

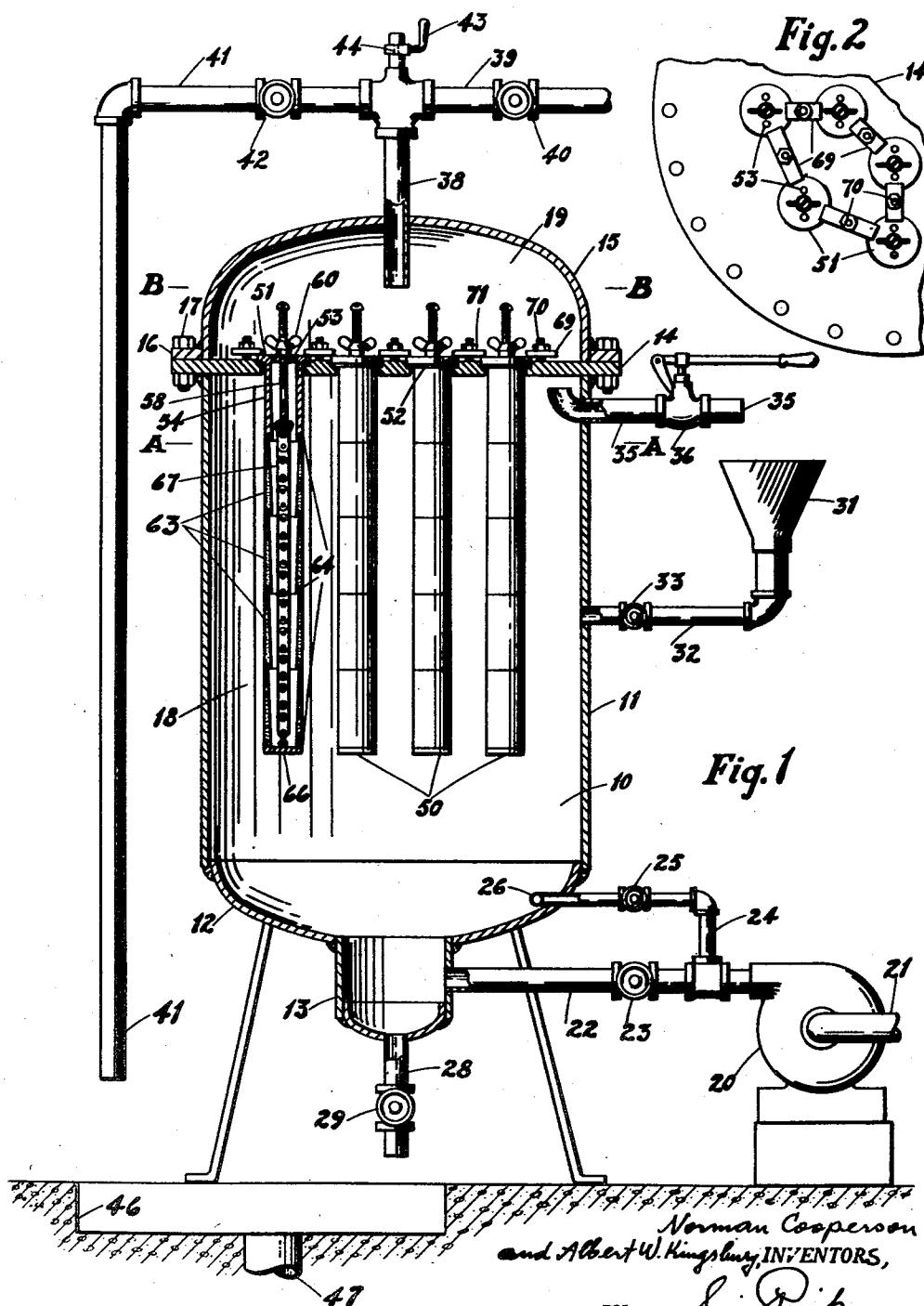
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FILTER AND METHOD OF BACKWASHING SAME

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FILTER AND METHOD OF BACKWASHING
SAME

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This invention relates to filters of the type having foraminous means and employing as the filtering material diatomaceous earth deposited on said foraminous means, and to an improved method of backwashing such filters.

Filters of this type have become well known and reference is made, by way of an example, to the U. S. Patent 2,423,172 of George Martin Booth, dated July 1, 1947, which discloses a filtering apparatus and a method of operating the same on which our invention is an improvement.

It is an object of our invention to provide an improved filtering apparatus which is adapted for more efficient operation and which can be constructed with less height than has heretofore been possible; another object is to provide a more effective method of backwashing.

The manner in which these objects are achieved is shown in the accompanying drawings in which:

Fig. 1 shows an apparatus in accordance with my invention in elevation, partly in section; and

Fig. 2 is a fractional plan view of the apparatus with the domed cover 15 removed.

Similar numerals refer to similar parts throughout the several views.

The apparatus comprises a tank 10 with a cylindrical side 11 and a dished bottom 12 to which is attached a pocket 13. To the top of the cylindrical portion 11 is welded a tube sheet 14. Over the tube sheet is fitted a domed cover 15 attached to the tube sheet 14 by means of a flange 16 and bolts and nuts 17. The space within tank 10 and below the tube sheet 14 forms an influent chamber 18, and the space within the domed cover 15 and above the tube sheet 14 forms an effluent chamber 19.

A pump 20 is provided with a suction pipe 21 receiving the liquid to be filtered and with a discharge pipe 22 fitted with a valve 23 and leading to the pocket 13. A branch 24 of the discharge pipe 22 is provided with a valve 25 and terminates in a bent portion 26 within the influent chamber 18 adjacent to the dished bottom 12. Leading from the lowest part of the pocket 13 is a drain pipe 28 fitted with a valve 29. A funnel 31 is provided for the introduction of filter aid and connected with the influent chamber 18 by a pipe 32 provided with a valve 33. A pipe 35 leads from a point as high as possible within the influent chamber 18 through a quick-opening valve 36 to the outside. An outlet pipe 38 leads from the level B B in the middle portion of the effluent chamber 19 through the cover 15, as shown, and has a branch 39 provided with a valve 40 and leading to a point of use, and another branch 41

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provided with a valve 42 and leading to a point of waste. The pipe 38 also communicates with an air vent comprising a cock 43 having therein a flow restricting passage 44. A sump 46 is arranged to receive the discharges from pipes 28 and 41 and lead them to a point of disposal through a pipe 47.

The tube sheet 14 carries a number of identical filter tube assemblies each referred to as whole by the numeral 50. The filter tube assemblies 50 may employ any foraminous material capable of retaining the diatomaceous earth used as filter aid, and we prefer to use the construction constituting the subject matter of a co-pending application of Durando Miller, Jr. Ser. No. 99,634, filed June 17, 1949. Each such filter tube assembly 50 comprises a support plate 51 which rests against the tube sheet 14 with an interposed gasket 52 and which is provided with openings 53. The plate 51 has an integral sleeve 54 on which is mounted a stack of foraminous filter elements 63 made of sintered bronze balls and rabbeted, as shown at 64, to each other, to the sleeve 54, and to a bottom plate 66 placed against the lowermost filter element 63. A chain 67 connects the bottom plate 66 with a partly threaded rod 58 passing through the plate 51 and is placed in tension by a wing nut 60. The plates 51 are held tightly against the tube sheet 14 by means of clamps 69, studs 70 and nuts 71.

In operating the apparatus the valves 33 and 42 are opened, all other valves being closed, and a quantity of filter aid is introduced as a slurry into the empty tank 10 through the funnel 31 and pipe 32, and drops onto the dished bottom 12 and into the pocket 13. Valve 33 is then closed and pump 20 started, with valves 23 and 25 opened. The incoming liquid fills the tank 10, stirs up the filter aid and carries it upward to be deposited as a layer against the filter elements 63, forming the so-called precoat. The discharge from the bent portion 26 of pipe 24 helps to stir up all filter aid resting on the bottom 12 and to suspend it in the upflowing water. During this filling operation, air is discharged through the outlet pipe 38, valve 42, and pipe 41.

As the apparatus is being filled with water, air remains trapped in the influent chamber 18 above the level AA and in the effluent chamber 19 above the level BB. As soon as the liquid has risen to the level BB the discharge of air stops and liquid flows from pipe 41. Such liquid is likely to be turbid at first, containing some particles of filter aid, but such turbidity will disappear within about one minute, whereupon valve 40 is opened

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and valve 42 is closed which places the apparatus in normal filtering service, the filtered liquid flowing via pipe 39 to a point of use. The rate of filtration may be between about 2 and 8 gallons per minute per square foot of area of the foraminous elements 63, depending on the viscosity and turbidity of the liquid to be filtered; when such liquid is water having a turbidity up to about 10 parts per million we find a rate of about 4 gallons per minute per square foot most satisfactory. With higher rates of flow the quantity of liquid that can be filtered between backwashings becomes less.

As filtration progresses, the turbidity in the liquid is retained by the blanket of filter aid deposited on the filter elements 63 causing the pressure loss through the filter elements 63 to increase gradually, and when the pressure in the influent chamber 18 has reached a predetermined value of somewhere between 10 and 100, say 50 pounds per square inch, the normal service operation is terminated in order to backwash the filter. During filtration the pressure in influent chamber 18 increases so that the air trapped in the influent chamber 18 is gradually dissolved when the liquid being filtered is capable of dissolving air, as is water or an aqueous solution. Such air thus may disappear either completely or at least to a substantial degree, the extent depending on the existing pressure, the temperature of the liquid, and its ability to dissolve air.

To terminate the service operation the valves 40 and 23 are closed and valves 29 and 42 are opened. The apparatus now drains through the pipe 28, air entering through the pipe 41. During this draining operation, the jet of liquid coming in through pipe 24 helps to stir up the contents of the lower portion of the influent chamber 18 and flush out all dirt and filter aid dropping from the filter elements 63. As soon as the tank has drained substantially empty valves 29 and 42 are closed and valve 23 is opened. Liquid now enters the tank 10, compressing the air as the tank is being filled. As soon as the air within the tank has been compressed to the maximum pressure which the pump 20 can produce, for instance 50 pounds per square inch, the liquid level in tank 10 will be somewhat below level AA. Now the cock 43 is opened so as to discharge air from the effluent chamber 19 through the flow restricting passage 44 without permitting the pressure within tank 10 to decrease appreciably. As compressed air is thus being discharged, liquid enters until it reaches the level AA, trapping a definite compressed air volume in the influent chamber 18 above the level AA. Thereupon, the liquid rises through the filter tube assemblies 50 into the effluent chamber 19 until it reaches the lower end of the outlet pipe 38, that is level BB. Then liquid will be discharged through the outlet pipe 38 and the cock 43, a second definite volume of compressed air being thus retained within tank 10 in the effluent chamber 19 above the level BB. The flow of liquid from cock 43 indicates that the tank has been prepared for the backwashing operation and cock 43 is now closed.

Valves 23 and 25 are then closed and the pump 20 may be shut down if desired. The quick-opening valve 36 is next opened, permitting the compressed air in influent chamber 18 to be exhausted rapidly to atmosphere through pipe 36. The compressed air in effluent chamber 19 consequently expands rapidly and forces the liquid in the effluent chamber 19 through the filter elements 63 at a high rate of flow, cleansing them

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of any remaining filter aid or dirt. This backwash operation takes but a fraction of a second and its end is indicated by the emergence of a small quantity of liquid from the pipe 36. The valve 36 is now closed.

The amount of impurities dislodged during the backwash operation is relatively small. Nevertheless, it is desirable to remove them and this is accomplished by opening valves 29 and 42 to drain the tank 10 preparatory to introducing a new batch of filter aid into the funnel 31 and resuming the cycle of operations as described. During this draining operation, the pump 20 need not but may be operated with valve 25 open to more effectively cleanse the lower portion of tank 10.

The flow restricting passage 44 must be small enough to exhaust the excess of air from the effluent chamber 19 without permitting the pressure therein to drop appreciably. Yet, the passage 44 should not be so small that an unnecessarily long period is required to exhaust the excess of air and leave in the tank 10 the two predetermined volumes of compressed air. The best size is one that will exhaust air at its elevated pressure at the same rate of flow at which the pump is capable of introducing liquid against a head equal to said elevated pressure to take the place of the exhausted air. In an apparatus having 16 square feet of area on the foraminous filter elements and operating at a filtration rate of 64 gallons per minute, with a pump capable of supplying such rate against a head of 50 pounds per square inch, a flow restricting passage one-half to three-quarter inch long and having a diameter of one-quarter inch is just right. A good size is one that will provide a free cross sectional area of about 0.002 to 0.004 square inch for each square foot of surface of the foraminous filter element, or a free area of 0.0005 to 0.001 square inch for each gallon per minute of pump capacity when operating against a head of about 50 pounds per square inch. The length of the passage should then equal two to three times its diameter. If the passage is made much longer, its diameter must be increased somewhat to retain the same resistance to flow.

If the liquid being filtered contains relatively large amounts of turbidity it may be advantageous, in the interest of longer filter runs, to continuously add filter aid to the liquid being filtered, termed body feed, in a manner well understood in the art.

While we have disclosed what we consider the preferred apparatus and method in accordance with our invention, modifications may be made without departing from its spirit, and reference is, therefore, made to the appended claims for a definition of the scope of our invention.

What we claim is:

1. In a filtering apparatus of the type comprising, in combination, means providing an influent chamber, means providing an effluent chamber, foraminous means separating said chambers, means for introducing filter aid and liquid to be filtered into said influent chamber, means for conducting filtered liquid from said effluent chamber, means in both said chambers for trapping in each a predetermined volume of air under pressure and means communicating with said influent chamber for rapidly venting compressed air therefrom to effect backwashing of said foraminous means, the improvement which comprises a closable air vent communicating with the middle portion of said effluent chamber, and

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a flow restricting passage in said air vent so dimensioned as to provide a resistance to flow of air equal to that of a passage having a length equal to two or three times its diameter, and a diameter providing a free cross sectional area of 0.002 to 0.004 square inch for each square foot of surface of said foraminous means.

2. In a filtering apparatus of the type comprising, in combination, means providing an influent chamber, means providing an effluent chamber, foraminous means separating said chambers, means for introducing filter aid into said influent chamber, a pump for introducing liquid to be filtered into said influent chamber, means for conducting filtered liquid from said effluent chamber, means in both said chambers for trapping in each a predetermined volume of air under pressure and means communicating with said influent chamber for rapidly venting compressed air therefrom to effect backwashing of said foraminous means, the improvement which comprises a closable air vent communicating with the middle portion of said effluent chamber, and a flow restricting passage in said air vent so dimensioned as to provide a resistance to flow of air equal to that of a passage having a length equal to two to three times its diameter, and a diameter providing a free cross sectional area of 0.0005 to 0.001 square inch for each gallon per minute capacity of said pump against a head of 50 pounds per square inch.

3. In the operation of a filtering apparatus having a lower influent chamber and an upper effluent chamber separated from each other by foraminous means, the method of backwashing said foraminous means which comprises draining both said chambers of liquid and filling them with atmospheric air, admitting liquid under pressure

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into said influent chamber until said air is compressed to a predetermined pressure between 10 and 100 pounds per square inch, exhausting some of said compressed air from said effluent chamber at a restricted rate of flow and without appreciably lowering the pressure therein while continuing the admission of liquid under pressure until a predetermined volume of compressed air remains in the upper portion of said influent chamber, another predetermined volume of compressed air remains in the upper portion of said effluent chamber and the remaining portions of both said chambers are filled with liquid, discontinuing the admission of liquid to said influent chamber and the exhaust of air from said effluent chamber, and then rapidly venting the trapped volume of compressed air in said influent chamber to a point of atmospheric pressure whereupon the volume of compressed air trapped in said effluent chamber expands rapidly and forces the liquid in said effluent chamber at a high rate of flow through said foraminous means.

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