

Oct. 31, 1950

L. E. LANCES
LIQUID-PERMEABLE TANK BOTTOM FOR
BEDS OF GRANULAR MATERIAL

2,528,062

Filed Feb. 12, 1948

4 Sheets-Sheet 1

FIG. 1.

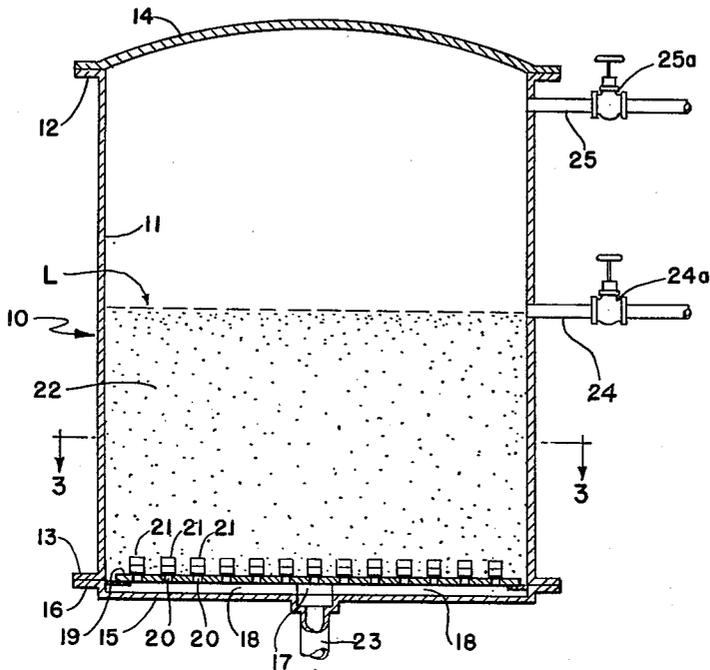
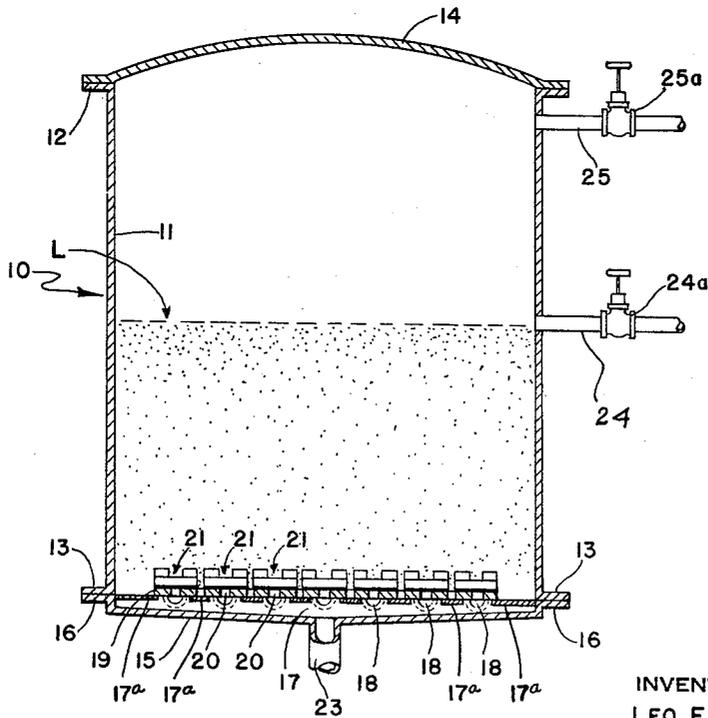


FIG. 2.



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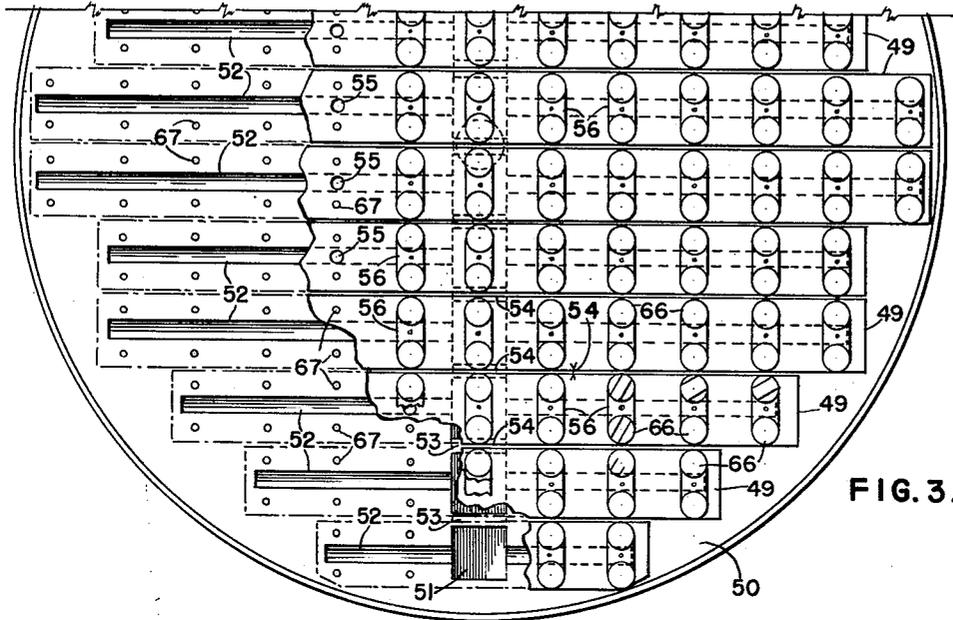


FIG. 3.

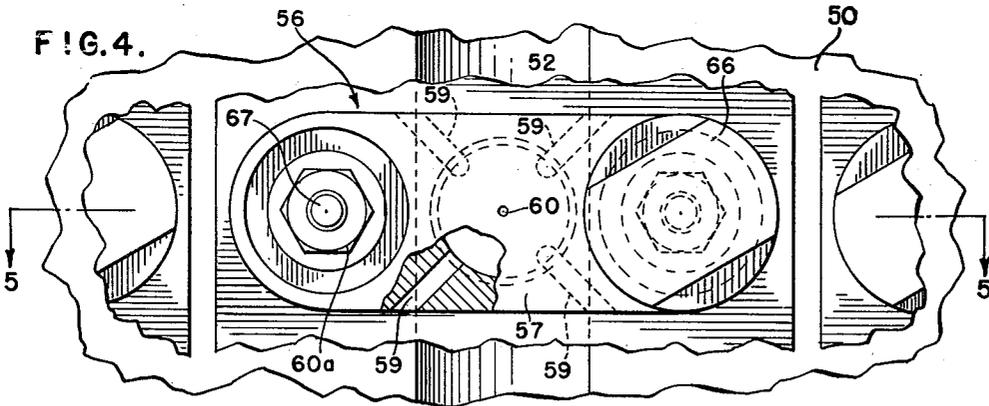


FIG. 4.

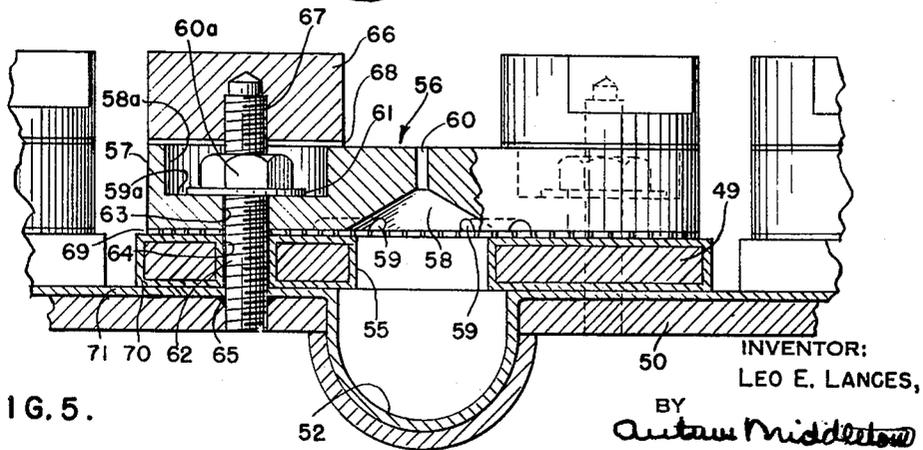


FIG. 5.

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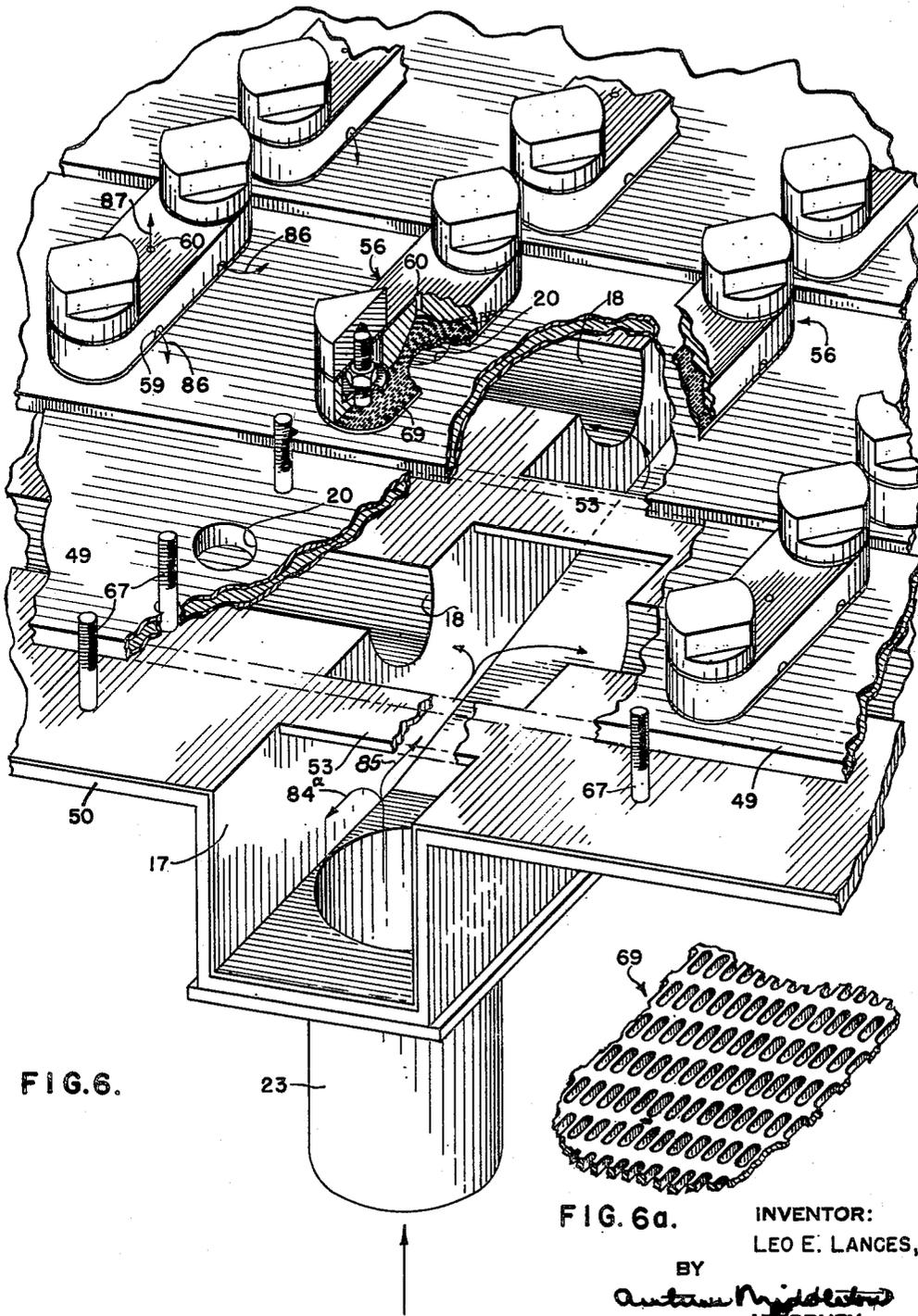


FIG. 6.

FIG. 6a.

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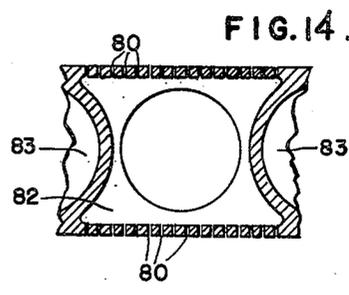
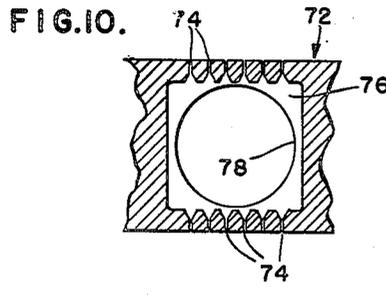
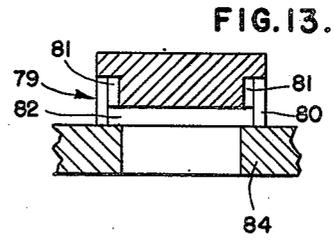
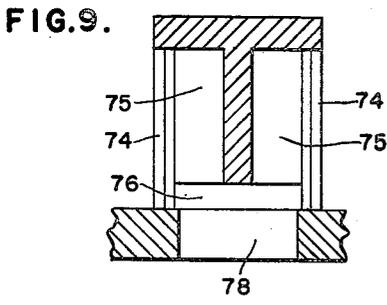
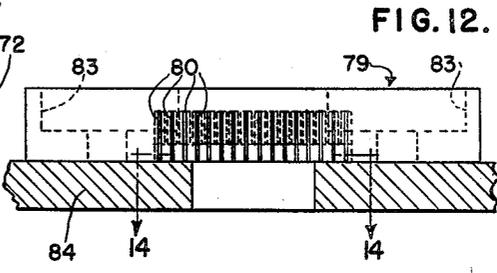
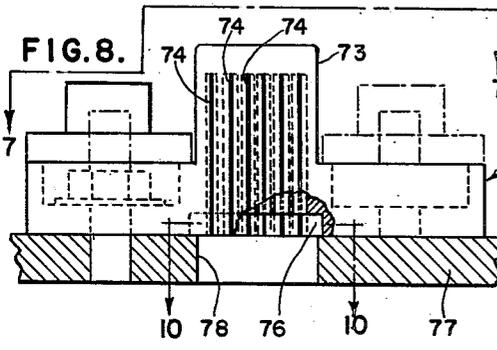
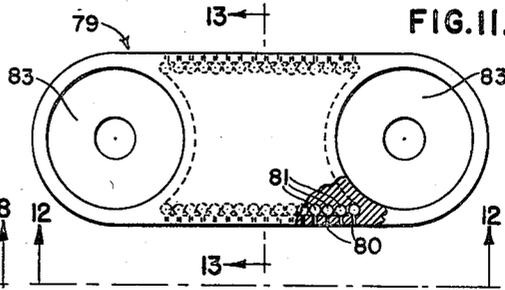
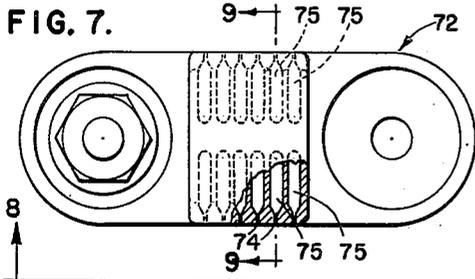
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UNITED STATES PATENT OFFICE

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LIQUID-PERMEABLE TANK BOTTOM FOR BEDS OF GRANULAR MATERIAL

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Application February 12, 1948, Serial No. 7,958

7 Claims. (Cl. 210-148)

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This invention relates to apparatus for treating liquids, in which the liquid percolates through a bed of granular material contained in a tank. More specifically it relates to improvements in the structure for supporting the bed of material in the tank, that is a structure in the nature of a liquid permeable false bottom or liquid-distributing supporting structure.

With respect to the bed-supporting and liquid-distributing structure in such apparatus it is a general problem that while liquid may pass upwardly or downwardly through the bed, granules or particles of the bed material should not escape downwardly through flow passages of the supporting structure. On the other hand the liquid permeating the structure, for instance upwardly, should be distributed by the structure as uniformly as possible with respect to the entire cross-sectional area of the bed. Yet it is desirable that the bed-supporting structure be compact in the sense that it should occupy only a minimum of vertical tank space in order to detract a minimum from the operative height of the tank as well as to minimize the volume of liquid which might be detained within or by the passages of the supporting structure itself. The importance of some of the more specific problems just mentioned will appear more clearly in the course of the subsequent description.

While the improvements in the bed-supporting and liquid-distributing structure of this invention may apply to plain filter operations with beds of granular filter material that is inert with respect to the liquid being filtered therethrough, the improved structure appears to be of special significance when applied to the operation of beds of granular contact material, that is material reacting chemically with the liquid or solution percolating through the bed.

An important application of the improved structure lies in its use for the operation of beds of granular ion exchange material, such materials being for example in the nature of organic or synthetic resinous materials variously also known as exchange resins or as organolites.

By way of example, the bed-supporting structure of this invention may be embodied in an apparatus adapted to serve for the purification treatment liquids through ion exchange whereby dissolved inorganic salts if ionized may be removed from a solution containing them. In this way, for example, sugar-bearing solutions or sugar juices may be freed of non-sugars or impurities represented by salts in solution, such as sulphates and chlorides found among others in naturally derived sugar juices.

Taking the case of purifying and de-ionizing beet sugar juice as an example, the sugar solution containing the dissolved and ionized salts or impurities is passed sequentially through a bed

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of cation exchange material and a bed of anion exchange material. The treatment unit containing the cation exchange material is herein also called a cation exchange cell or station, while the unit containing the anion exchange material is also termed an anion exchange cell or station.

The principle of the chemical mechanism per se of such a de-ionizing or purification operation through ion exchange is well known. Briefly the cation exchange material having been loaded with exchangeable H-ions by regeneration or treatment with a strong mineral acid such as H_2SO_4 of a suitable concentration upon contact with the sugar juice takes up the cations of the ionized salt while releasing the molar equivalent of H-ions into the solution or juice and to that extent acidifying that solution. The thus acidified sugar juice then passes through the anion exchange material which has previously been regenerated by contact with an alkali such as Na_2CO_3 of a suitable strength. The thus conditioned anion exchange material upon contact with the acidified sugar juice adsorbs the acid previously induced in the juice and thus there passes from the bed a juice that is purified, that is, freed of salts as well as substantially neutralized. The anion exchange material therefore is also termed an acid-adsorbing exchange material. Another interpretation is that the anion exchange material by regeneration becomes loaded with exchangeable OH-ions which are subsequently released into the sugar juice in exchange for the molar equivalent of the anions of the acid, so that as a net result the acid will have been replaced with the molar equivalent of pure water.

Certain crystallizable sugars, such as sucrose, contained in sugar juices tend to be changed to invert sugars in an acid medium whereby they lose the ability to crystallize. Where the objective is to obtain crystallized sugar as the end product following ionic purification of the sugar juice, it is desirable to minimize the time of detention of the juice in the acid phase that is temporarily induced in the juice due to the exchange of cations against H-ions, in order that inversion might be discouraged. The compactness of the bed-supporting structure according to this invention is a contributing factor in minimizing that detention.

In the case of ionic sugar juice purification it is important for several reasons that the flow of liquid be uniformly distributed throughout the cross-sectional area of the bed. One reason is that the bed should be progressively and uniformly exhausted in the direction of the flow of the juice through the bed. Another reason is that when displacing residual sugar juice or regenerant solution from the bed with water there should be as nearly as possible a volumetric displacement of the residual volume from the bed,

that is the displacement should take place with a minimum of intermixing between the displacing volume of water and the respective volume of liquid that is being displaced by it. This illustrates the specific importance of the improvements in the bed-supporting and liquid-distributing structure according to this invention.

In view of the foregoing objects, this invention provides a bottom plate embodying a system of channels or channel-like depressions in the plate. This channel system comprises a primary horizontal liquid distributing channel from which branch off a plurality of secondary channels extending transversely of or laterally from the primary channel. This channel system is overlain by a cover plate or plate sections fastened to the bottom plate and having rows of openings substantially evenly distributed over the cross-sectional area of the bed to provide flow passages or communicating openings between the channel system and the bed of granular material resting upon the cover plate. Each of the openings in turn is provided upwardly with a multiple passage distributing head or distributing cap.

According to one feature a member or gasket of liquid permeable or porous or finely reticulated material is interposed between the distributing cap and the cover plate.

According to another feature the distributing cap is in the form of a flange member held to the cover plate by anchoring bolts. Other features lie in the specific construction of the distributing heads and in the manner of their attachment to the cover plate. Still other features lie in more specific arrangements of multiple passages or liquid-distributing slots in the distributing heads.

In one embodiment strip-like sections longitudinally coextensive with the secondary channels take the place of the cover plate. More specifically, each distributing head is held by bolts or studs extending through the cover plate sections or strips although anchored in or screwed into the bottom plate.

The invention possesses other objects and features of advantage, some of which with the foregoing will be set forth in the following description. In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit. In the accompanying drawings there has been illustrated the best embodiment of the invention known to me, but such embodiment is to be regarded as typical only of many possible embodiments, and the invention is not to be limited thereto.

The novel features considered characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawings in which

Fig. 1 is a diagrammatic sectional view of a tank embodying the flow-distributing system taken longitudinally of the primary channel;

Fig. 2 is a diagrammatic sectional view taken at right angles to the section of Fig. 1, that is, transversely of the primary channel and thus longitudinally of the transverse secondary channels;

Fig. 3 is a plan view of the distributing system with strip-like cover-plate sections broken away to show the arrangement of the channel system,

and distributing units mounted on the cover-plate sections;

Fig. 4 is a greatly enlarged partly broken away plan detail view of a distributing unit of Fig. 3 and structure directly adjoining it;

Fig. 5 is a partial vertical section taken on line 5—5 in Fig. 4;

Fig. 6 is a perspective view of a portion of the distributing system or tank bottom of Figs. 3 to 5 with parts broken away to show the primary channel with secondary channels branching therefrom;

Fig. 6^a is a greatly enlarged perspective view of a broken-off portion of a reticulated screening member or plate associated with a distributing head, and through which the liquid must pass;

Figs. 7 to 10 are views of a modified multiple passage distributing-head with narrow slot openings, Fig. 7 being a part-sectional top view taken on line 7—7 of Fig. 8, Fig. 8 being a part-sectional side view taken on line 8—8 in Fig. 7, Fig. 9 being a cross-sectional view taken on line 9—9 of Fig. 7, and Fig. 10 being a section on line 10—10 of Fig. 8;

Figs. 11 to 14 are views of a further modified distributing unit, Fig. 11 being a part-sectional top view, Fig. 12 being a part-sectional side view taken on line 12—12 of Fig. 11, Fig. 13 being a cross-sectional view taken on line 13—13 of Fig. 11, and Fig. 14 being a partial cross-section on line 14—14 of Fig. 12.

The diagrammatic sectional view in Figs. 1 and 2 shows a tank 10 comprising a cylindrical wall 11 having a top flange 12 and a bottom flange 13, a top or cover 14 connected to the top flange 12 and a bottom member 15 connected to the bottom flange 13. The bottom member 15 is formed with a flange 16 and with a system of channel-like depressions comprising a main or primary channel 17 from which extend lateral or secondary channels 18. The primary channel 17 has bridge portions 17^a unitary with the bottom chamber 15 for a purpose hereinafter to appear.

The bottom member 15 or channel system is overlain by cover-plates or plate-like strips 19 fastened to the bottom member 15. The cover-plates 19 have flow passage openings 20 registering with the channel system and disposed in a substantially uniform pattern over the cross-sectional area of the tank for the sake of an even distribution with respect to that area. Each flow passage opening 20 is covered by a flow-distributing unit or head 21. The bottom member 15 together with the apertured cover-plates 19 and the distributing-heads 21 are herein termed the flow-distributing and bed-supporting bottom structure since a bed 22 of granular material, in the present instance of ion exchange material, is supported by it. The primary bottom channel 17 has a bottom inlet or outlet in the form of pipe 23, while the tank wall has inlet or outlet connections such as indicated by pipes 24 and 25 shown to have control valves 24^a and 25^a respectively.

Fig. 3 may be said to be a plan view of the bottom structure of the tank of Fig. 1 and to represent an enlarged section on line 3—3 of Fig. 1. A number of strips or strip-like cover-plates 49 corresponding to plates 19 in Figs. 1 and 2 are co-extensive with and overlying individual flow channels of the channel system. In other words, there is a bottom member 50 which corresponds to the bottom chamber 15 of Fig. 1 and has a channel system similar to that

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of Figs. 1, 2, and which comprises a diametrically disposed main or primary channel 51 which corresponds to primary channel 17 in Fig. 2, and from which extend laterally in both directions secondary channels 52 which correspond to the secondary channels 18 in Fig. 1. The primary channel 51 is modified by embodying bridge portions 53 unitary with the bottom member 50 and extending from side to side across the channel 51, this being for the purpose of sealing corresponding gaps 54 between the strips 49.

The cover strips or plates 49 are provided with flow passage openings 55 registering with respective flow channels. A flow-dividing or distributing head 56 similar to the ones indicated at 21 in Figs. 1 and 2, is associated with each flow passage opening 55 in such a manner that the flow through the opening is subdivided by a plurality of small flow passages through which subdivisions of the flow pass close to the bottom or associated cover plate 49.

A distributing head 56 as shown more clearly in the greatly enlarged detail view of Figs. 4 and 5, as well as in the large partial Fig. 6 perspective view of the bottom structure, comprises an elongated flange member 57 of a material that is acid- as well as alkali-resistant, such as for example a plastic composition. The flange member 57 is formed with a conical recess 58 at the bottom and about centrally of the flange member, from which recess radiate horizontal inverted or bottom channels 59. Whereas four such horizontal bottom channels are shown, any suitable number of such channels may be provided. There is also provided a narrow vertical bore 60 representing a fifth flow channel rising from the highest point of the conical recess 58.

At the top of the elongated flange member 57 at each end thereof there is provided a cylindrical depression or recess 58^a in the flange member, the bottom face of which recess forms a shoulder 59^a against which is tightened a nut 60^a having a washer 61. This nut is tightened upon a stud 62 extending through holes 63 and 64 provided in the flange member 57 and in the plate 49 respectively, the lower or foot end of the stud 62 being fixed in the bottom member 50, for example by welding as indicated at 65. A threaded closure cap 66 also consisting of acid-resisting or plastic material is screwed tightly upon the exposed threaded top end portion 67 of stud 62, and through a washer 68 of suitable material closes the recess 58^a thereby encasing the top end portion 67 of the stud as well as nut 60^a against contact with surrounding liquid. In this way a pair of studs 62 hold a flange member 57 tightly to the top face of the cover-plate 49 and over a flow passage opening 55 in the cover plate. A plate of finely reticulated or screening material 69 is interposed and confined between the flange member 57 and its associated cover-plate 49. A coating of acid and alkali resistant material such as rubber may be provided upon the cover-plates 49 as well as upon the bottom member 50 such coatings being indicated at 70 and at 71 respectively.

Figs. 7 to 10 represent another embodiment of the distributing head 56 shown in Figs. 1, 2, 3, 4, 5, and 6, this embodiment residing mainly in a difference in the arrangement of the subdivisive flow passages, the concept being to provide narrow vertical slot-like openings instead of those having round or half-round cross-section, such as shown in the flange member

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57. In view of the narrowness of the vertical slots, this embodiment dispenses with the additional screening plate or member such as shown at 69 in Figs. 5 and 6 as well as in the detail Fig. 6^a.

Hence, the Figs. 7 to 10 embodiment comprises an elongated flange member 72 which is similar to the flange member 57 except that its middle portion is formed with an upward block-like extension 73 which makes possible the provision at each side of the flange member of narrow vertical slot-like outlet openings 74 representing the mouths or outlets of corresponding vertical channels or divisional flow passages 75 which are supplied with liquid from a chamber or recess 76 provided in the bottom of the flange member 72. The manner of fastening the flange member 72 by means of studs upon a cover plate 77 and over a flow passage opening 78 therein is the same as previously described in connection with the flow distributing head of Figs. 4 and 5.

The embodiment of the distributing-head in Figs. 11 to 14 as represented by a flange member 79 is similar in principle to that of Figs. 7 to 10 with respect to flow distribution by way of narrow vertical slot-like openings, although this embodiment lacks the central block-like extension of the Figs. 7 to 10 embodiment. That is to say, there are provided narrow vertical slot-like outlet openings 80 in the sides of the flange member 79 which correspond to vertical bores or distributing channels or passages 81 supplied from a chamber or recess 82 provided in the bottom of the flange member 79. By comparison with the Figs. 7 to 10 embodiment the vertical slot-like openings 80 are of considerably lesser height although greater in number and are supplied from the bottom chamber 82 that is larger than the corresponding bottom chamber in the Figs. 7 to 10 embodiment. At 83 are indicated depressions for the nuts of anchoring studs (not shown), while a portion of the associated cover-plate is shown at 84.

Operation

For the purpose of describing the operation, it will now be assumed that there is an upflow of liquid through the bottom structure of the tank into and through the bed of granular material upon it. This operation will be described in view of the embodiment of Figs. 1, 2, 3, 4, 5, 6, and 6^a. The main flow of the liquid being supplied to the bottom flows upwardly through the vertical inlet connection or pipe 23 into the main or primary channel 17. Upon entering into channel 17 the flow splits in opposite horizontal directions with one-half of it flowing towards one end of the channel, that is in the direction of arrow 84^a, while the other half flows towards the other end of the channel, that is in the direction of arrow 85 (see Fig. 6). Each half portion of the main flow in turn splits into subdivisive streams passing into the secondary channels 18, branching off at right angles to the main channel 17 in both lateral directions.

For the understanding of the further operation it will suffice to follow the flow of the subdivisive stream of liquid through one of the secondary channels 18 to and through an opening 20 of the corresponding cover-plate 49 and through the final flow-dividing openings of an associated distributing head or unit 21. Accordingly a portion of such a subdivisive stream from a secondary channel passes upwardly through an opening 20 and through the screening plate or member 69 into the bottom depres-

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sion or recess 58 of flange member 57, whence the liquid issues in final subdivisional streams through the radial channels 59 and through the vertical bore 60 as indicated by arrows 86 and 87 respectively in Fig. 6.

While the final or liquid-issuing channels or bores 59 and 60 may be so dimensioned and disposed as to discourage the passage therethrough of granules of the material of the bed above, should undersized grains nevertheless pass through these final channels and into the chamber 58, they are then retained or arrested by the screening member 69 which prevents them from reaching the underlying distributing channel system of the bottom member 15 or to reach the main supply or discharge connections 23 through which such grains might get lost.

In the operation the bed 22 of ion exchange material is to be kept in submergence substantially at all times, such submergence being indicated in Figs. 1 and 2 by a tentative liquid level L shown to be substantially at or somewhat above the top of the bed 22.

While the bed-supporting and flow-distributing structure as well as its operation have been described on the assumption that there is an upflow of liquid through the flow-distributing bottom structure into the tank, it should be understood that the direction of flow of the liquid through the tank may be reversed so as to be from the tank through the bottom structure which condition could be indicated by a reversal of the flow arrows now shown. Indeed, when conducting ion exchange operations some phases of the operating cycle may require upflow, while others may require downflow of liquid through the ion exchange bed.

Where the ion exchange treatment system requires passing the liquid sequentially through a cation exchange bed and an anion exchange bed, there will be experienced an acid as well as an alkali condition of the liquids passing through the beds. Such conditions will be due to the fact that the liquid passing through the cation exchange bed becomes acidified, although it is being de-acidified when subsequently passing through the anion exchange bed. Conditions which are either strongly acid or strongly alkali are also experienced inasmuch as the cation exchange material when exhausted must be regenerated with a strong mineral acid of suitable concentration, for example H_2SO_4 or HCl , while an exhausted anion exchange bed must be regenerated with a suitable solution of a strong alkali, for example Na_2CO_3 . It is for this reason that acid- and alkali-resistant coatings have been indicated upon parts coming in contact with the liquids, or that such parts have been described as consisting of an acid- or alkali-resistant material.

I claim:

1. A liquid-distributing bottom structure for a tank comprising a bottom plate provided with depressions representing a channel system comprising a primary channel and a plurality of secondary channels extending laterally from said primary channel having transverse bridge portions the top face of which is co-planar with the top face of said bottom plate and disposed in staggered relationship with respect to said secondary channels, strip-like plate elements longitudinally coextensive with respective secondary channels and having a plurality of flow passage openings spaced from one another along the length thereof, said plate elements alternating with

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and marginally overlying said bridge portions and having sealing contact with the top face of said bottom plate as well as with the top face of said bridge portions so that liquid through said channel system must pass through said openings, and a plurality of flow subdividing distributing heads each associated with a respective flow passage opening and having sealing relationship with the top face of the plate elements, and bolt connections for fastening said distributing heads and said plate elements to said bottom plate all in sealing relationship with one another.

2. A liquid distributing structure according to claim 1, in which said bolt connections comprise studs threaded into said bottom plate extending as a common fastening through said distributing heads as well as through said plate elements.

3. A liquid distributing structure according to claim 1, in which at least one of said distributing heads comprises a flange member having a plurality of subdivisional flow passages, and in which said bolt connections comprise studs threaded into said bottom plate and extending as a common fastening through said flange members as well as through said plate elements.

4. A liquid distributing structure according to claim 1, in which at least one of said distributing heads comprises a flange member having a plurality of subdivisional flow passages, with the addition of a flat screening member interposed between said flange member and its plate element.

5. A liquid distributing structure according to claim 1, in which at least one of said distributing heads comprises a flange member having a recess at the underside thereof to form a chamber overlying an associated flow passage opening and provided with subdivisional flow channels extending from said chamber.

6. A liquid distributing structure according to claim 1, in which at least one of said distributing heads comprises a flat screening member interposed between it and the associated plate element.

7. A liquid distributing structure according to claim 1, in which at least one of said distributing heads comprises a flange member having a plurality of subdivisional flow passages, in which said bolt connections comprise a pair of studs with nuts for said distributing head, and an internally threaded closure cap surrounding each nut and screwed upon the exposed end of the stud and tightened against the top face of the flange member for tightly encasing said nut.

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