PATENT SPECIFICATION

Convention Date (Australia): Aug. 18, 1933.

443,137

Application Date (In United Kingdom): Aug. 20, 1934. No. 22746/35.

(Divided out of No. 443,112.)

Complete Specification Accepted: Feb. 20, 1936.

COMPLETE SPECIFICATION

Improvements in and connected with Filters

We, FILTRATION AND WATER SOFTENING PROPRIETARY LIMITED, a Company organised and existing under the laws of the State of Victoria, of 395, Collins Street, Melbourne, in the State of Victoria, Commonwealth of Australia, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to improvements in and connected with filters of the kind having a filter bed of sand or like granular material and is applicable both to filters of the gravity and pressure types.

In the filtration of water by means of graded beds of sand and gravel or other suitable comminuted material, it is customary to first coagulate the impurities by treatment with a suitable coagulant and then to cause the water to pass downwards through the filter bed.

The impurities removed from the water form a film of "floc" at the upper surface of the filter bed and on the grains of material forming the upper zone of said bed, and, though this film plays an important part in the filtering operation, it gradually increases the resistance to the flow of water therethrough and consequently must be removed at intervals.

This removal of accumulated impurities is usually effected by a reverse flow of prefiltered wash water and, as it is desired to agitate the filter bed in order to obtain an effective dislodgment and removal of the impurities, the reverse flow of wash water is sometimes accompanied by agitation with air or by means of rakes.

Of recent years, however, it has become a common practice to agitate the bed by employing a high velocity reverse flow of wash water, thus obviating the necessity of employing agitation by air or mechanical means.

With this last mentioned method of cleaning the filter bed, the velocity of the wash water is sufficient to cause at least a partial hydraulic suspension of the granular particles forming the bed which accordingly assumes an expanded condition during the washing or scouring operation. For this purpose the upward velocity of wash water is usually from about 24" to 32" vertical rise per minute. The expression "vertical rise per minute" designates the velocity the wash water would have if the filter bed were not present, the actual velocity between the particles being, of course, much higher.

The wash water—in the case of a gravity or open filter—is usually discharged from the upper end of the filter chamber by means of one or more discharge troughs disposed horizontally about 18" to 24" above the filter bed or by means of one or more discharge openings disposed at the requisite height at one or more sides of the filter chamber.

From this description, it will be understood that, in the case of a gravity filter, the wash water usually flows laterally to a greater or lesser extent above the filter bed when passing to the discharge means.

In the case of filters of the enclosed or pressure type, the collection and discharge of the wash water is usually effected by means of a perforated plate or pipe, but, as far as we are aware, no means have been provided in either this or the gravity type of filter for obtaining a uniform upward flow through the surface of and above the filter bed, though considerable attention has been paid to the problem of obtaining a uniform distribution of wash water below the filter bed.

Now, it has been found that the impurities deposited on the surface of the filter bed—and which it is desired to discharge during the washing operation—consist in part of relatively compact flaky particles the density of which is not much less than that of the sand grains.

We have ascertained that, during the washing of the filter bed by the high velocity method, these flaky particles and certain other foreign materials remain suspended just above the surface of the expanded filter bed and settle on the surface of the bed when the washing operation is completed.

In this connection, it should be noted

that, in the case of a filter chamber of uniform or substantially uniform cross-sectional area, the velocity of flow during washing decreases towards the top of the expanded bed where the particles are more widely separated and that a substantial drop in velocity occurs above the expanded bed. This relatively lower velocity above the filter bed is detrimental to the removal of the aforementioned flaky particles of floc and the like.

It is now considered good practice for the wash water to flow at such a high velocity that the individual particles of the filter bed will be effectively scrubbed and with such velocities (about 28" to 32" vertical rise per minute) the volume of the expanded bed is usually about 40% to 50% greater than the volume of the bed during the filtering operation.

It is found that this large expansion of the bed sometimes allows the heavier particles of suspended floc to fall into the bed during the washing operation, thus further serving to prevent their removal.

This disadvantage cannot be satisfactorily overcome by employing a still higher wash water velocity which would serve to carry off and discharge the heavier floc particles because such higher velocity would result in a greater expansion of the filter bed and it has been found that, if the expanded volume is more than about 50% of the compacted volume, the scouring action is less efficient owing to the greater separation of the individual sand particles. In addition, the increased consumption of wash-water is a disadvantage.

Now, the object of the present invention is, inter alia, to provide a method of and means whereby the above mentioned disadvantages will be overcome or minimised and the efficiency of the washing operation will be enhanced.

Accordingly one feature of the present invention resides in a method of washing a filter bed by an upward flow of wash water at a rate sufficient to cause expansion of the bed consisting in increasing the velocity of the wash water in a zone disposed immediately above the upper surface of the expanded bed, the current through the upper portion of the bed being substantially uniform in velocity, said zone of increased velocity being disposed in such close proximity to the upper surface of the expanded bed and the velocity in the zone being increased to such an extent that the removal of impurities which ordinarily remain in suspension above the said surface of the filter bed, is facilitated.

The relative positions of the said zone and the said upper surface of the bed may be so controlled as to prevent any substantial loss of material forming part of the bed, while facilitating the discharge of materials disposed immediately thereabove.

Apparatus in accordance with the invention may embody a filter having a filter bed, and a plurality of substantially vertical draw off passages arranged above the filter bed and forming a zone of increased velocity for the wash water, the lower ends of said passages being so arranged as to be disposed immediately above the upper surface of the filter bed when the latter is expanded by an upward flow of wash water.

Other features of the invention reside in the construction and arrangement of the parts and are set forth in the following detailed description.

Whilst the invention is especially applicable to filters which are cleansed by a high velocity flow of wash water, as above described, it should be recognised that some of the advantages of the invention are applicable to relatively low velocity flows of wash water.

Having set forth the object and nature of the invention, reference will be made to the accompanying drawings which illustrate several preferred forms thereof and in which:—

Figure 1 is a diagrammatic view in vertical section of an enclosed filter chamber in accordance with the invention.

Figure 2 is a view in plan of the filter shown in Figure 1.

Figure 3 is a view similar to Figure 1 showing a filter chamber with an adjustable diaphragm.

Figure 4 is a diagrammatic view in vertical section of the upper portion of an enclosed filter chamber and shows a further modification.

Figure 5 is a diagrammatic view in vertical section of an enclosed filter chamber having a plurality of vertical draw-off passages near its upper end.

Figure 6 is a view in plan of the filter shown in Figure 5, and

Figure 7 is a diagrammatic view showing a modification of the construction illustrated in Figure 1.

In the various figures of the drawings the reference numeral 10 designates a filter chamber provided at its upper end with an inflow passage 11 and at its lower end with an effluent passage 12. The chamber 10 contains a graded bed of suitable comminuted material usually consisting of sand 13 and gravel 14.

During the normal filtering operation, water enters the upper end of the chamber through the passage 11, passes down-

that, in the case of a filter chamber of uniform or substantially uniform cross-sectional area, the velocity of flow during washing decreases towards the top of the expanded bed where the particles are more widely separated and that a substantial drop in velocity occurs above the expanded bed. This relatively lower velocity above the filter bed is detrimental to the removal of the aforementioned flaky particles of floc and the like.

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During the normal filtering operation, water enters the upper end of the chamber through the passage 11, passes down-

wards through the filter bed and is discharged through the effluent passage 12.

When the filter bed is being washed, pre-filtered wash water enters the lower end of the chamber through the passage 12, passes upwardly through the filter bed at a relatively high velocity so as to cause an expansion thereof and is discharged through the passage 11. Though the passages 11 and 12 are described as serving both for normal filtration and for reverse upward flow during washing, it will be clear that separate pipes may be provided for these purposes. In such cases the passages 11 shown at the upper ends of the filter chambers should be regarded as wash water discharge passages as the present invention is concerned primarily with improvements in connection with the washing of filter beds.

Though, the drawings illustrate filters of the pressure or enclosed gravity type, it will be understood that the invention is equally applicable to filters of the open gravity type.

Figures 1 and 2 illustrate one elementary form of the invention in which the upper end of the chamber 10, which is of relatively small cross-sectional area, converges towards a narrow central passage 15 with which the passage 11 communicates.

During normal downward filtration when the filter bed is compacted, the upper surface of the sand bed is in the position designated by the reference numeral 16.

When, however, the filter bed is subjected to a high velocity upward flow of wash water, the filter bed is expanded so that the upper surface of the sand is approximately in the position shown by the reference numeral 17. Accordingly this upper surface of the expanded sand bed is disposed just below the zone of increased velocity, occasioned by the converging upper end of the filter chamber 10 and passage 15 thus obviating the discharge of sand from the chamber. On the other hand, the said flaky particles and other foreign matter which normally remains in suspension just above the expanded sand level are disposed in the zone of increased velocity and are carried out of the chamber with the wash water.

By reason of the parallel sides of the filter chamber, the velocity of the wash water through the upper portion of the expanded bed is substantially uniform. Although it is not essential to employ a parallel sided filter chamber as shown, it is necessary for the wash water velocity through the upper portion of the bed to be substantially uniform in order that the upper surface thereof will be stable and accurately controllable.

It will be understood from the above description that the invention as illustrated in Figure 1 consists not merely in providing a zone of increased velocity but also in so positioning this zone that its lower end will be closely adjacent to the expanded level 17 of the filter bed.

As the degree of expansion of the said bed during washing is dependent on such factors as the size and specific gravity of the sand particles and the temperature and upward velocity of the wash water, it is usually necessary to provide suitable means for regulating the velocity of the water to ensure that the level of the upper surface of the expanded bed will be disposed in an appropriate position with respect to the zone of increased velocity.

Accordingly, a suitable control valve 18 may be fitted to the passage 12 as shown (or to the wash water discharge passage 11). This valve 18 may be controlled manually for which purpose a suitable inspection window (not shown) may be fitted to an upper portion of the filter chamber, but preferably it is controlled automatically by any known means responsive to variations in one or more of the conditions referred to above.

For example, as shown in Figure 1, a float 19 may be arranged to respond to the level of the expanded sand and cause the valve 18 to open or close to a greater or lesser extent as required to maintain a constant predetermined level. Such control means do not form part of the present invention and will, therefore, not be described in detail as many different known arrangements may be employed for the purpose. However, in explanation of the diagram in Figure 1, it may be stated that 20 and 21 designate line conductors of an electric circuit, the former being connected to a contact 22 on the float rod and the latter being connected to a pair of motor reversing relays 23 and 24 arranged in parallel and connected at their opposite ends to contacts disposed at each side of the contact 22.

Relays 23 and 24 serve to control the energisation in opposite directions of an electric motor (not shown) for actuating the valve 18.

As one alternative, a photo-electric cell apparatus responsive to the comparative opacity of the upper portion of the expanded filter bed may be employed to control the regulating valve as 18.

In lieu of providing means for maintaining a relatively constant degree of sand expansion during the washing of the filter bed, the zone of increased velocity may be adjusted to correspond with variations in the level of the expanded bed.

Such an arrangement is illustrated in Figure 3 in which the restricted passage is provided in a diaphragm 25 arranged for vertical adjustment within the filter chamber. The adjustment of the diaphragm may be effected either manually or automatically as by any of the means previously referred to.

In the construction shown in Figure 3, the diaphragm 25 is supported from the lower end of a vertical screwed shaft 26 which extends through a gland in the top of the filter chamber. This screwed shaft is fitted with a nut in the form of a worm wheel 27 which is restrained against vertical movement by a bracket 28. The worm wheel 27 is in mesh with a worm 29 on a spindle adapted to be rotated in either direction by any suitable means to cause the diaphragm to be raised or lowered as required.

Figure 4 shows a modification in which, in lieu of an adjustable diaphragm as 25 a central displacement member 30 is provided. This displacement member is capable of being raised and lowered to regulate the position of the annular zone of increased velocity formed thereby.

It will be clear that the upper end of the filter chamber may be similarly shaped to provide an annular zone of increased velocity even when the central member as 30 is not adjustable.

In a further modification (not illustrated), the diaphragm as 25 is constructed in the form of a float which is responsive to the level of the expanded filter bed thereby ensuring that the zone of increased velocity is maintained in correct relationship thereto.

Figures 5 and 6 diagrammatically illustrate a vertical section through and plan of a filter chamber of relatively large area and having a partition 33 extending horizontally thereacross at a position just above the surface of the expanded sand bed.

This partition or diaphragm is provided with a plurality of vertical passages 15 which may be of inverted funnel shape as shown at the left of the Figure or they may be plain as indicated at the right of the Figure.

These vertical passages are evenly spaced over the area of the filter chamber so as to ensure that the draw-off above the filter bed will be substantially vertical and uniform.

In the modification shown in Figure 7, the upper portion of the filter chamber is similar in form to that shown in Figure 1.

An annular constricted space 44 is formed within the chamber by means of a central displacement member 46 supported by arms 47. This annular space 44 is disposed above the normal level 16 of the surface of the filter bed and below the position 17 occupied by same when the bed is expanded during washing.

In operation the increased velocity within the annular space 44 causes the grains forming the filter bed to be subjected to a more intense scouring action while impurities disposed above the surface 17 of the expanded bed are removed as in the preceding constructions owing to the increase in velocity immediately above said surface 17.

If desired, any or all of the draw-off passages 15 may be provided with suitable projections preferably in the form of helical vanes, to cause the water passing therethrough to have a rotary movement imparted thereto.

In our co-pending application No. 23995/34 (Serial No. 443,112) there is claimed a filter consisting of a filter bed and one or more substantially vertical passages: forming a zone of increased velocity for wash water, said passage or passages being of appreciable height and having its or their lower ends disposed above the normal level of the upper surface of the filter bed, and constructed and arranged so that when the filter bed is initially expanded by an upward flow of wash water, the increased velocity in said zone will cause a secondary expansion of the filter bed so that the upper surface of the finally expanded bed will be disposed within said zone and at a section thereof in which the velocity is substantially uniform. It is further claimed in Specification No. 23995/34 (Serial No. 443,112) to provide a construction at the upper end of each of said passages to cause a still further increase in the velocity of the wash water.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. The method of washing a filter bed by an upward current of wash water, at a rate sufficient to cause an expansion of the bed, consisting in increasing the velocity of the wash water in a zone immediately above the upper surface of the expanded bed, the current through the upper portion of the bed being substantially uniform in rate of flow, and the zone of increased velocity being disposed in such close proximity to the upper surface of the expanded bed and the rate of flow of water in the zone being increased to such an extent that the removal of impurities which ordinarily remain in

suspension above the said surface of the filter bed, is facilitated.

2. A method as claimed in claim 1 in which the relative positions of said zone of increased rate of flow and the said upper surface of the expanded bed are so controlled as to prevent any substantial loss of material forming part of the bed while facilitating the discharge of impurities disposed thereabove.

3. In a filter, a filter bed and a plurality of substantially vertical draw off passages arranged above the filter bed and forming a zone of increased rate of flow for the wash water, the lower ends of said passages being so arranged as to be disposed immediately above the upper surface of the filter bed when the latter is expanded by an upward flow of wash water.

4. In a filter, a filter bed, one or more substantially vertical draw off passages, arranged to form a zone of increased rate of flow immediately above the upper surface of the filter bed when the latter is expanded by an upward flow of wash water, and means for automatically controlling the relative position of said passage or passages and said upper surface of the expanded bed.

5. In a filter as claimed in claim 3 or 4, a member or members forming a zone of increased velocity at a position disposed above the normal level of the upper surface of the filter bed and below the level of said upper surface when the filter bed is expanded during the washing operation.

6. In a filter as claimed in claim 3 or 4, a valve for controlling the velocity of the wash water, and means for automatically controlling said valve in such manner as to cause the upper surface of the expanded filter bed to occupy a predetermined position.

7. In a filter as claimed in any of claims 3—6, means for introducing wash water to a lower portion of the filter bed at a velocity sufficient to cause an expansion of the filter bed.

8. In a filter as claimed in any of claims 3—7 a plurality of substantially vertical passages spaced substantially uniformly over the whole area of the filter bed whereby the flow of wash water will be substantially vertical and substantially uniform over the whole area of the bed, and in which the lower ends of said passages are so disposed as to form a zone of increased velocity immediately above the upper surface of the expanded bed.

9. In a filter as claimed in claim 3, 4 or 8 the construction wherein said draw-off passages are provided with outwardly flared lower ends.

10. A filter as claimed in any of claims 3—9 in which the vertical passages are provided with means to cause the water passing therethrough to have a rotary motion imparted thereto.

11. A filter constructed and arranged substantially as hereinbefore described and as illustrated in the drawings.

12. The method of washing a filter bed substantially as hereinbefore described.

Dated this 12th day of August, 1935.

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Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1936.