Nov. 17, 1942. W. C. LAUGHLIN 2,302,450

FILTER

Filed June 29, 1940

FIG. 1.

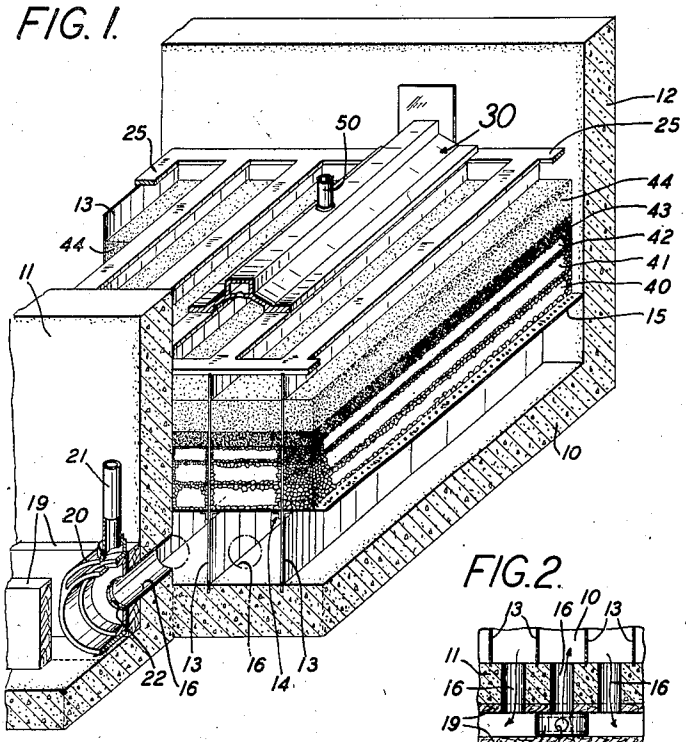


FIG. 2.

FIG. 3.

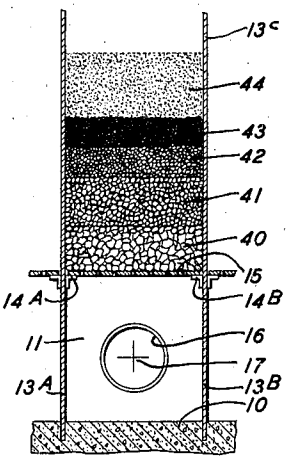


FIG. 4.

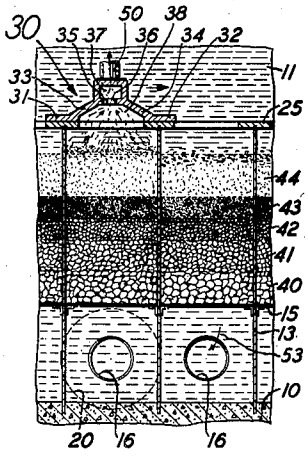


FIG. 5.

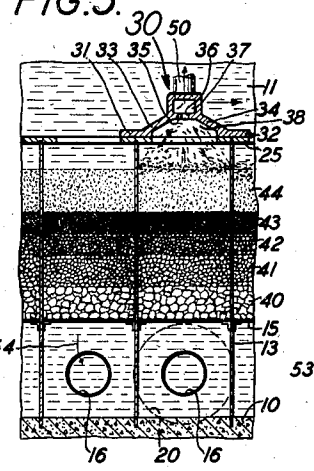
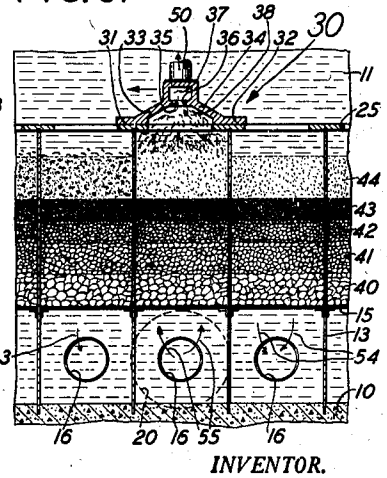


FIG. 6.



INVENTOR.
WILLIAM C. LAUGHLIN

BY

C. P. Jacobs

ATTORNEY.

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FILTER

William C. Laughlin, New York, N. Y.

Application June 29, 1940, Serial No. 343,062

7 Claims. (Cl. 210—130)

This invention relates to filter apparatus, and more particularly to the form in which separate vertical transverse compartments are provided with cleaning material and which are periodically subjected to a cleaning. Embodiments of this type are described and shown in my co-pending application, Ser. No. 325,100, filed March 21, 1940.

The objections to the use of gravel and sand layer filters is that the backwash water serves to churn the gravel and sand to such an extent that intermingling of gravel and sand results, rendering the filter bed useless or so inefficient as to require replacement.

The object of this invention is to overcome these disadvantages and to provide a filter bed with layers which will at all times remain in proper relationship.

The invention consists in disposing between the gravel layer and sand layer, a porous layer of such characteristics that the gravel and sand layers remain as such without intermingling with each other, though the sand particles or the gravel particles intermingle with each other separately, without intermixing. Such an intermediate layer must have the attribute that each constituent part has a specific gravity such as to resist the forces and actions of the backwash cleaning fluid and while allowing the fluid to pass, itself remaining in position, whereby the gravel remains confined below and the sand remains confined above, without intermixing with the constituents of the intermediate layer.

The use of such a stabilizing intermediate layer is to fulfill the purpose of the graduated gravel bed, namely to distribute the ascending water, while the various layers of differently sized gravels remain in their position. These layers are usually arranged with the largest size gravel lowermost. Due to the gradual decrease in size, the resistance to the uprising water increases as the size of the gravel decreases, giving therefore more uniform distribution of water with each size. Also usually there is a layer of fine sand above the gravel layer. The finer the sand particles, the greater the boiling of the same on the up current of the cleaning water. Instead of one layer of sand, a quantity of differently sized sands have previously been used in their respective layers. As there is a tendency of the light gravel to rise and float, with the fine sand directly on the gravel of ⅛" to 1/16", a mixing of the same took place, and in the hope of avoiding this, deep beds were utilized.

The invention enables shallow gravel beds and relatively shallow sand beds to be used, by reason of the provision of the intermediate layer of porous material of a constituency of relatively heavy specific gravity. The use of such an intermediate layer permits a higher velocity for the use of backwash water.

Such an intermediate layer may be of magnetite placed on the finest or top layer of gravel, and next below to the fine effective sand. The relative high specific gravity of the magnetite prevents the boiling of the gravel into it, and the intermixing of the fine sand with the magnetite. The weight of such over intermediate layer thus acts to keep the strata formation of the layers of gravel and sand.

In other words, in the old filters a gravel bed top layer of ⅛" to 1/16", the backwash would lift the gravel and mix it with the fine sand, whereas with a weighted intermediate layer, like magnetite, the lower gravel and upper sand layers remain in position as relatively fixed, and the fine sand can freely boil with the particles displaced from each other, whereby the impurities are readily removable.

The invention comprises a comparatively shallow graduated gravel bed supported by a perforated plate with a total area of openings in the plate such as will cause wash water to pass through the openings at high velocity, with a layer of heavier specific gravity constituents between the gravel layer and a superposed sand layer, whereby the intermediate layer acts as the final point of water distribution into the fine sand uppermost layer, permitting the sand to boil and the dirt to be washed out without the intermediate layer moving or rising.

By the action described, an outlet cleaner, or dirty water take-off box, may discharge from each compartment the impurities thus separated, as a direct flow from below upwardly.

The invention will be further described, embodiments shown in the drawing, and the essential features of the invention set forth in the appended claims.

In the accompanying drawing,

Fig. 1 is a perspective view partly in section of part of a filter apparatus, with a plurality of vertical compartments.

Fig. 2, a detail view of the backwash valve movable to close the lower end opening of each vertical compartment.

Fig. 3 is a vertical section through one vertical compartment showing the superposed layers of filter material upon the perforated plate, in relation to the end opening.

Fig. 4 is a horizontal sectional detail of a plurality of compartments, showing the dirty water take-off box in one position in respect thereto.

Fig. 5 is a similar view with the dirty water take-off box in another position, and

Fig. 6 is a similar view with the dirty water take-off box in still another position.

Similar characters of reference indicate like parts.

Referring particularly to Fig. 1, the filter apparatus there shown, is formed of a bottom wall **10**, side walls **11** and **12**, end walls not being shown. Transversely of the apparatus, and perpendicular to the side walls **11** and **12**, are vertical partitions **13** which extend from side wall to side wall and divide the apparatus whatever may be its width between sidewall and sidewall, and whatever may be its length between endwall and endwall, into separate vertical compartments. About one-third of the height of the vertical partitions **13**, suitable means **14** are provided for supporting perforated plates **15** which are horizontally disposed and form a perforated support extending from sidewall **11** to sidewall **12**. Such means **14** may be secured to the vertical partitions and to the perforated plates. Angle irons **14A** and **14B** support the plate **15**, but any other suitable means may be provided, as the plate may be supported in any other suitable manner, as long as it is arranged about one-third or one-fourth up from the bottom wall **10**.

In the embodiment shown, the vertical partitions are embedded in the bottom wall **10** but any other suitable fixing means may be utilized. The endwall **11** has a plurality of circular openings **16**, spaced from each other, so that the center of said circular openings is eccentric with the geometrical center of the configuration formed by the perforated plate **15**, the bottom **10** and the two intervening parts **13A** and **13B** of the partitions **13**. The center is indicated by **17**. Absolute accuracy of the disposition of the centers is not necessary, as the opening **16** can be arranged anywhere within the parts **15**, **10** and **13A** and **13B**. A back wash valve guide **19** is arranged forming an effluent channel, which latter is adjacent the sidewall **11**, and these guide walls **19** guide a valve **20** which is movable longitudinally from end to end of the apparatus. The valve **20** has a pipe **21** supplied with a washing fluid, and has an opening **22** adapted to register with any of the openings **16** in the wall **11**. When communication between the openings **16** and **22** takes place, the washing water enters the opening **16** and flows into the lower part of the vertical compartment, and filling the lower part, the washing water rises in the compartment until it is about to overflow the same.

The vertical partitions **13**, are provided at their upper ends with horizontally disposed plates **25** and upon them the dirty water take-off box **30** having two shoes **31** and **32** is slidable. The dirty water take-off box **30** is moved from end to end of the apparatus, preferably periodically, to cover the open top of the vertical compartment which is being supplied at its bottom with washing water, and by means not shown in the drawing.

The first improvement consists in providing each vertical compartment with an intermediate layer of material of relatively high specific gravity between the layers of graded gravel and the layer of sand. In the embodiment of Fig. 3, three layers of gravel are shown, indicated by **40**, **41** and **42**. The lowermost layer **40** has gravel of ½" to ⅜". The next superposed layer **41** is of gravel ⅜" to ¼", and the uppermost superposed layer **42** of gravel is of ¼" to ⅛". These gravel layers are held down by a layer of magnetite **43** or the like, of about ⅛" to 1/16"; and finally the top layer **44** is of sand. This sand layer extends only partially towards the uppermost ends **13c** of the partitions, whereby a space is provided between the top surface of the sand and the horizontal partition **25**. Magnetite has a higher specific gravity than gravel or sand, and thereby it acts as a stable intermediate layer stabilizing the gravel and sand layers.

The second improvement consists in the dirty water take-off box **30**, in that it is connected with a suction producing apparatus (not shown) by a pipe **50**, so that a suction action causes the impurities washed from the sand to be drawn into the dirty water take-off box **30**. The box **30** has shoes **31** and **32** which rests upon the horizontal plates **25**. This cooperation of the shoes and plates forms a seal, which prevents supernatant unfiltered liquors intermingling with and diluting the dirty wash water produced when the filter medium is backwashed. The vacuum action serves to draw the box down against the plate, and the liquid above the box serves to press the box down upon the plate. Between the shoes **31** and **32**, two walls **33** and **34** incline upwardly and merge into a horizontal wall **35** having spaced openings **36**, which communicate with a conduit **37** which is in communication with the pipe **50**. As suction is applied, the impurities resting upon the top sand layer or the "boiling" dirty water, are drawn into the space **38** of the box **30**, and then into the conduit **37**, and pipe **50** to some suitable place of discharge.

Figure 4 shows the relative position of the box **30** in respect to one compartment, the suction box being "on." This suction action and the consequent cleaning is contrary to the normal filtering action which has a descending action in that the fluid to be filtered is above the top sand layer and as the fluid descends through the top sand and layers below the same, the effluent finally reaches the space in the compartment below the perforated plate, and discharges through the opening **16** and into the effluent channel, leaving the impurities or other constituents in adsorption with the sand. This upward filter-cleaning action is clearly seen in Figures 4 and 5. It will be understood that while the cleansing action takes place, filtering is interrupted for the time being. The arrows **53** and **54** in Figures 4 and 5 show the normally downward filtering action taking place.

In Fig. 6, the opening **16** is provided with arrows **55** which show that the washing water enters the opening **16**, and this fluid then rises through the gravel layers and layer of magnetite and top layer of sand, taking the adhering impurities with it until sucked in by the box **30** as described. It is seen that there is a joint action between the vacuum action of the box **30** and the upward back wash action, brought about by the registering of the valve opening with the opening **16** of that particular vertical compartment.

In the filter beds heretofore used, the backwash action rising from the bottom of the bed caused the gravel of the gravel layers to intermingle with the sand, and this intermingling was accentuated by the suction action utilized to separate the impurities from the top layer of sand of the filter bed which also caused the sand to boil and to draw with it the gravel of the gravel layer immediately below the same. With

the present invention, however, the intermediate layer prevents intermingling of the gravel with the sand and, by virtue of its higher specific gravity yet porous characteristic, permits the passage of high-velocity fluid therethrough without itself losing its layer-like or strata formation. In other words, this intermediate layer acts in the nature of a porous wall formed of material having a specific gravity higher than either the gravel below or the sand above, in whatever direction the flow of fluid therethrough may be.

Instead of magnetite, leaden bullets of suitable size can be used, or any other material whose specific gravity is such that it is higher than the gravel particles to prevent them from rising to intermingle with the sand, and higher than the sand particles to prevent the material of the intermediate layer from rising into the sand layer and mixing therewith.

It will thus be seen that with the present invention, the efficiency and life of the filter beds are greatly increased by maintaining the sand and gravel layers in their respective stratas. The weighted intermediate layer permits only the top sand layer to "boil," with the top surface of the sand normally below the top edges of the vertical partitions. The sand particles thus entrained can be easily substituted by new sand particles supplied to take the place of those removed. The provision of the said space reduces the removal of the sand to a minimum.

A filter bed constructed in accordance with the present invention, in which a dirty water take-off box removes the dirty water when the filter-bed is being subjected to backwashing from below upwardly, can be used in sewage treatment plants and will produce uniformly clean final effluents, the sand bed being a perfect flocculating apparatus gathering the minute floc in a layer at the surface of the sand; such a bed can also be used in water treatment to remove algae and amorphous matter at high filter rates, and is especially adapted to filtration of water prior to the slow sand filters because of the capacity and efficiency of the bed for removing solids, thus permitting an increased capacity and less frequent cleaning of the slow sand filters. The filter bed is especially adapted to swimming pools and similar purification installations because of the simple low pressure automatic operation and can easily be provided with means for chlorine dispersion. Furthermore the filter can be used for the recovery of products now going to waste, as cleansing of liquors for re-use or to prevent pollution, or can be used for any operation where a clean effluent is required.

From the foregoing it is believed that the construction and advantages of the present invention will be readily understood by those skilled in the art without further description, it being clear that changes may be made within the principle of the invention described without departing from the scope thereof as set out in the following claims.

What is claimed is:

1. In filter apparatus of the type including a plurality of vertical compartments containing a filter bed for each of said compartments, comprising gravel strata in the lower portion of said compartments, a layer of sand in the upper portion of said compartments, and an intermediate layer of a specific gravity higher than the gravel and sand interposed between said gravel strata and said layer of sand for preventing intermingling of said sand and gravel during the cleaning operation of said filter bed, means for periodically backwash cleaning said filter material from the underside of said compartments upwardly, means supplying said backwash cleaning means with backwash liquid, means straddling only the top of the compartment being cleaned for receiving the backwash water, and leaving adjacent compartments uncovered, and inlet and outlet filtering liquid means.

2. In filter apparatus of the type including a plurality of shallow vertical compartments, each containing filtering material in the form of a filter bed for each of said compartments comprising a gravel strata in the bottom of said compartments, and a sand strata in the upper portion of said compartments, and an intermediate weighted strata of material for maintaining said gravel and said sand in their respective stratas during the backwash cleaning operation of said filter apparatus, means for periodically backwash cleaning said filtering material from the under-side of said compartments to the upper part thereof; backwash supply means, backwash removal means straddling one only of the compartments, the one being subjected to backwashing, inlet means for the fluid to be filtered, and filtered liquid exit means, each of the compartments being like the other and capable of being connected with the backwash supply means, and with the top straddling means, the top straddling means being capable of sliding from the top of one compartment to the top of another compartment.

3. In combination, a plurality of parallel upright walls, horizontal walls at right angles thereto, a box over the top edges of said two adjacent upright walls and the connecting longitudinal wall, means for forming a suction within the box and between two adjacent upright walls, a filter material between said walls, a backwash supply for said filter material, a backwash outlet for said box, a supply of the liquid to be filtered, and an outlet for the filtrate, said suction causing the box to be pressed against the horizontal walls, whereby a sealing action between two adjacent longitudinal walls and the box is obtained, and the backwash is drawn from the filter material to the backwash outlet without mixing with the liquid being filtered.

4. In filtering apparatus including a filter bed consisting of superposed layers of gravel and sand; an inlet for the unfiltered liquid supplied to and above the filter bed and an outlet for the filtered liquid coming from below the filter bed, said filter bed being between said inlet and outlet, the combination of backwash supply means below the filter bed, backwash outlet means above said filter bed, and between said backwash supply and outlet means therefor, and a layer of material disposed between said sand and gravel and having a specific gravity higher than that of said sand for preventing intermixture of the gravel with the sand both during the filtering and during the backwashing action.

5. In filtering apparatus of the type including a plurality of vertical compartments, each containing a filter bed comprising superposed layers of gravel and of sand, and an intermediate layer of material of higher specific gravity than said sand interposed between said first named layers for preventing intermingling of said sand and said gravel during the movement of the liquid in an upward direction through said filter bed, means for periodically backwash cleaning said

filtering material from the underside of said compartments, suction removal means of the dirty wash-water at the upper end of the compartment being backwashed, and inlets and outlets for the filtering liquids, the relative specific gravity of said material and said sand being such that upon the flow of the backwash upwardly through the filter bed, the sand material remains in layer form without substantial intermingling with the higher specific gravity material during its boiling necessary to remove its impurities, and said sand, said material, and said gravel remaining in layer form during the downward flow filtering operation.

6. In a filter apparatus having a bottom, side and end walls including a plurality of open top channels parallel with each other from end wall to end wall, a horizontal transverse perforated plate in each channel intermediate its top and bottom, a filter bed supported by each plate, said filter bed consisting of superposed layers of material graduated in respect to specific gravity, one of said interposed layers being of higher specific gravity than the layer above it, in combination therewith of a launder at right angles to the channels having an orifice communicating with each channel into which filtered liquor from below the plate of the channel enters, backwash means travelling in the launder for forcing a required portion of fluid through an orifice and upwardly from the bottom and through the plate of a channel, means over the channel being backwashed for removal from the top of the channel of the dirty wash water as produced by the backwash means without intermingling of such dirty wash water with the supernatant and unfiltered liquid of adjacent channels, means connecting the backwash means with the removal means, means for moving the backwash means and removal means in unison from channel to channel, inlet means for the liquid to be filtered, outlet means for the filtrate, and backwash inlet and outlet means.

7. In a filter apparatus having a bottom, side and end walls, a plurality of partitions extending vertically upwardly from said bottom and spaced from each other from end wall to end wall and extending from side wall to side wall, horizontally disposed perforated walls intermediate the top and bottom ends of said partitions, and a filter material held on said perforated walls, the combination therewith of horizontally aligned top plates upon each upper end of the said partitions, a dirty water take-off box having enclosing walls spaced substantially equal to the space between the aligned top plates for forming a closed space over two adjacent partitions, a pair of shoes on said box spaced the distance between said top plates and extending over said top plates for sliding on said top plates, said pair of spaced shoes forming a seal with a pair of said spaced top plates when the box covers the open end of adjacent partitions, means supplying the fluid to be filtered above said partitions and said box, and means supplying a fluid below the filter material for passage to said take-off box.

WILLIAM C. LAUGHLIN.