,862

UNITED STATES PATENT OFFICE.

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APPARATUS FOR THE SOFTENING OR PURIFYING OF WATER OR FOR CARRYING OUT PROCESSES BASED UPON EXCHANGE REACTIONS.

Application filed March 15, 1923, Serial No. 261,858, and in Great Britain March 11, 1927.

This invention relates to apparatus for carrying out processes involving exchange reactions and more particularly to apparatus for softening water and for purifying water, for example, for removing iron compounds therefrom.

It is the main object of the present invention to produce a simple form of apparatus in which successive operations of carrying out an exchange reaction, regenerating the exchange material and washing the same may be carried out automatically, that is to say, without the need of control by human agency, and is simple so as not to have any liability to become out of order and is yet economical of regenerating agent and washing water.

According to the present invention, an apparatus is arranged so that the successive operations consisting in the treatment of water or other liquid by an exchange material, regeneration of that exchange material and washing of the same are carried out in cycles in the same vessel or vessels and are controlled by the operation of valves admitting the liquid to be treated and the regenerating solution and allowing of the outflow of the treated liquid, for example, to storage tanks or to a main, and of the exhausted regenerating agent and wash water to waste; these valves are controlled automatically by a balance mechanism which derives its power from the liquid. This is effected by leading some of the liquid to a receptacle forming part of the balance mechanism, for example the liquid may be passed after treatment to a proportioning device from which a proportion or fraction of the treated liquid may be led to the receptacle on the balance mechanism. This balance mechanism may conveniently consist of a lever mounted to rock about a spindle which is operatively connected with the various valves, the receptacle being mounted upon one arm of the lever, and a weight being arranged to move between limits along the other arm. The liquid will then be admitted to the receptacle, and when the latter is full the mechanism will automatically be moved so as to admit the regenerating solution. The lever will be restored to its initial position when the receptacle has emptied itself. Since time must be allowed for complete regeneration to take place and for the exhausted regeneration solution to be thoroughly washed out with water, the receptacle is arranged to empty itself slowly; for example a siphon may be arranged with an adjustable valve so that the time taken for the emptying may be regulated easily. The weight moves along the arm of the balanced lever from near to the end of that arm to a point close to the axis about which the lever rocks, and is made less than the weight of the liquid in the receptacle when the latter is full. The arrangement is preferably such that the weight moves out to the end of the arm as soon as the balance mechanism starts to return to its original position, and thus the necessary turning couple for operating the valves is ensured. A lost motion device may be inserted between the balance mechanism and the valves so as to allow the mechanism to rock through a small angle before taking up the load.

Preferably the treated liquid is led to a small tank provided with two orifices of different sizes, and the outflow from the small orifice then goes to the receptacle on the balance mechanism. Such an arrangement ensures that the fraction of the liquid passing to the receptacle will be constant.

A further feature of the present invention consists in maintaining the regenerating solution in a concentrated form in a storage tank from which it flows to a small measuring vessel having an outlet larger than the inlet from the storage tank. This measuring vessel is provided with a float valve arranged to close the outlet when the level of regenerating solution in the vessel falls sufficiently.

The invention is particularly applicable to apparatus used in the softening of water by means of exchange material such as artificial or natural zeolite or glauconite, but it is applicable to other exchange reactions; for example it can readily be applied to the removal of iron compounds from water by the use of an exchange material containing manganese. Furthermore it can, of course, be applied to water softening plant in which the flow during softening is either downwards or upwards through the bed.

In order that the invention may be clearly understood and readily carried into effect, a water softening plant in which the flow is

downwards through the bed will now be described more fully by way of example with reference to the accompanying drawings, in which:—

Figure 1 shows a side elevation of the plant; some parts being in section;

Figure 2 shows to an enlarged scale a view of the linkage mechanism by which the valves are operated.

In the drawings a container 1 of usual construction is filled with a bed of base exchange material, such for example as grains of baked glauconite. The crude water to be softened enters through a pipe 2 provided with a control valve 3 and flows downwards through the bed of glauconite. An outlet pipe 4 leads from near the bottom of the container 1 and has two branches, a pipe 5 with a control valve 6 for the softened water and a pipe 7 with a control valve 8 through which the effluent from the container 1 flows to waste during the processes of regeneration and washing of the glauconite bed.

The brine used for regeneration is kept in concentrated form in a storage tank 9 which communicates by way of a pipe 10 with a measuring vessel 11. The outlet of this vessel 11 is connected by a pipe 12 having a control valve 13 with the intake of an ejector nozzle 14 disposed in the inlet pipe 2.

The control valves 3, 6, 8 and 13 are connected by mechanical linkages 15, 16, 17 and 18 respectively to a horizontal spindle 19 on which a lever 20 is rigidly fixed. One arm of this lever 20 is shaped as a receptacle 21 into which water is delivered through a pipe 22, and the other arm of the lever 20 is made as a hollow tube in which a spherical weight 23 can roll. The lever 20 is so proportioned that the tubular arm just overbalances the receptacle when the latter is empty, but when the latter is full the weight of the water and the receptacle just overbalances the tubular arm and the spherical weight 23 even though the weight is at the end of the arm. A siphon 24 is provided in the receptacle 21 and has an adjustable valve 25, so that when the receptacle 21 is full and the lever 20 tilts to the position shown in dotted lines in Figure 1, the receptacle slowly empties itself at a rate that can easily be regulated.

The water which flows into the receptacle 21 through the pipe 22 is a fixed proportion or fraction of the soft water passing out through the pipe 5. This proportioning is effected by arranging the pipe 5 to deliver into a small proportioning box or tank 26 provided with a relatively large orifice 27 and a relatively small orifice 28. The majority of the water in the tank 26 will then flow through the orifice 27 into a soft water storage tank or reservoir 29, but clearly a small but fixed proportion of the softened water will flow through the orifice 28 into the pipe 22. A cut-off valve 30 is provided at the top of the pipe 5 and is controlled by a float 31 so that when the tank 29 is full the operation of the whole apparatus may be stopped.

The measuring vessel 11 for the regenerating brine comprises a small cylinder through the top of which a pipe 32 projects. The other end of this pipe 32 communicates with the top of the brine storage tank 9, and the depth which the pipe projects into the vessel 11 may easily be adjusted. A small disc 33 is arranged to slide in the vessel 11 above a float 34 which is shaped so as to close the outlet pipe 12 from the vessel 11 when it is in its lowest position. This outlet pipe 12 is made of larger cross-section than the inlet pipe 10.

The operation of the apparatus is as follows:—During the process of softening, the lever 20 is turned to the position shown in full lines in Figure 1, and in this position the valves 3 and 6 are fully opened while the valves 8 and 13 are completely closed. The hard water enters through the pipe 2, passes down through the bed of glauconite into the container 1, and emerges as soft water through the pipe 4 passing through the pipe 5 to the proportioning box 26. As explained above, a definite small fraction of the softened water passes from the box 26 down through the pipe 22 into the receptacle 21. The amount of water passing into this receptacle 21 is so arranged that the bed of glauconite is practically exhausted during the time taken to fill the receptacle. When the receptacle 21 is full, the lever 20 tilts over, and as soon as it has passed the horizontal, the weight 23 runs down the tubular arm of the lever 20 with the result that the lever is then considerably unbalanced, and in turning further to the position shown in dotted lines in Figure 1, can exert sufficient power to move the valves 3, 6, 8 and 13. In order to allow the lever 20 to begin to move without having to move the valves, a lost motion device is inserted in the spindle 19. This lost motion device consists of a horizontal projecting arm 35 which can move between the two arms of a fork 36. When the lever 20 has turned to the position shown in dotted lines, the valves 8 and 13 will then be completely open, and the valve 6 completely shut, while the valve 3 in the inlet pipe 2 will then be partially shut. At the same time, the siphon 24 will have been completely covered, and water will, therefore, begin to run out of the siphon 24 to waste.

The reduced stream of water passing through the inlet pipe 2 and ejector nozzle 14 will draw in brine from the measuring vessel 11 so that the glauconite bed will be regenerated. At the start of the regeneration the measuring vessel 11 will be filled up to the level of the bottom of the pipe 32, but since the pipe 12 is larger than the pipe 10 it will gradually empty itself, and consequently the float 34 will sink until finally when it is

near the bottom it will be drawn down quickly to close the outlet pipe 12 by reason of the suction of the ejector 14. Concentrated brine will continue to flow, however, from the tank 9 through the pipe 10 until the disc 33 rises into contact with the end of the pipe 32, thus providing a fresh measured charge of brine for the next period of regeneration. However, when the float 34 has closed the outlet pipe 12, crude water will continue to pass through the inlet pipe 2 and down through the glauconite bed, washing out the exhausted brine solution. Both this wash water and the exhausted brine solution, of course, pass to waste through the pipe 7.

The adjustable valve 25 on the siphon 24 is so arranged that the time taken for the receptacle 21 to empty itself is exactly that required for the regeneration and washing of the glauconite bed. When the receptacle 21 is completely empty, the lever 20 will start to turn back to the position shown in full lines in Figure 1, and as soon as it has passed the horizontal, the weight 23 will roll from the point close to the axis of the spindle 19 to the extreme end of the tubular arm of the lever, and will thus provide the necessary power for the return of the various control valves to the positions in which softening takes place. By reason of the lost motion device 35, 36, the lever 20 is again free to start to turn before it has to take up the load of the valves.

The apparatus illustrated and described in detail has been given merely by way of example. The invention is not, of course, in any way limited to it. For example, any suitable form of proportioning device may be used in place of the box 26, or in the case of a supply to a pressure main, the box 26 may be enclosed and subjected to pressure in the main; in this case, however, the flow through the small orifice 28 may still return to the receptacle 21.

Again, it will be clear that although in the apparatus described a proportion of the softened water is delivered into the receptacle 21, the plant may easily be arranged so that instead the proportion of the hard water entering the apparatus may be used to fill the receptacle. Further, of course, any suitable arrangement of linkage may be employed between the spindle about which the balanced lever turns and the valves, and again it will be obvious that instead of employing the moving weight, a receptacle could be arranged at each end of the balance mechanism and could equally be supplied with water.

Finally, the proportioning device may be replaced by any suitable form of liquid meter arranged to close an electric circuit when a predetermined amount of liquid has passed. In this case the flow of liquid into the receptacle on the balance mechanism should be such that the receptacle will just be filled in the shortest time in which the said predetermined amount of liquid can be treated. The closing of the electric circuit can then be arranged to release a catch which frees the balance mechanism, and the latter will then operate in the fashion described above. In this case also, of course, the time of regenerating and washing will be determined only by the rate at which liquid flows out of the balance mechanism. A suitable overflow must be provided in the receptacle on the balance mechanism so that when it has filled before the catch is released, the liquid which continues to flow in can easily escape. Since the treated liquid outlet pipe will be closed directly the catch is released and the balance mechanism tilts, no further liquid will flow to the meter until the receptacle has emptied itself and the balance mechanism has tilted back to its original position.

We claim:

1. An apparatus for the treatment of liquid by a base exchange material, consisting of a container for the base exchange material, inlet and outlet pipes for the liquid to be treated connected to said container, a control valve arranged in said inlet pipe, a balance lever mechanism linked to said valve, a receptacle mounted upon said mechanism, and means for supplying a predetermined proportion of the liquid flowing from the treating apparatus to said receptacle.

2. An apparatus for the treatment of liquid by a base exchange material, consisting of a container for the base exchange material, inlet and outlet pipes for the liquid to be treated connected to said container, a control valve arranged in said inlet pipe, a balance lever mechanism linked to said valve, a receptacle mounted upon said mechanism, and a proportioning device associated with said outlet pipe for supplying a fraction of the treated liquid to said receptacle.

3. An apparatus for treating a liquid by means of a base exchange material, comprising a container for said base exchange material, inlet and outlet pipes for the liquid connected to said container, valves in said pipes for controlling the inflow and outflow of liquid to the container, a storage tank for regenerating solution, a pipe connecting said tank to said container, a controlling valve in said pipe, a drain connection from said container, a valve controlling said drain connection, a balance lever device linked to all four of said valves, a receptacle mounted upon said balance lever device, and means for leading some of the liquid to said receptacle.

4. An apparatus for the softening of water, comprising a container for base exchange material, inlet and outlet pipes for water to be treated connected to said container, a storage tank for regenerating solution, a connecting pipe from said tank to said container, a valve in said last-mentioned pipe, a balance

lever mechanism linked to said valve, a receptacle carried upon said balance lever mechanism, means for leading some of the liquid to said receptacle so as to overbalance said mechanism after the flow of a predetermined amount of liquid, and a siphon device for emptying said receptacle in order to allow the return of said balance mechanism to cut off the supply of regenerating solution.

5. An apparatus for the softening of water, comprising a container for base exchange material, inlet and outlet pipes for water to be treated connected to said container, a storage tank for regenerating solution and a connecting pipe for said storage receptacle to said container, a valve in said last-mentioned pipe, a balance lever mechanism linked to said valve, a receptacle carried upon said balance lever mechanism, means for leading some of the liquid to said receptacle so as to overbalance said mechanism after the flow of a predetermined amount of liquid, a siphon device for emptying said receptacle in order to allow the return of said balance mechanism to cut off the supply of regenerating solution, and an adjustable valve associated with said siphon for regulating the time taken for the emptying of said receptacle.

6. An apparatus for the treatment of liquid by means of base exchange material, comprising a container for base exchange material, inlet and outlet pipes for said liquid connected to said container, a valve in said inlet pipe, a double-armed balanced lever linked to said valve, a receptacle carried on one arm of said lever, means for leading a predetermined proportion of the liquid flowing from the treating apparatus to said receptacle, and a weight carried on the other arm of said lever so as to be movable thereon between limits.

7. An apparatus for the treatment of a liquid by a base exchange material, consisting of a container for base exchange material, inlet and outlet pipes for said liquid connected to said container, a control valve in said inlet pipe, a supply pipe for regenerating solution connected to said container, a control valve in said last-mentioned pipe, a balance lever mechanism operative between and directly linked to said control valves, and means for permitting rocking of said lever after a predetermined volume of liquid has flowed and for return of the same after a predetermined further interval of time.

8. An apparatus for the treatment of a liquid by a base exchange material, consisting of a container for base exchange material, inlet and outlet pipes for the liquid to said container, a storage tank for regenerating solution, a pipe connecting said tank to said container, a drain connection from said container, valves controlling each of said three pipes, and said drain connection, a double-armed balanced lever, a shaft linked to said valves, and a lost motion connection between said double-armed lever and said shaft.

9. An apparatus for the softening of water, consisting of a container for base exchange material, inlet and outlet pipes for the water connected to said container, a storage tank for regenerating solution, a measuring vessel for said solution, an inlet pipe to said measuring vessel from said tank, an outlet pipe from said measuring vessel to said container and of larger cross-section than said second mentioned inlet pipe, a valve in said second mentioned outlet pipe, means for opening said valve after a predetermined volume of water has flowed through the container and for closing said valve after a measured volume of regenerating solution has flowed through same.

10. An apparatus for the softening of water, consisting of a container for base exchange material, inlet and outlet pipes for the water connected to said container, a storage tank for regenerating solution, a measuring vessel for said solution, an inlet pipe to said measuring vessel from said tank, an outlet pipe from said measuring vessel to said container and of larger cross-section than said second mentioned inlet pipe, a valve in said second mentioned outlet pipe, means for opening said valve after a predetermined volume of water has flowed through the container and for closing said valve after a measured volume of regenerating solution has flowed through same, and a float valve in said measuring vessel arranged to close the outlet pipe therefrom when said vessel has become empty.

11. An apparatus for softening water, consisting of a container for base exchange material, inlet and outlet pipes for the water connected to said container, a storage tank for regenerating solution, a small closed measuring vessel for said solution, an inlet pipe from said storage tank to said measuring vessel, an outlet pipe from said measuring vessel to said container of larger cross-section than said second mentioned inlet pipe, an automatically operated control valve in said second mentioned outlet pipe, a vent pipe connecting said measuring vessel with said storage tank above the level of the solution therein, and a float valve in said measuring vessel adapted to close said vent pipe when said measuring vessel contains a predetermined volume of solution but to sink and close the solution outlet pipe when the predetermined volume of solution has flowed to the container.

In witness whereof we hereunto subscribe our names this 6th day of March, 1928.

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