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METHOD OF AND APPARATUS FOR SOFTENING WATER BY BASE EXCHANGE

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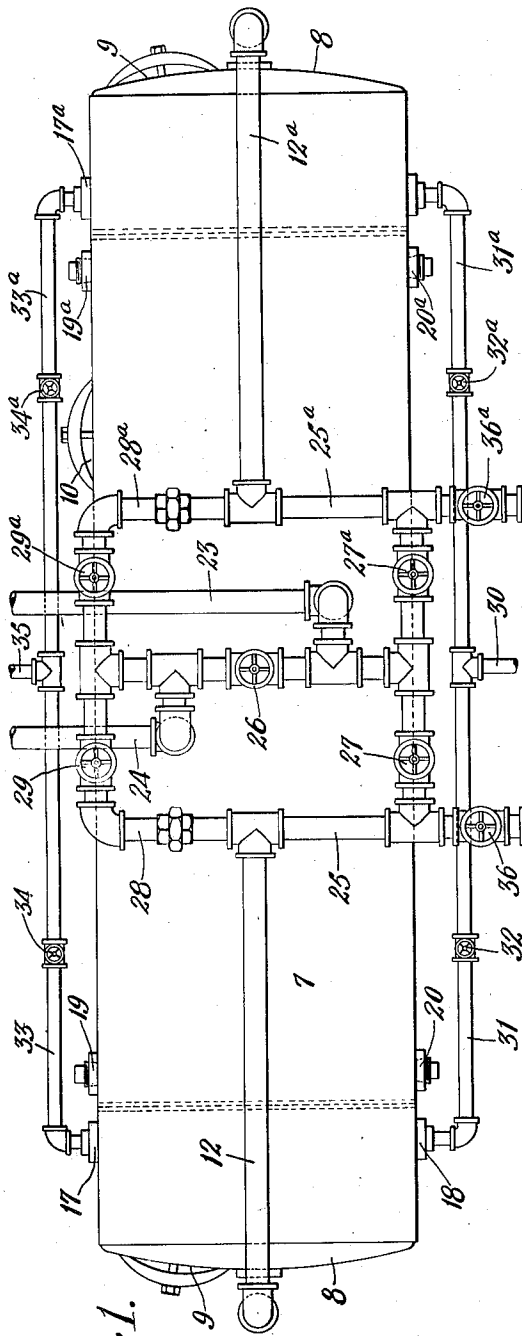


Fig. 1.

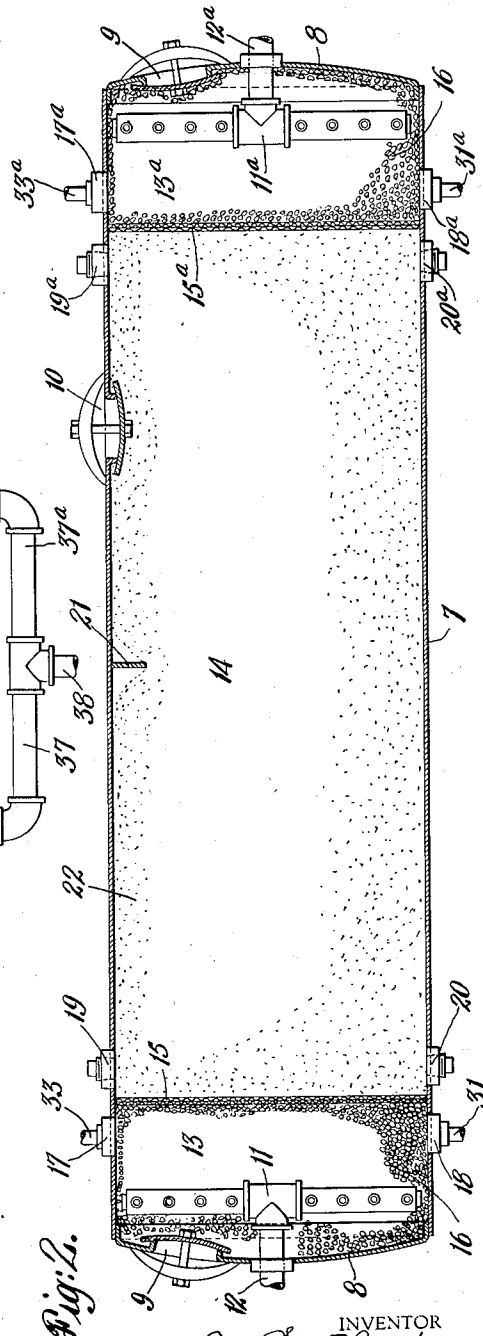


Fig. 2.

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METHOD OF AND APPARATUS FOR SOFTENING WATER BY BASE EXCHANGE

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This invention relates to an improved method of softening water by base-exchange as well as to an improved apparatus for use in connection therewith.

5 Stated in broad terms the principal object of the invention is to make the fullest possible use of available base-exchange material, to increase the efficiency of a given water softening installation and to material-
10 ly lower the cost both of installation and operation per unit of softened water.

Another important object of the invention is to materially reduce the weight and size of a softening installation of given capacity.
15 As incidental to this feature, it is an object of the invention to adapt softening installations to situations not heretofore available and in this way to make it possible to more conveniently locate the softening equipment
20 and to permit better use of the floor area, all of which is particularly important in certain types of commercial installations where floor space may be expensive and loading strictly limited.

25 Another object of the invention is to provide for thorough cleansing of the apparatus without the necessity of any special provisions for back-washing or other expedient which would take the apparatus out of service.
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Still another object of the invention is to more uniformly utilize the full capacity of the bed of softening material and to prevent what is known as local channeling.

35 Still another object of the invention is to provide a softening equipment thru which the hard water and/or the regenerating solution can be passed thru the tank or bed of softening material in either direction.

40 I also provide a softening equipment in which the tank can be disposed in a horizontal or a substantially horizontal position instead of the customary upright or substantially vertical position heretofore in use.

45 A further object of the invention is to provide a softening apparatus in which it is not necessary to drain the tank either prior to or subsequent to regeneration.

50 I also provide a softening apparatus in which the rate of flow can be materially in-

creased while at the same time loss of the "fines" in the softening material can be almost wholly overcome.

The foregoing together with such other objects as may appear hereinafter or are incidental to my invention are obtained in the following manner, reference being had to the accompanying drawing which illustrates a preferred form of apparatus in which my improved method of softening can be carried
55 out.

In the drawing, Figure 1 is a side elevation of my preferred apparatus, and Figure 2 is a vertical longitudinal section of the apparatus with certain of the piping connections
60 omitted for the sake of clearness.

By referring to the drawing it will be seen that I provide a softening tank 7 preferably disposed in a horizontal or nearly horizontal position. The tank can be of any preferred
65 construction but should, of course, be of sufficient strength to withstand whatever water pressure to which it may be subjected. In the present instance the end plates 8 are convex and each is provided with a suitably closed
70 manhole 9. The shell of the tank is also provided with a manhole 10.

The tank may be of varying diameter in proportion to the length, but I have found in practice that a very satisfactory installation can be made by having the tank substantially three times as long as its diameter.

Adjacent the inner face of the left-hand end plate 8 I have provided a suitable distributor 11 and in a similar location at the opposite end another distributor 11a which are
85 connected to the outside by means of the pipes 12 and 12a respectively.

The interior of the tank 7 is divided into three compartments 13, 13a and 14 by means of the vertically disposed screens 15 and 15a.
90 The chambers 13 and 13a at the left and right-hand ends respectively of the tank 7 are of comparatively small size and are filled with some suitable filtering material such as coarse sand or small pebbles 16. There are
95 openings 17 and 17a respectively, at the top of the chambers 13 and 13a, as well as openings 18 and 18a at the bottom, as clearly seen in Fig. 2. These openings may be fitted with
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closing plugs or coupled to pipes as desired and in accordance with the manner in which the softener is operated as hereinafter more fully described.

5 The large central chamber 14 of the tank 7 is provided in the upper face at the left and right-hand ends, respectively, with suitably plugged openings 19 and 19a opposite to which, in the lower or bottom portion of the tank, are the plugged openings 20 and 20a.

10 In the upper part substantially midway between the screens 15 and 15a, the tank 7 may be provided with the downwardly extending baffle plate 21 in the shape of a segment of a circle which will act to prevent short circuiting of the flow should there be any substantial space between the tank and the top of the bed of zeolite.

15 In the chamber 14 I place the base-exchanging material 22 which may be of any desired character although I prefer to use a synthetic material of light specific gravity and the chamber is preferably filled substantially full.

20 The hard water comes in thru the pipe 23 and can be passed as desired either to the outlet 24 if the softener is not in operation, or to the distributors 11 and 11a thru the connections 25 and 12 or 25a, and 12a. These connections are controlled respectively by the valves 26, 27 and 27a, as clearly seen in Fig. 1.

25 The outlet 24 is also connected to the headers 11 and 11a by means of the connections 28 and 28a under the control of the valves 29 and 29a also as clearly shown in Fig. 1.

30 Softening of the water may be effected by passing the hard water thru the tank in either direction. For example with the valves 26, 27a and 29 closed and valves 27, and 29a open the hard water can be delivered to the header 11 at the left-hand end of the tank thru the pipe 25, and pipe 12 and after it has passed thru the tank it is delivered as soft water thru the header 11a, pipe 12a, connection 28a and outlet 24. The reverse operation can take place with equal facility so that the water can be passed thru the tank in a direction from right to left instead of from left to right.

35 The foregoing gives rise to a number of very important advantages. For example, by alternating the flow thru the tank with each regeneration of the base-exchanging material, it is possible to wash out whatever dirt or sediment may have been filtered out of the water by the filtering material 16. In this way the efficiency of the softener will never be cut down and it will never be necessary to take the softener out of service in order to back-wash or clean the sand or pebbles.

40 Furthermore this reversal of the direction of flow will make far better use of the available base-exchange material than has been possible heretofore. It is a well known fact that that portion of the body of base-ex-

change material which first comes into contact with the hard water more quickly becomes exhausted than the remaining portions. By reversing the flow more even use of the base-exchanging property of the material is made possible.

70 It should also be noted that this constant reversal of the flow of the hard water prevents the possibility of any mud or silt working its way into the grains of the base-exchange material.

75 I find also that my invention almost entirely obviates the troubles incident to what is known as local "channeling" in the zeolite or base-exchange material. Such channeling produces preferential passages thru the bed of softening material and greatly reduces the capacity of the bed because all portions of the material are not effectively used. By providing substantially equal areas of contact between the bed of base exchanging material and the chambers 13 and 13a (as shown) and by substantially filling the chamber 14 with zeolite my arrangement serves to prevent such local or preferential channeling.

80 By my invention I am also enabled to substantially increase the rate of flow of the water thru the casing because I have eliminated the commonly used "free-board" space usually found above the bed in vertical softeners. This "free-board" space has been provided for the purpose of enabling the particles of the zeolite to rise up or roll either during operation of the device as a softener or during a back-washing operation and in order to avoid loss of the "fines" the speed or rate of flow had to be cut down below the point at which the water would carry off the fine particles. Volume of flow was provided for by increasing tank diameter.

85 With my invention, however, the "free-board" space is not necessary and the fact that there can be provided a filtering bed of pebbles or sand 16 at either end of the tank, makes it possible to retain substantially all of the bed of base-exchange material even though there be a large percentage of "fines" and even though the rate of flow be substantially increased. Whatever "fines" may work themselves thru the bed into the pebbles at one end are there caught by the pebbles and then returned to the bed or caught by the pebbles at the opposite end when the direction of the flow is reversed.

90 The size of a tank can be materially reduced, therefore, because in the first place the "free-board" space is not necessary and in the second place the rate of flow can be increased with my invention. The elimination of the "free-board" space reduces the quantity of water present in the tank at any one time and because the tank can be made smaller it can be placed in positions not heretofore available for softening apparatus such as the upper floors of buildings where the

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permissible load is limited. My tank can be hung from the ceiling if desired where floor space is not available.

Regeneration can also be accomplished from either direction and preferably in alternate directions as in the case of the flow of the hard water. The brine solution can be introduced thru the pipe 30 and delivered to one end or the other thru the pipes 31 and 31a under the control of the valves 32 and 32a. The pipes 31 and 31a enter respectively the bottom of the chambers 13 and 13a thru the openings 18 and 18a previously referred to, circulation of the salt solution being established thru the bed by withdrawal from the upper part of the chamber 13 or 13a at the opposite end of the casing. For instance, if the salt solution is introduced at the bottom of the chamber 13 withdrawal will take place from the top of chamber 13a thru the opening 17a and pipe 33a, but if the salt is being introduced into the bottom of the chamber 13a withdrawal will take place from the top of chamber 13 thru the opening 17 and connection 33. Connections 33 and 33a are provided respectively with the valves 34 and 34a and they come together in a common discharge 35. Valves 32 and 34a are open and valves 32a and 34 are closed when the salt is being passed thru the bed in a direction from left to right and vice versa. I prefer to pass the salt solution thru the bed in the same direction in which the hard water has just previously passed as this will bring the fresh brine solution into contact with the most exhausted part of the bed in the first instance. This, however, is not essential as will be readily understood.

After regeneration has taken place, the valves in the salt circulation system just described are all shut off and the brine now present in the tank removed in the following manner. Hard water is turned into the tank from the inlet pipe 23 in the direction desired which, for example, we will assume is from left to right. Valve 27 is open, of course, but the other water valves so far described are all closed. The incoming raw water flows out from the header 11 and the salt water in the tank is pushed out ahead of it through the header 11a, pipe 12a, pipe 25a and past valve 36a through the drain connection 37a. In the reverse direction the spent brine is discharged thru the heater 11, pipe 12, pipe 25, valve 36, and pipe 37. The pipes 37 and 37a are preferably united in a common waste pipe 38.

The body of brine in the tank passes out through the waste pipe 38 with substantially no intermixing or dilution of the salt solution with the incoming hard water. In this way there is practically no wash water necessary in order to rid the tank of brine, the action which takes place being based probably upon the combined effect of the differ-

ence in densities, the equal areas at each end of the bed of zeolite, the even and uniformly packed condition of the zeolite, and the fact that the operation takes place at all stages under the normal water pressure present in the line. The heavier salt solution passes outwardly in an apparently undisturbed body before any substantial mixing action takes place. The tank can be cleared of brine solution in a very short time and with a minimum loss of water.

I also wish to point out that by suitable connections and valves the brine solution could be passed into the tank through either of the headers 11 and 11a and out through the other, and removed in a similar manner thru the pipe 38.

If, for any reason, it is necessary to withdraw the base-exchange material from the chamber 14 or the sand or pebbles 16 from the chambers 13 and 13a, it is only necessary to remove the pipe connections or the plugs, as the case may be, from the openings 18, 18a, 20 and 20a in the bottom of the tank. The contents will then flow out by gravity, thus making it extremely easy to renew or replace, or for any other reason, remove the contents of the chambers 13, 13a and 14, a feature which is of distinct advantage in large capacity plants.

The main bulk of the base-exchange material is, of course, introduced through the manhole 10 and that of the sand or pebbles through the manholes 9, but the openings at 17, 17a, 19 and 19a in the top of the tank are also used for this purpose, and, indeed, in the case of the base-exchange material, I find it very convenient to introduce a portion of the bed thru the openings into which the plugs 19 and 19a are fitted. And in filling the chamber with zeolite, I find the following procedure highly effective. As the base exchange material is added, the water is permitted to flow through the tank, and as it passes through the chamber 14, it carries the particles of zeolite against one or the other of the screens 15, 15a, as the case may be. This is repeated until the chamber is as full as desired.

Furthermore, during operation of the device the particles of the base-exchanging bed have a tendency to shift themselves first against one screen and then against the other, and as they move from side to side they may leave a small area at the upper corners of the chamber 14 immediately below the plugs 19 and 19a in which no base-exchange material will be present. I prefer to fill these small areas from time to time by insertion of additional softening material through the openings in question.

I claim:—

1. In apparatus for softening water by base exchange comprising in combination, a tank, a confined bed of zeolite in said tank,

means for passing fluids thru said tank and said bed in substantially horizontal flow lines, and a baffle extending downwardly from the top of the tank across the line of flow and into said bed of zeolite.

2. In an apparatus for softening water by base exchange, the combination of a stationary tank having a chamber completely filled with base exchanging material, and means for passing fluids through said bed in substantially uniform horizontally traveling flow lines.

3. In an apparatus for softening water by base exchange, the combination of a stationary tank, oppositely disposed distributing chambers in said tank arranged so that flow from one to the other will take place in substantially horizontal flow lines, a bed of base exchanging material confined in and completely filling the space between said chambers, the areas of contact between said chambers and said bed of base exchanging material being substantially equal, and means for passing fluids through chamber, bed and chamber, as aforesaid.

4. In an apparatus for softening water by base exchange, the combination of a stationary tank, a pair of spaced filters disposed within the tank so that flow from one to the other will take place in substantially horizontal flow lines, a bed of base exchanging material confined in and completely filling the space between said filters, the areas of contact between the filters and said bed being substantially equal, and means for passing fluids, as aforesaid, through filter, bed and filter.

5. In an apparatus for softening water by base exchange, the combination of a stationary tank, oppositely disposed distributing chambers in said tank arranged so that flow from one to the other will take place in substantially horizontal flow lines, finely divided filtering material such as gravel or sand confined in and completely filling each of said chambers, a bed of base exchanging material confined in and completely filling the space between said chambers, the areas of contact between said bed and the finely divided material at each side being substantially equal, and means for passing fluids as aforesaid, through chamber, bed and chamber.

In testimony whereof I have hereunto signed my name.

GUY SCOTT APELDORN.