No. 649,409.

Patented May 8, 1900.

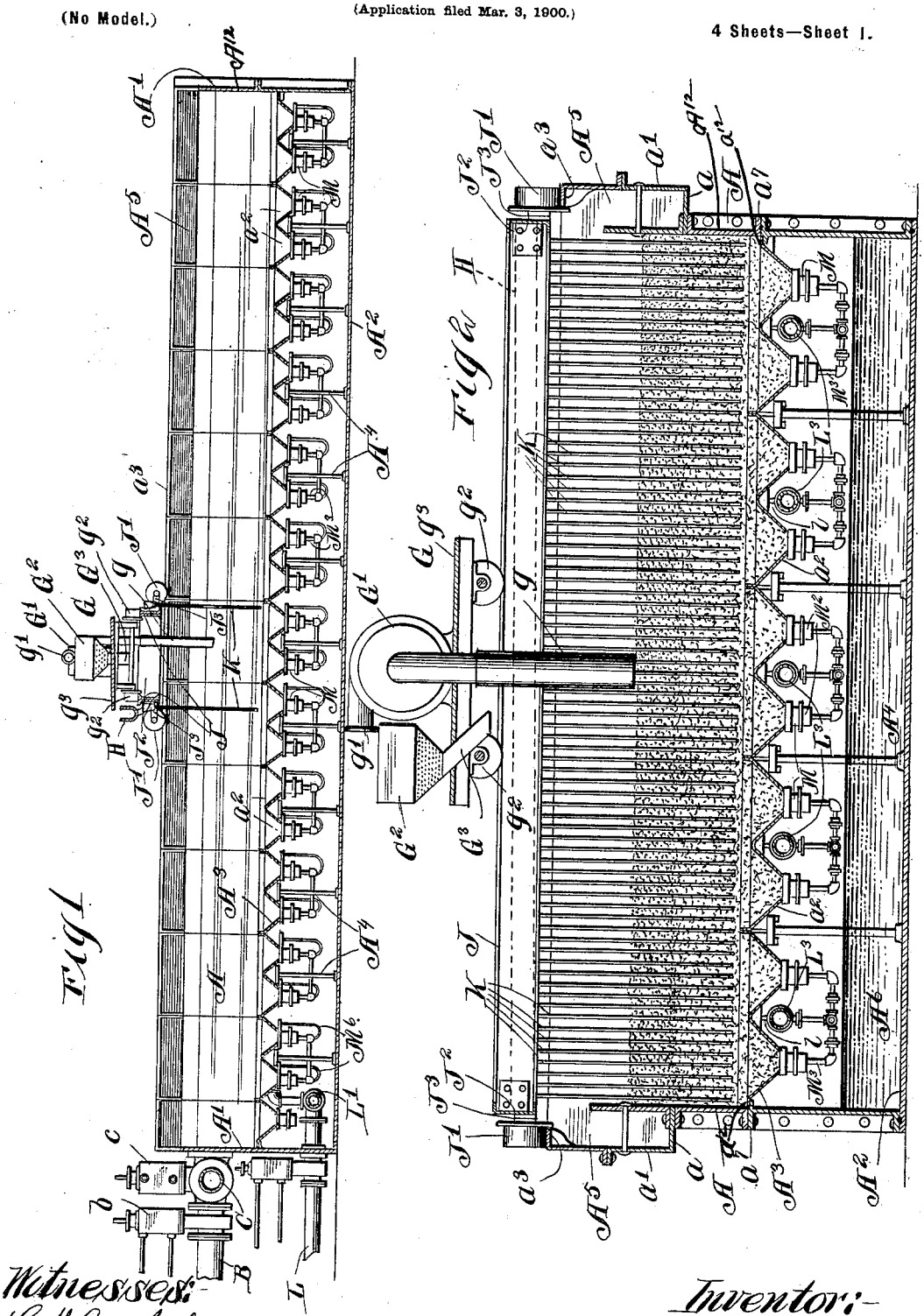
I. H. JEWELL.

FILTER.

(No Model.)

(Application filed Mar. 3, 1900.)

4 Sheets—Sheet 1.



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4 Sheets—Sheet 2.

Fig 3

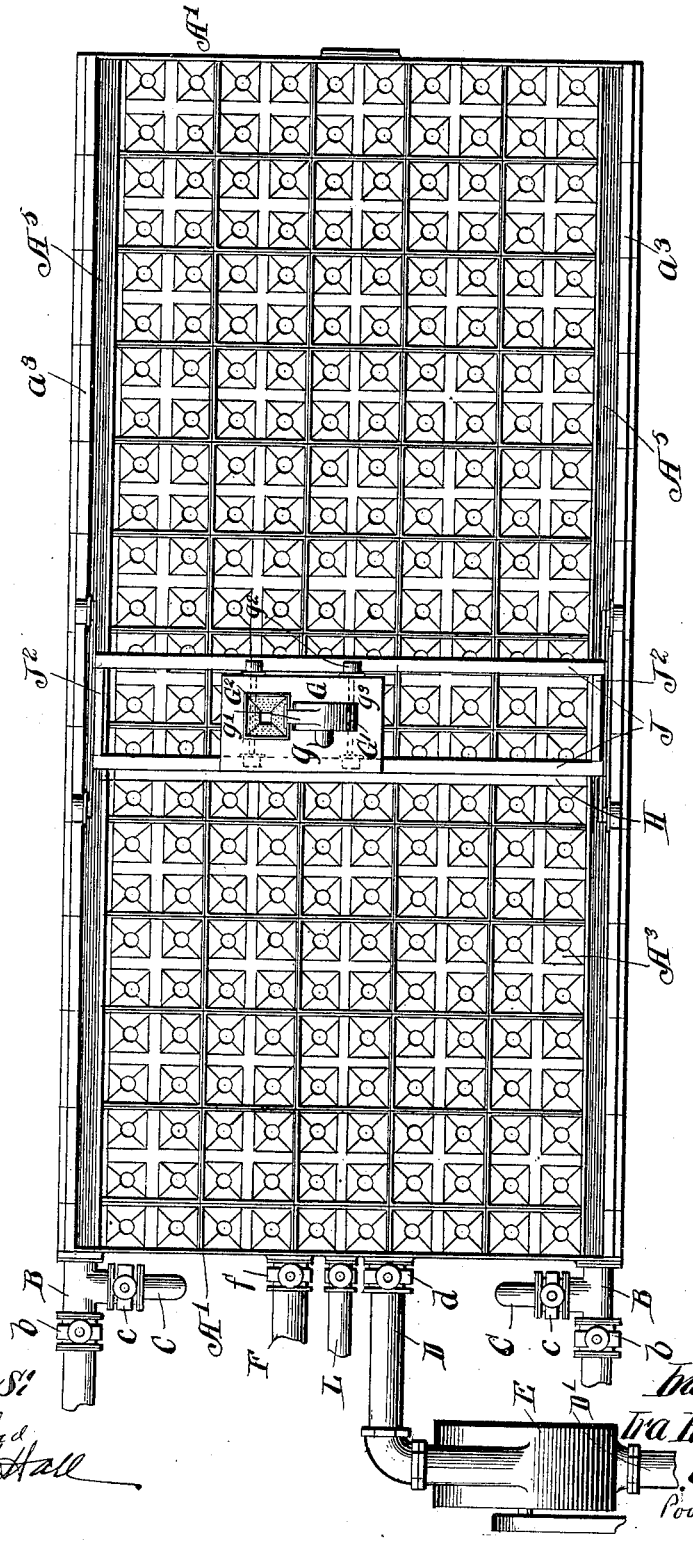

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Fig 4

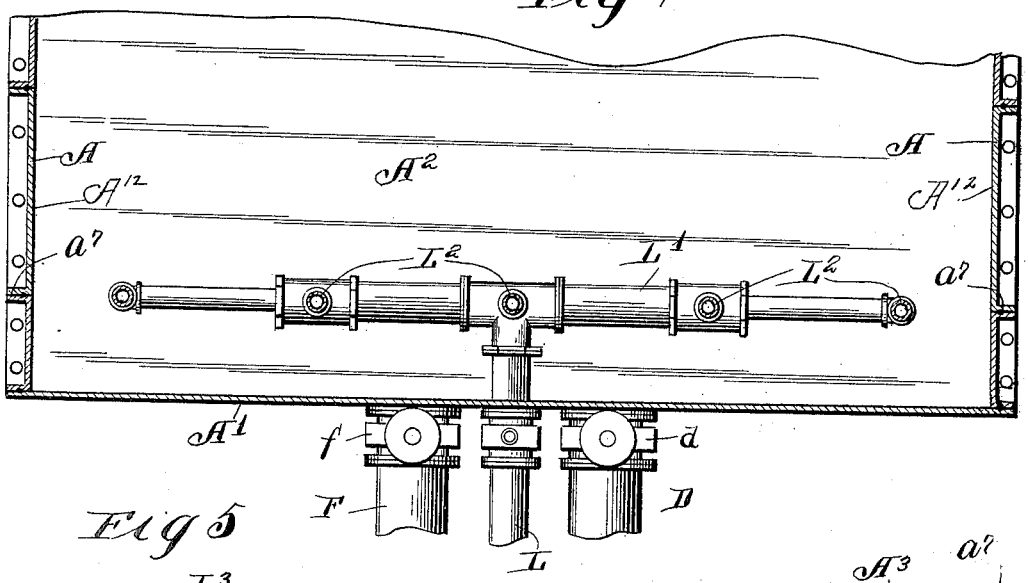

Fig 5

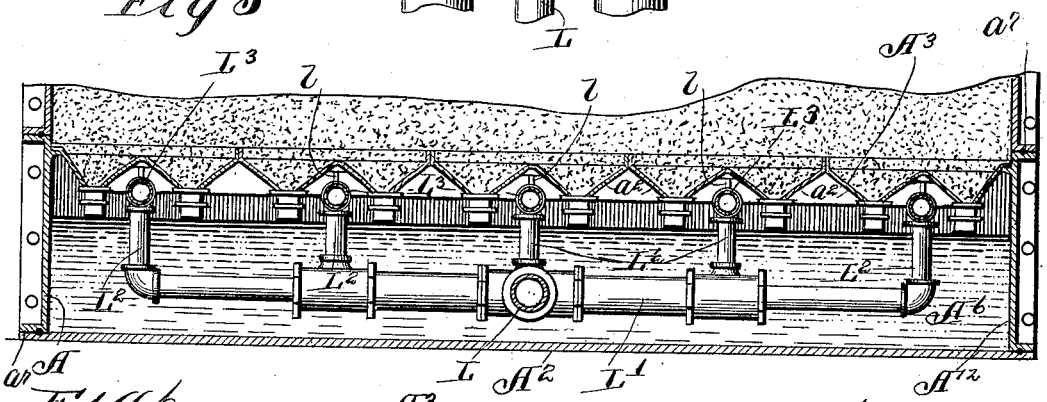

Fig 6

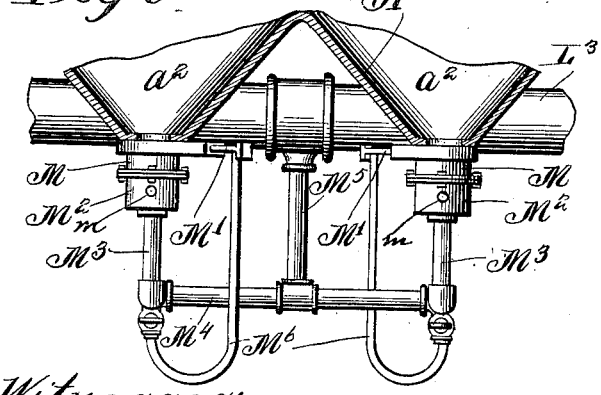

Fig 7

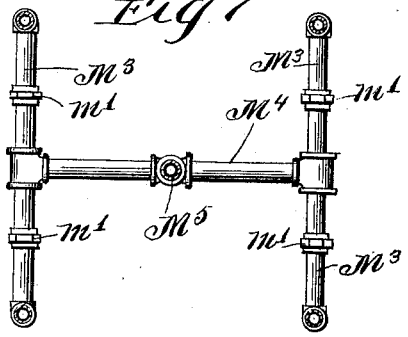

Fig 8

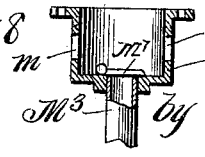

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Fig 9

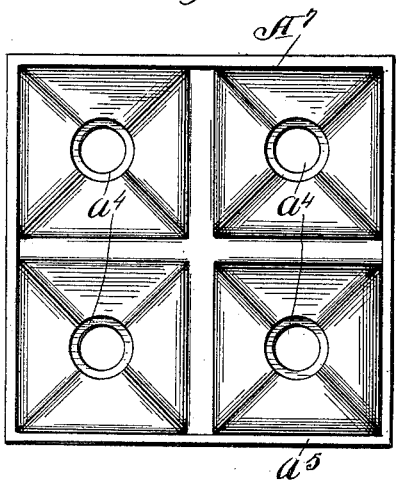


Fig 10

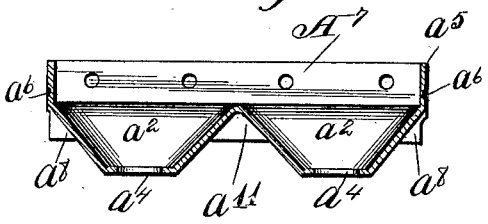


Fig 11

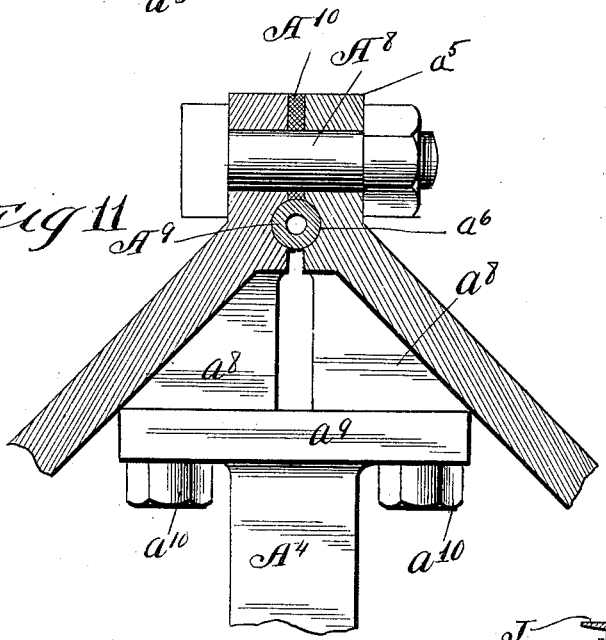


Fig 13

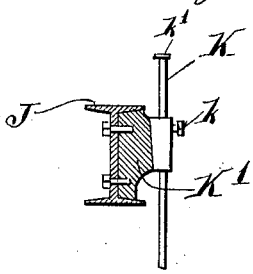
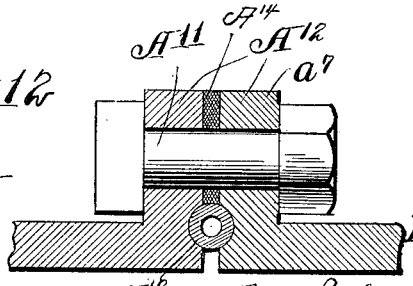


Fig 12



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UNITED STATES PATENT OFFICE.

IRA H. JEWELL, OF CHICAGO, ILLINOIS.

FILTER.

SPECIFICATION forming part of Letters Patent No. 649,409, dated May 8, 1900.

Application filed March 3, 1900. Serial No. 7,174. (No model.)

To all whom it may concern:

Be it known that I, IRA H. JEWELL, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Filters; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in filters and embraces as its principal features means for cleansing the filter-bed and for maintaining the bed in a condition most favorable for purifying the water treated thereby, an improved construction of the filter-bed bottom and of the filter-tank, means for controlling the discharge of the filtered water from the bed, and means for freeing the water of organic matter held in solution therein.

Heretofore the most common method of cleansing or washing filter-beds is to reverse the direction of the filtered water and force the same upwardly through the bed either independently or conjointly with stirring devices for agitating the bed, thereby driving out the impurities deposited in the bed, the wash-water and the impurities dislodged from the bed rising above the filter-bed and floating away from the same. When the filter-bed is washed in this manner, the operation of the filter must be entirely suspended, and a large volume of water is required to properly wash the bed and carry the impurities away from the filter. Furthermore, in accordance with the good practice the water used for such washing should be filtered water, as it would obviously be impossible to properly clean the bed with raw water or water with the natural impurities therein. Another method of cleansing filter-beds of relatively-large area is shown in my prior United States Letters Patent, No. 587,969, granted August 10, 1897, which consists in successively lifting portions of the filtering material from the bed by means of a suitable pump, separating the water and impurities from the filtering material, directing said water and impurities to a place outside of the filter, and redepositing the cleansed filtering material upon the filter-bed. By the apparatus shown in said patent the upper part of the filter-bed may be cleansed without entirely discontinuing the operation of filtration, or the entire bed may be removed, cleansed, and redeposited thereby where such complete cleansing is required. Furthermore, it has been proposed heretofore to employ air in connection with means for cleansing filter-beds by upward washing either while the bed is being washed or at other times for the purpose, on the one hand, of agitating the material forming the filter-bed, so that the wash-water will act more effectively thereon, and for the purpose, on the other hand, of oxygenating the filter-bed.

It is one of the objects of this invention to combine in a single apparatus or filter two or more of the cleansing means above referred to and heretofore employed to be used in some instances with a special construction of filter and to so combine their operations that the cleansing of the filter-bed may be effected under all usual conditions surrounding a filtering plant and with all the characters of water which the filter may be used to purify, whereby the individual or combined operations of the several cleansing means may be depended upon to maintain the filter in condition for supplying pure water at all times at a minimum expenditure of time consumed in cleansing the filter, of expense of the operation of cleansing, and of the volume of filtered water used for the purpose of such cleansing operation, so that the quality of the filtered water may be maintained uniform and at a high standard.

A further object of the invention is to provide means in connection with such cleansing devices for freeing the water of objectionable organic matter held in solution therein.

A still further object of the invention is to improve the construction of filters, and thereby render the operation of the same more efficient than heretofore, and to cheapen the construction and maintenance of the same and the convenience of installing the filter and to provide means for controlling the discharge of the filtered water from the filter.

These and other objects of the invention will more fully appear from the following description of the invention and the statement of the operation of the various parts thereof in the different combinations in which they

may be employed by the operator of the filter; and the invention consists in the matters hereinafter set forth, and more particularly pointed out in the appended claims.

In the drawings, Figure 1 is a longitudinal section of a filter made in accordance with and provided with my invention. Fig. 2 is a transverse vertical section thereof. Fig. 3 is a plan view of the filter, showing the relative positions of the inlet and outlet pipes. Fig. 4 is a detail plan section of the end of the filtered-water tank. Fig. 5 is a detail transverse section of the lower part of the filter-tank at one end thereof, showing the arrangement of the air-pipes. Fig. 6 is an enlarged fragmentary detail of two adjacent screen-holders and showing the connections between the same and one of the air-pipes. Fig. 7 illustrates the manner of connecting four adjacent screen-holders with an air-pipe. Fig. 8 is a detail of the means for connecting an air-pipe to the screen-holder. Fig. 9 is a plan view of one of the cast-metal sections of which the filter-bed bottom is composed. Fig. 10 is a cross-section therethrough. Fig. 11 is a fragmentary detail of the means for connecting adjacent sections of the filter-bed bottom. Fig. 12 is a fragmentary view of means for attaching together the several sections from which the tank is made. Fig. 13 is a detail of the means for adjusting the stirrer-arms.

As shown in said drawings, A A designate the side walls, A′ the end walls, and A^2 the bottom wall of a filter-tank, which tank is herein shown rectangular.

A^3 designates as a whole the filter-bed bottom, which is supported above the level of the tank-bottom A^2 and on which the filter-bed is sustained in the usual manner. Said filter-bed bottom is supported upon the upper ends of a plurality of columns A^4 A^4, which rest at their lower ends on the tank-bottom, as herein shown. Said columns are attached at their upper and lower ends to the filter-bed bottom and filtered-water-chamber bottom, respectively. A^5 A^5 designate longitudinal chambers, one on each side of said filter-tank and desirably extending the entire length thereof. Said chambers are formed between the upper edges of the side walls of the tank and horizontal and vertical plates *a a′*, attached to said side walls, the vertical plates extending above the upper edges of the side walls, as shown in Fig. 2. Said chambers are independent from each other and are each connected with raw-water-inlet pipes and waste-pipes and in the usual operation of the filter constitute the settling-basins of the filter into which the raw water is delivered and from which it overflows upon the filter-bed and constitutes overflow-tanks into which the washing-water is discharged when the filter-bed is being cleansed by forcing the wash-water upwardly therethrough.

B B designate raw-water-inlet pipes leading to the chambers, and said pipes are provided with valves *b b* of any suitable construction to control the passage of water therethrough. C C are the wash-water-outlet pipes connected with said pipes B inside the valves thereof and designed to direct the wash-water from the filter to a sewer or like place. The pipes C are provided with controlling-valves *c*. When the filter is in its usual operation, the valves *c* are closed and the valves *b* opened, and when the filter is being cleansed by reversal of the direction of water therethrough the valves *c* are opened and the valves *b* closed.

D designates a pipe leading from the filtered-water chamber A^6 and adapted to discharge into a storage-reservoir or like place. Desirably said pipe will be connected with a pump E, herein shown as of the rotary type, whereby the discharge of the water from said chamber may be maintained uniform and the work done by the filter readily determined, and whereby also the operation of the filtration may be prolonged, so that the filter-bed need not be so frequently cleansed. F designates a wash-inlet pipe through which water is delivered to the filtering-water chamber for the purpose of cleansing the bed by forcing the same upwardly therethrough. Said pipes D and F are provided with valves *d f*, by which the passage of water therethrough is controlled.

The apparatus located above the filter for cleansing the filter-bed from above is constructed and operated substantially like the apparatus shown in my prior patent, No. 587,969, granted August 10, 1897, and is made as follows:

G designates a truck carrying a suction-pump G′, preferably of the rotary type and which has movement both transversely and longitudinally of the filter-bed. Said suction-pump is provided with an inlet-pipe *g*, which extends downwardly into position for lifting portions of the filtering-bed. A discharge-pipe *g′* leads from the pump and discharges the filtering material into a hopper G^2 on the truck. The agitation given to the filtering material by the pump in elevating the same and discharging it into the hopper will ordinarily be sufficient to separate the filtering material from the impurities and water contained therein, and the walls of said hopper G^2 are perforated, through which the water charged with impurities from the filter-bed is expelled. Said expelled water is discharged on the platform g^3 of the truck, which is inclined toward a trough H, (shown in section in Fig. 1 and in dotted lines in Fig. 2,) which is movable with said truck. Said trough inclines from one side of the filter to the other and is adapted to discharge at one end into one of the chambers A^5 at the side of the filtering-bed. The hopper is provided with a discharge-pipe G^3, by which the cleansed filtering material may be redeposited on the filter-bed. The pump may be driven by any suitable motor. (Not herein

shown.) The truck G is supported on wheels g^2, which rest on tracks formed on the upper edges of bars J, which extend transversely across the top of the filter-tank. The said bars J are embodied in a traveling carriage, which supports the truck and pump and which carriage is adapted to be moved longitudinally of the filter-bed from one end to the other thereof, and upon which the truck may be moved longitudinally of the bed. The bars J, as herein shown, have the form of I-beams and are connected at their outer ends by transverse bars J^3, desirably of the same cross-section to complete the frame of the carriage. Said carriage is provided on its ends with rollers or wheels J^3, attached to laterally-extending arms rigid with the carriage, and is supported and travels on tracks a^3, which are located at the upper edges of the vertical walls a', constituting the outer wall of the chambers A^5. The operation of the foregoing construction is generally similar to that shown in my said prior patent and need not herein be more fully elaborated. The process of cleansing the filter-bed by means of the pump G' and related parts may be carried out without interrupting the operation of the filter when it is desired to cleanse only the upper stratum of the bed. In this instance the raw-water-inlet pipe B at one side of the filter will be closed and the pipe C connected therewith to bring it in communication with the adjacent chamber A^5, while the other raw-water-inlet pipe will be in communication with the opposite chamber A^5. The trough H will be directed to discharge into that one of the chambers A^5 which is open to the sewer through the pipe C, and the raw water will enter the filter through the other chamber A^5 and pass upon the bed in the usual manner. The operation of the filter, therefore, while not full at this time, is not entirely suspended.

A plurality of stirrer-arms are provided for loosening the filtering material, and as a further and separate improvement in constructions of this character said stirrer-arms are attached to and movable with the carriage. In this instance said stirrer-arms, which are designated by the letter K, are attached to the bars J of the truck-carriage through the medium of a plurality of supporting-brackets K', (shown more clearly in Fig. 13,) which project laterally from said bar J and are provided at their outer parts with vertical sockets, through which the said arms pass. Preferably said arms are vertically adjustable on said brackets and are held in their adjusted positions by set-screws k, passing through the brackets and impinging against the arms. Such vertical adjustment permits the arms to loosen the bed to a greater or less depth, as desired. In practice the bars may be connected so as to be simultaneously elevated and depressed—as, for instance, by a transverse connecting-bar k', attached to the upper ends of the arms.

I have provided, in connection with filters which are constructed to have the filter-beds thereof cleansed by passing the water upwardly therethrough, means for forcing air through the filter-bed, either at the time the same is being washed for the purpose of loosening the filtering material composing the bed, or thereafter for the purpose of oxygenating the filter-bed, and as a further and separate improvement I have provided means whereby the air and water may be directed through the bed from the same point or points. As herein shown, the construction by which this result is effected is made as follows:

L, Figs. 1, 3, and 4, designates an air-inlet pipe which passes into the filtered-water chamber A^6 of the filter and is connected inside of said chamber with a distributing pipe or head L', extending transversely across the chamber at one end thereof. Said distributing pipe or head is connected by short vertical pipes L^2 with a plurality of horizontally-extending distributing-pipes L^3, which are located near the lower surface of the filter-bed bottom A^3 and are connected by pipes with the screen-holders in such manner as to deliver air thereto. Said distributing-pipes L^3 are sustained by means of hangers l, which latter are connected at their upper ends with webs a'' on the under side of the filter-bed bottom between the funnel-shaped depressions thereof, said hangers being attached to the webs in any suitable manner. The construction by which the pipes are connected with the screen-holders to be used either independently or conjointly with the upward washing will be more readily understood by reference to the construction of the screen-holders and the filter-bed bottom, which will now be described.

The filter-bed bottom is provided with a plurality of openings through which the water passes from the filter-bed to the filtered-water chamber, and within said openings are located screens either of the usual or preferred type. As herein shown, the filter-bed bottom is provided with a plurality of depressions equal in number to the openings therein, and at the bottom of each depression is located one of said openings. Said depressions form in the filter-bed bottom a plurality of funnel-like projections a^2, which extend into the filtered-water chamber below the filter-bed bottom and at the bottom of which screen-holders are located. The upper margins of the inclined funnel-like projections are brought close together, so as to minimize or entirely do away with the horizontal surfaces between adjacent screens, so that therefore all the water passing through the filter-bed is directed to the screens without passing laterally over horizontal surfaces and also diffuses the wash-water forced upwardly through the bed uniformly therethrough.

M designates a tubular screen-holder which is located below and surrounds each opening

in the filter-bed bottom and is adapted to contain the screen which supports that portion of the filtering material resting above the same. Said screen-holders and screens may be made substantially like the construction shown in my prior United States Letters Patent, No. 646,837, granted April 3, 1900, and are attached to the lower ends of said funnel-shaped projections a^2 of the bed-bottom. Said screen-holders are each provided with a valve or closure M′ like the corresponding part of the construction of the above-mentioned patent, which closes the holder when it is desired to clean or repair the screen therein. The holders M are partially closed at their lower ends by removable casings M^2, which are attached thereto by means of radial annular flanges on the contacting faces of the casings and holders, through which holding-bolts pass, as shown in Fig. 6. To the lower end of each of said removable casings is attached a vertical pipe M^3, which is connected by means of a horizontal pipe M^4 with a vertical pipe M^5, which latter is connected with one of the longitudinal distributing air-pipes L^3 before referred to. The said casings M^2 are provided with laterally-directed openings m m, located, as herein shown, on opposite sides of the casing and through which the filtered water passes from the screen-holder into the filtered-water chamber and through which also the wash-water passes, which is directed from the filtered-water chamber upwardly through the filter-bed. When the air and water are being forced simultaneously through the filter-bed, the air rises centrally upwardly through the casing and screen-holder and the water strikes the air on entering the casing at an angle, and thereby becomes thoroughly mixed with the air as to act more effectively as a cleansing agent when it comes in contact with the bed. Moreover, the connections of the air-pipes with the screen-holders are such that the air may be continuously forced upwardly through the bed during the process of filtration, or ozone or other purifying agent may at such time be forced through said bed for a purpose which will more fully hereinafter appear.

As a convenient arrangement of the air-conducting pipes the longitudinal distributing-pipes L^3 are placed between each alternate row of screen-holders, which latter are disposed in parallel rows longitudinally of the filter, and each of the vertical distributing-pipes M^5, depending from the pipes L^3, are located approximately centrally of four adjacent screen-holders and connected with such adjacent screen-holders. This construction is more clearly shown in Figs. 6 and 7, wherein it will be seen that each pipe M^5 is provided with two oppositely-extending pipes M^4, which latter are at their ends in turn connected with two of the pipes M^3, leading oppositely therefrom and connected with the screen-holders. The pipes L^3 being located between the funnel-shaped projections a^2 on the under side of the filter-bottom, as shown in Fig. 5, are entirely out of the way of a person entering the filtered-water chamber for the purpose of repairing or cleaning the screens or for other purposes. The pipes M^3, connected with the casings M^2 of the screen-holders, are made in two parts, which are connected by couplings m, as shown more clearly in Fig. 7, whereby the parts of said pipes adjacent to the screen-holders may be removed with the casings M^2 when access to the screen is desired.

The valves M′ of the screen-holders may be made like those shown in my prior patent above referred to, and in order to overcome the resistance offered to the closing of the valves when so made by the body of sand in the holders, through which the valves must be moved to close the holders, the said valves may each be provided at its advance edge with a plurality of discharge-openings like the valve shown in Fig. 3 of said prior patent adapted to be connected with the air-supply through the medium of flexible hose M^6, connected at one end with the shank of the valve and at its other end with one of the horizontal pipes M^3. A valve m^2 is located between each flexible pipe M^6 and the pipe M^3 to control the passage of the air to the screen-holder valve.

As a further and separate improvement in filters of this character I propose to construct the filter-bed bottom of a plurality of metallic segments, preferably cast metal, which when joined together constitute a continuous rigid bottom. Conveniently each section of said bottom is made to contain four of the funnel-shaped projections a^2 and four openings through which the water passes, as shown in Figs. 9 and 10. Each section, as shown in said figures, consists of a rectangular plate A^6, having four symmetrically-disposed depressions, and at the bottom of each depression is located one of the water-openings a^4, through which water passes from the bed to the screen, and vice versa. Each of said plates is provided on its upper sides with a marginal flange a^5, made to conform to the shape of the plate. The plates when assembled to form the filter-bed bottom fit closely together and are secured together by means of bolts A^8, passing through the adjacent flanges a^5, as shown more clearly in Fig. 11. The plates adjoining the side walls of the filter-tank are provided with laterally-extending flanges a^{12}, by which said plates are attached to inwardly-extending flanges in said side walls. With this construction the filter-bed bottom may be made to approximate any size desired by the use of the required number of segments and which segments may be made in quantities and kept as a stock article. Suitable water-tight joints are provided between the several segments, which may be of any preferred form.

An improved form of making a water-tight joint between the sections adapted to be at-

tached together to constitute a continuous rigid structure, as the filter-bed bottom described, is illustrated in Fig. 11. As herein shown, the proximate faces of the flanges a^5 of adjacent sections are provided with grooves a^6, which when the sections are placed together are in lateral alinement with each other, and within said grooves is located a suitable packing, consisting, as herein shown, of a pipe A^9, made of a suitably-soft metal and which when the parts are clamped together by the bolts A^8 is compressed between said parts. After being clamped together in the manner described a space will desirably be left between said flanges, which is filled by a mass of cement A^{10} or the like, as shown in Fig. 11, said material being placed in said space when in a fluid or semifluid condition and afterward allowed to harden therein. Said hardened filling, together with the cylindric packing A^9, provides a water-tight joint, which is so constructed as to avoid deterioration and is therefore lasting. In some instances the cylindric packing alone may be sufficient to answer the purpose.

As a still further improvement in filters of this character I propose to construct the tank of a plurality of plates or segments, which are joined together in the manner to constitute a water-tight chamber or tank. The plates A^{12}, constituting the side walls of said tank, are herein shown as substantially rectangular and provided at their edges with laterally-extending flanges a^7, which surround the same and conform to the shape thereof. Said plates are attached together by means of clamping-bolts A^{11}, which pass through flanges of adjacent plates. The proximate faces of said plates or flanges are grooved, as in the construction of the filtered bottom segments above described, and interposed between each adjacent plate is a cylindric packing A^{13}, consisting of a relatively-soft metal pipe, which is compressed between the plates when the latter are clamped together and forms a tight joint between the same. The said packing is supplemented by a mass of cement A^{14}, as in the prior construction.

As a means for attaching the supporting-columns A^4 to the filter-bed bottom the proximate angular faces of the funnel-shaped projections of the plates A^7 are provided with lugs a^8, which are adapted to fit upon and to be attached to the flanged heads a^9 of the columns A^4. Said lugs are attached to the flanges of the column by means of screw-bolts a^{10}, which pass upwardly through the flanges of said head and into the lower side of the lugs a^8. The webs a^{11} are located between the adjacent depressed portions of each plate, to which the hangers l, supporting the distributing-pipes L^3 of the air-distributing system, are attached and upon which the same are supported.

I will now proceed to describe the various methods of using my multiple system for cleansing filter-beds, and at the same time, in order to make clear the advantages thereof over prior methods of cleansing filter-beds, point out briefly the difficulties encountered in the art of filtration and the effects of such difficulties as the art of filtration has been heretofore practiced. My invention has been more especially designed for filters of large area used in connection with a water plant supplying a large number of people—as, for instance, a town or city—and where it is therefore necessary not only that the filter be kept in condition for supplying pure water, but that its capacity be substantially maintained for a given volume of water per day, and that its usual operation may be carried on notwithstanding unfavorable conditions which may arise. Certain of the features of the invention relating to the cleansing devices may, however, be used with filters of smaller capacity.

In washing filter-beds with a reverse current of water a large volume of water must be supplied under a given pressure, usually in the neighborhood of five gallons per square foot area. Therefore a filter having a thousand square feet area would require approximately five thousand gallons per minute of water to be reversed therethrough to cleanse the filter-bed. Because of the fact that such a large amount of water is required to cleanse a filter by the upward current therethrough filters larger than twenty-four feet in diameter have not previously been practical or made, though under the old practice it would be possible to build the circular form of mechanical filters larger were it possible to obtain a sufficient amount of water to wash the same. Larger filters have heretofore been desired, but owing to the above difficulty of washing have not been made. When, on the other hand, several ways of cleansing the filter-bed are provided, I am enabled, if there is not sufficient water to cleanse the bed by the upward reverse current, to supply other means for cleansing the bed, and in this way larger filters are made practical. A filter requiring to cleanse the filter-bed a reverse current of five thousand gallons per minute under a pressure approximately at the inlet-valve of the filter of ten pounds per square inch would require more water for cleansing than a water-works can at all times spare for this purpose. This is due to the fact that many places have a very small storage capacity for the filtered water, and when there is not sufficient storage capacity to supply the amount required for the use of the district supplied and also the amount required for washing it is obvious that the washing operation cannot proceed, but must be delayed until favorable circumstances. In filters of the size above mentioned the length of time required for the washing operation is from ten to twelve minutes, and the volume to cleanse the filter will be from fifty to sixty thousand gallons. Moreover, under such circumstances, or circumstances even more favorable to the operation of filtration, should a fire break

out in the city supplied by the filter plant and an extra pumpage of water be required it would be out of the question for the superintendent or operator of the plant to cleanse the filter bed or beds or to get satisfactory results at all. It has been the practice in some instances in order to forestall such untoward events to provide either a reserve reservoir or a number of filter units greater than necessary to supply water under ordinary conditions. Where such provisions are not made, it frequently becomes necessary to put the filter plant out of operation and pump the raw water into the city-mains. Such practice may obviously prove disastrous when the water is foul and polluted with disease germs. By providing other methods for cleansing the filter-bed—such, for instance, as shown in my prior patent, No. 587,969, dated August 10, 1897—I am enabled at times when there is not sufficient water to cleanse the filter-bed by the reverse current to effect the cleansing by the device shown in said patent, and thus render it unnecessary to shut down the filter. Moreover, I am enabled in times of shortage of water, when the entire filter cannot be cleansed from below, to use the apparatus above conjointly with the reverse current and not only save a large amount of water in cleansing, but hasten the cleansing operation. In this way a volume of water—say two gallons per minute instead of five—would be turned on from below, requiring to wash a filter—say twenty thousand gallons of water instead of fifty or sixty thousand gallons, as in the previous case—and after the two gallons of water per minute had been turned from below the lifting device from above would be started and cleanse the upper portion of the filter-bed of the impurities driven upwardly from the lower portions of the filtering material by the restricted reversed current, so that all the impurities could be more readily and practicably caught by the lifting device. Otherwise the lifting device would remove only the upper portion of the impurities near the surface, (which latter, however, contains a large per centum of the impurities of the bed;) but when it is possible to do so it is preferable to drive the impurities which are in the lower part of the filtering material to the upper surface and have the lifting device remove them conjointly with the surface accumulation. Moreover, if it be not possible to wash the filter with two thousand gallons of water per minute from below, with the lifting apparatus from above, conjointly, as previously stated, I may employ either the lifting apparatus alone or the following means conjointly with the overhead apparatus: The raw water may be turned into the filter from one side and the opposite side of the filter open to the waste, whereby the raw water would enter on one side of the filter and the waste water flow out at the other. At the same time the stirrer-arms may be moved from one end of the bed to the other, thereby breaking up the surface accumulation. Said arms will be at this time adjusted so as to be near the surface of the bed, so that the impurities at the surface of the bed are swept off into the sewer by the raw water. I may at the same time employ the lifting device to assist in this operation by removing the surface accumulation with a small portion of the sand, cleansing and redepositing the same. The operation of filtering may at this time be partially carried on. In the use of the lifting device alone for this purpose the operation of the filter need not be interrupted. Moreover, the limited upward flushing may be used to good effect combined with the lateral flushing with raw water alone from one side of the bed to the other, the reverse current acting to drive the impurities to the surface of the bed and the raw water to sweep the same off the bed. Moreover, instead of using the upward flushing to force the impurities to the surface while the lifting device is in operation I may turn on the air-supply and by that means agitate the filtering material from below and drive the accumulation of filth which was lodged down near the bottom of the filter-bed upwardly toward the surface, and thereby remove the same with the lifting device. If it is preferred, the lateral flushing of the surface of the bed by the raw water may be used conjointly with the air from below. With this operation it would in most cases require that the filter be shut down. If, however, only a small portion of air be admitted, just sufficient to dislodge and drive the impurities upwardly, the closing of the filter would not be required, because when a small amount of air be admitted it will be diffused in a sort of atomizing effect throughout the granular filter-bed and a large portion of the air would be caught in the current of water in passing downward and be carried away. I would prefer, however, merely enough air to drive the impurities to the surface of the bed and at the same time, of course, allow some air to be caught by the water as it passes downwardly to assist in purifying the same at the time the filtration is not altogether discontinued during this cleansing process. Furthermore, I may use the air and water conjointly from below in an upward flow, and at the same time using the raw water from one side to sweep the surface accumulation off into the waste-channel, and conjointly with these employ the lifting device to assist in removing the surface accumulation. The stirrer arms or rakes on the lifting apparatus would at this time of course be brought into use. In such event the air would facilitate in driving the impurities upwardly, as well as to agitate the sand of the filter-bed and cause the grains to rub against each other to free themselves of the impurities clinging thereto. The stirrer-arms would also at this time assist in the agitation of the

sand of the filter-bed. The more vigorously the sand is agitated during the washing operation the more thorough is the cleansing.

By reason of the various combinations of cleansing devices above described I am enabled to at all times keep the filter-bed clean independently of the storage capacity of the filtered water and am not driven to the necessity of using raw or unfiltered water for cleansing purposes. Moreover, I am enabled to effect a large part of the cleansing by the use of raw water, and therefore save a large amount of filtered water for cleansing purposes.

When the water contains a larger amount of dissolved organic matter than is permissible in a good grade of water, I may force air continuously through the filter-bed during the operation of filtration in such limited quantities that it would be taken up by the downward currents of water and be carried away and have a beneficial effect of purifying the water. The excess of air not taken up by the water would be beneficially diffused throughout the sand bed and oxygenate the filtering material, and such oxygenation would in itself independent of the quality of the water indirectly assist in the purification thereof by the succeeding volumes of water taking it up. The air being forced into the sand bed from below in the manner described permits the air to be diffused thoroughly with a kind of atomizing effect between the interstices of the sand grains, whereby it is better distributed than if it were attempted to mingle the air with the water after the same had left the filter. It will of course be understood that when the air is used as above described the force or pressure on the air-supply pipe will be less than the gravity pressure-head on the filter effluent, so that the air will not rise to the surface of the bed, but only sufficient be diffused therethrough to be taken up by the water, as above described. It will furthermore be understood that the air-pipes described may be connected with a source supplying ozone and that ozone may be diffused through the bed for the purpose of purifying the water and destroying dissolved organic matter and bacteria. One of the greatest difficulties in filtering plants is the removal of dissolved organic matter, and attempts have been made to ozonate the water in the reservoir after it has passed through the filter. It is too expensive to attempt the oxygenation or ozonation of the water when it is heavily charged with suspended organic impurities, and it is therefore desirable to only use ozone or atmosphere on a water after the impurities have been removed. With the foregoing described method I remove the greater part of the impurities at or near the surface of the filtering material, and the ozone or air passing into the bed in the bottom thereof comes in contact practically with a filtered water with equally as good results as though the water had been discharged from the filter into a storage-basin and there treated. By this means I produce a water which will not sustain germs, and therefore more healthful than the merely filtered water.

It may be stated that the condition of the water entering the filter will determine largely which of the above-described means will be used to cleanse the filter-bed. When, for instance, the water is very muddy, it will be best practice to use the lateral surface flushing and lifting device without the water entering from below, for the reason that with very muddy waters the most impurities are caught near the surface of the filter-bed, at which place the impurities very rapidly accumulate and retard the flow of water downward through the filter-bed. If the water be of a good grade, the raw water entering the filter will not deposit so many impurities at or near the surface of the bed, so that the bed does not in such event get foul so rapidly. The necessity, therefore, of frequently cleansing the bed would not occur, and therefore the reverse current may be used either alone or with the air. If the filtered-water supply permits, and if it does not permit, the lifting device may be used to remove the surface accumulation to good advantage and even to remove the entire bed. I am not aware that in previous constructions of filters there have been two separate chambers on opposite sides of the filter, each connected with the raw-water inlet and the waste, whereby the raw water and sewer outlet may be used alternately, as above described, during the process of cleansing and during the operation of filtration. It is obvious that when the water is very muddy such surface washing or flushing by the raw water in the above manner is very valuable, because the more suspended impurities and filth the water contains the more it costs to produce a good effluent or clear filtered water, and it is therefore better practice to get rid of as much filth and impurities from the filter-bed as possible without using filtered water. The foregoing described means of cleansing filter-beds renders it unnecessary to use in the process of filtration as great a quantity of coagulants as heretofore necessary, thereby saving considerable expenditures in this direction, from two to ten dollars or more per million gallons of water. In case of muddy water and the lateral flushing by raw water could not be used freely I would use the lifting device and raw water conjointly or separately or employ such combinations, using the least possible amount of filtered water in addition to the raw water and apparatus above or air and by this multiple cleansing system save great expense in cleansing filter-beds.

The use of the pump at the filtered-water-effluent pipe enables the amount of water taken from the filter in a given time to be determined and the rate of flow thereby controlled and enables such rate to be varied to correspond with the demand made upon the

filtering plant. Moreover, by the use of such pump I am enabled to produce a suction on the filter-bed which will act, in conjunction with the gravity-head, to overcome the film of surface accumulation, and thus prolong filtration and render it unnecessary to so often wash the filter-bed. Such regulations may be readily effected by varying the speed of the pump and without the necessity of stopping the pump or process of filtration. The pump may, if desired, be connected with the main pumping-engines, so that the rate of flow might be determined by the speed of the engines and made to deliver a volume of water required on the high-pressure service.

The segmental construction of the tank and filter-bed bottom is of great importance, as will appear from a consideration of the following: Filtering-tanks have heretofore been made of boiler-plates or of cypress lumber, and the largest single unit heretofore made so far as I am aware is in the neighborhood of twenty-four feet in diameter, having a capacity of one million gallons. If such a tank when placed in the waterworks is unsatisfactory or for other reason its removal be desired, the expense of removing the same would be great and, in fact, almost or quite equal to the original cost of the tank. With a filter-tank made of a plurality of sections or segments, as herein shown, I am enabled to ship sections directly from the foundry with little or no machine-work having been done thereon and to build a tank of any size desired, and if the removal of the tank be desired the tank may be taken apart with little expense and removed. Moreover, it may be in this manner enlarged or the size thereof diminished, and such work may be done with comparatively-little expense. Moreover, in large waterworks tanks are required to be made of various dimensions. The building provided may be of a certain size, and it is required that the filters to be placed within that building must be made to fit into the space provided. With my invention the filter may be made to suit the space provided, thereby avoiding waste space in the building. The drawings here show a filter presumably twenty feet in diameter by fifty feet long, having a thousand square feet filtering area and with a capacity of about three million gallons per day, rated upon the average quality of water. By means of the segmental construction herein shown I am enabled to build a filter of large size, which with boiler-plate or cypress lumber would be very expensive, if not altogether impossible in practice. While the filter shown is oblong, it may be made round or irregular in shape to fit within whatever building-space may be in a plant, and thereby save a waterworks considerable expense. The oblong form is, however, very convenient in practice by reason of the fact that several filters of this form may be very compactly arranged.

Heretofore filters of large area have been made circular in cross-section. With the form shown in the drawings the tanks occupy less building-space than heretofore, for it is readily seen that when tanks are made round there is much floor-space lost between the circumference of any given tank and its next adjoining one or the wall of the building, while if the tank is oblong almost the entire space of a building may be occupied.

The provision of the cylindric compressible packing in connection with the opposing grooves in the proximate faces of adjacent sections of the tank and filter-bed bottom, is of much practical importance as it avoids the necessity of machine-work on the contacting parts of the sections and therefore cheapens the construction of the filter-bed bottom. With the construction described the sections may be incorporated into the bottom as they are taken from the foundry and with little or no machine-work thereon, and the cylindric packing inserted between the same affords a joint which may be made perfectly water-tight.

The form of the filter-bed bottom herein shown is of considerable importance, as it avoids horizontal surfaces of the bottom between adjacent screen-holders and is such as to distribute the water uniformly throughout the bed when the bed is being washed by forcing the water upwardly therethrough. Said construction also facilitates the conduction of the water through said filtering-bed to the screen-holder by reason of the fact that the water, which passes through the filter-bed in direct lines, is guided more directly to the screens by the inclined surfaces surrounding the same than if said openings were surrounded by horizontal surfaces. No opportunity is therefore afforded for the forming of mounds of the filtering material between the adjacent screen-holders, as in the case where the filtering-bed bottom is made flat in its part between the screen-holders and which mounds when the filter is cleansed by forcing the water upwardly therethrough are not permeated by the wash-water nor by the currents of air directed through the bed, so that in such case there would always be a portion of the bed not subjected to the cleansing action under ordinary conditions and which would be sufficient to taint the water passing therethrough in the regular process of filtration.

The provision of the funnel-shaped depressions is very desirable for the following reasons: The water in filtering has a tendency to travel downward in straight lines, and if the screen-openings were placed at a distance apart and at the level of the bed a part of the water-currents would strike the horizontal parts of the bed and in order to reach the screens would need to travel laterally toward the screens. It has been the practice heretofore to use small screens and a large number of the same. With my construction I am able

to use larger screens and to place them wider apart, which is not only desirable in practice, but is valuable as a constructive feature.

The purpose of supporting the filter-bed bottom on columns which are fastened both to the filter-bed bottom and on the support on which the columns rest will be made clear by consideration of the following: In washing a filter by reversing the water upwardly through the filter-bed, which is the usual practice in washing mechanical filters, there is a pressure exerted on the filter-bed bottom, which may become so great as to counteract the weight of the filter-bed bottom and superposed filter-bed. In such case a great strain would be brought upon the bed-bottom and tend to buckle the same upwardly. The columns, however, attached as stated, serve to hold the filter-bed bottom from being forced upwardly when the pressure of the wash-water becomes so great as to overcome the weight of the bed-bottom and superposed sand.

The air-pipes M^3 are provided with check-valves M^7, located, as shown in Fig. 8, within the casings or hoods M^2 and opening upwardly to permit the passage of air into the screen-holder, but which prevents the passage of water into said pipe M^3 when the valve is seated. Said valve is herein shown as of the ordinary flap type, but may be made of other construction and otherwise located.

The valve controlling the supply of raw water, the waste water, the wash-water, and the air to the filter may be controlled by the hydraulic actuating means set forth in another application filed by me concurrently herewith, Serial No. 7,175, or may be otherwise controlled, as found most convenient or desirable.

I claim as my invention—

1. The combination with a filter having a granular filter-bed constructed to be cleansed by forcing a fluid upwardly therethrough, of mechanism traveling over the bed for cleansing the filter-bed from above and constructed to be used either separately or conjointly with the upward cleansing means.

2. The combination with a filter having a granular filter-bed constructed to be cleansed by forcing a fluid upwardly therethrough, and a pipe designed for connection with a raw-water supply and discharging upon the bed at one side thereof so as to flush the upper surface of the bed from one side to the other thereof.

3. The combination with a filter having a granular filter-bed, of means for laterally flushing the upper surface thereof from the raw-water inlet, and raker-arms for loosening the material forming the filter-bed.

4. The combination with a filter having a granular filter-bed constructed to be cleansed by forcing a fluid upwardly therethrough, of means for laterally flushing the upper surface of the bed from the raw-water inlet and stirrer-arms for loosening the material forming the filter-bed.

5. The combination with a filter having a granular filter-bed constructed to be cleansed by forcing a fluid upwardly therethrough, of means for laterally flushing the upper surface of the bed from the raw-water inlet, stirrer-arms for loosening the material forming the filter-bed, and means for vertically adjusting the stirrer-arms.

6. The combination with a filter having a granular filter-bed constructed to be cleansed by forcing a fluid upwardly therethrough, of means for successively lifting, cleansing and redepositing the material constituting the filtering-bed, and vertically-adjustable stirrer-arms for loosening the material constituting said bed.

7. The combination with a filter having a granular filter-bed constructed to be cleansed by forcing water upwardly therethrough, of means for successively lifting, cleansing and redepositing the material constituting the filter-bed.

8. The combination with a filter having a granular filter-bed and a plurality of air-pipes adapted to discharge air upwardly through the filter-bed and connected with a source supplying air under pressure, of means for successively lifting, cleansing, and redepositing the material constituting the filter-bed.

9. The combination with a filter having a granular filter-bed constructed to be cleansed by forcing water upwardly therethrough, of means for successively lifting, cleansing and redepositing the material constituting the filter-bed, and stirrer-arms movable with said upper cleaning apparatus.

10. The combination with a filter having a granular filter-bed, and a plurality of air-pipes adapted to discharge air upwardly through the filter-bed and connected with a source supplying air under pressure, of means for successively lifting, cleansing and redepositing the material constituting the filter-bed, and stirrer-arms movable with said upper cleaning apparatus.

11. The combination with a filter comprising a tank which is open at its top and a filter-bed therein, of two independent chambers, one at each side of the tank in positions to overflow into said tank and adapted for connection, one with the raw-water-inlet pipe and the other with the wash-water waste-pipe.

12. The combination with a filter comprising a tank which is open at its top, and a filter-bed therein, of two independent chambers, one at each side of the tank in positions to overflow into said tank, each of said chambers being provided with valved pipes leading both to the raw-water supply and to waste.

13. The combination with a filter comprising a tank which is open at its top and a filter-bed therein, of two independent chambers one at each side of the tank in positions to overflow therein, each of said chambers being provided with a valved raw-water-inlet pipe and with a valved outlet-pipe leading to waste, and means for forcing a cleansing fluid upwardly through the filter-bed.

14. The combination with a filter comprising a filter-tank which is open at its top and a filter-bed therein, of two independent chambers one at each side of said tank in positions to overflow into the tank or the tank thereinto, each of said chambers being provided with a valved raw-water-inlet pipe and with a valved outlet-pipe leading to waste, means for forcing a cleansing fluid upwardly through the bed, and a plurality of stirrer-arms for loosening the material forming the filter-bed.

15. The combination with a filter comprising a filter-bed bottom and a filter-bed supported thereon through which a cleansing fluid may be forced upwardly for the purpose of cleansing the same, and independent chambers located one at each side of the tank, a pump for successively lifting portions of the filter-bed and supernatant water and impurities, means for separating the water and impurities from the filtering material, means for directing the water charged with the impurities to one of said chambers, and a means for redepositing the cleansed filtered material upon the filtering-bed.

16. The combination with a filter comprising a filter-bed bottom and a filter-bed supported thereon through which a cleansing fluid may be forced upwardly for the purpose of cleansing the same, and independent chambers one located at each side of the tank, and one of which is connected with the waste-water pipe of a pump for successively lifting portions of the filter-bed and supernatant water and impurities, an inclined truck-frame on which said pump is supported, means for separating the water and impurities from the filtering material, and directing it on said truck-frame, and discharging into one of said side chambers and means for redepositing the cleansed filtering material upon the bed.

17. An apparatus for cleansing filtering-beds of large area comprising, in combination, a device for successively lifting portions of the filtering-bed, cleansing the same, and redepositing the cleansed portions on the filter-bed, means for giving movement to said device longitudinally and transversely of the filter-bed and stirrer-arms movable with said device.

18. An apparatus for continuously cleansing filter-beds of large area, comprising means for successively lifting portions of the filter-bed, cleansing the same and redepositing the cleansed filtering material on the filter-bed, a carriage which carries said cleansing means and extending transversely across the filter-tank, supporting-wheels thereon which travel on tracks connected with the upper walls of the tank, a truck having wheels which travel transversely of the tank on said carriage and which directly supports the cleansing means and stirrer-arms depending from said carriage.

19. The combination with a filter comprising a filter-bed bottom having a plurality of openings therein, and screens located in said openings, of an air-pipe adapted to discharge air into said screened openings and connected with a source supplying air under pressure.

20. The combination with a filter comprising superposed filter-bed chamber and filtered-water chamber, screen-holders between said chambers, and depending into the filtered-water chamber, and air-pipes connected with said screen-holders and connected also with a source supplying air under pressure.

21. The combination with a screen-holder, and a screen therein, of an air-pipe connected with said holder below the screen.

22. The combination with a screen-holder, and a screen therein, of a removable perforated casing at the lower end thereof and a pipe connected with the casing.

23. The combination with a filter-bed bottom provided with a plurality of depressions and with openings at the bottoms of said depressions, of screens located below said openings.

24. A filter-bed bottom for filters, provided with a plurality of depressions at the lower parts of which are provided openings, the parts of said bottom surrounding each opening being inclined, and the inclined parts of said depressions surrounding each opening being continued to the inclined parts surrounding the adjacent openings.

25. A filter-bed bottom comprising a plurality of metal segments provided with marginal flanges, and provided also with openings extending therethrough, and clamping-bolts passing through said flanges and fastening said several segments together.

26. A filter-bed bottom comprising a plurality of metal segments which are provided with openings extending therethrough, which are adapted to be joined together edge to edge, and means for firmly securing said sections together to constitute a continuous filter-bed bottom.

27. The combination with a tubular screen-holder, and a screen removably contained in the lower end of the holder, of an air-pipe connected with said holder below the screen, and means for closing the holder above the screen.

28. A filter-bed bottom comprising a plurality of metal segments having one or more openings therethrough, means for firmly securing adjacent sections edge to edge and means for providing a water-tight joint between said segments.

29. A filter-bed bottom comprising a plurality of metal segments which are joined together edge to edge in the completed structure, each of said segments being provided with one or more depressions and with an opening at the lower end and centrally of each depression, and means for firmly uniting the segments edge to edge.

30. As a new article of manufacture, a segment for filter-bed bottoms, provided with an opening therethrough and at its margin with means for securing it to adjacent segments.

31. As a new article of manufacture a segment for filter-bed bottoms, provided with one or more openings and with a surrounding marginal flange by which it may be attached to adjoining segments.

32. As a new article of manufacture, a segment for filter-bed bottoms provided with one or more depressions and with an opening located at the lower end of each depression and centrally thereof, said segment being provided at its margins with means for securing it to adjacent segments.

33. A filter-bed bottom comprising a plurality of segments, which are joined together edge to edge and each provided with one or more openings extending therethrough, the proximate faces of adjacent segments being provided with longitudinal depressions, a cylindric packing located between the adjacent sections and fitting in said depressions, and means for clamping the adjacent sections together.

34. A filter-bed bottom comprising a plurality of segments, which are joined together edge to edge and each provided with one or more openings extending therethrough, the proximate faces of adjacent segments being provided with longitudinal depressions, a cylindric packing located between adjacent sections and fitting in said depressions, cement between said segments partially investing the packing and means for clamping the segments together.

35. A filter-bed bottom comprising a plurality of similar segments joined together edge to edge and each segment provided with one or more openings extending therethrough, and with a marginal flange, the proximate faces of the flanges of adjacent segments being provided with longitudinal depressions, a cylindric packing located between said flanges and fitting in said depressions, and bolts passing through and clamping the flanges together.

36. A filter-tank made of a plurality of metal segments joined edge to edge by means affording water-tight joints, said segments being made of a form permitting a less or greater number thereof to be employed to construct a tank of less or greater longitudinal or lateral dimensions.

37. A filter-tank made of a plurality of metal segments, each consisting of a flat metal plate provided with marginal flanges, the adjacent segments being secured together by bolts passing through the flanges, and packing between said flanges, said segments being formed to permit a tank of less or greater longitudinal or lateral dimensions to be made of a less or greater number of segments.

38. A filter comprising superposed filter-bed chamber and filtered-water chamber, a filter-bed bottom for supporting the filter-bed, means for forcing water upwardly through the bottom to wash the filter-bed, and columns which rest at their lower ends on the filtered-water-chamber bottom and attached thereto, and support at their upper ends the filter-bed bottom and attached thereto.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two witnesses, this 28th day of February, A. D. 1900.

IRA H. JEWELL.

Witnesses:
C. W. HILLS,
WILLIAM L. HALL.