(No Model.) 8 Sheets—Sheet 1.

J. T. MANNING.

FILTER.

No. 594,637. Patented Nov. 30, 1897.

FIG. I.

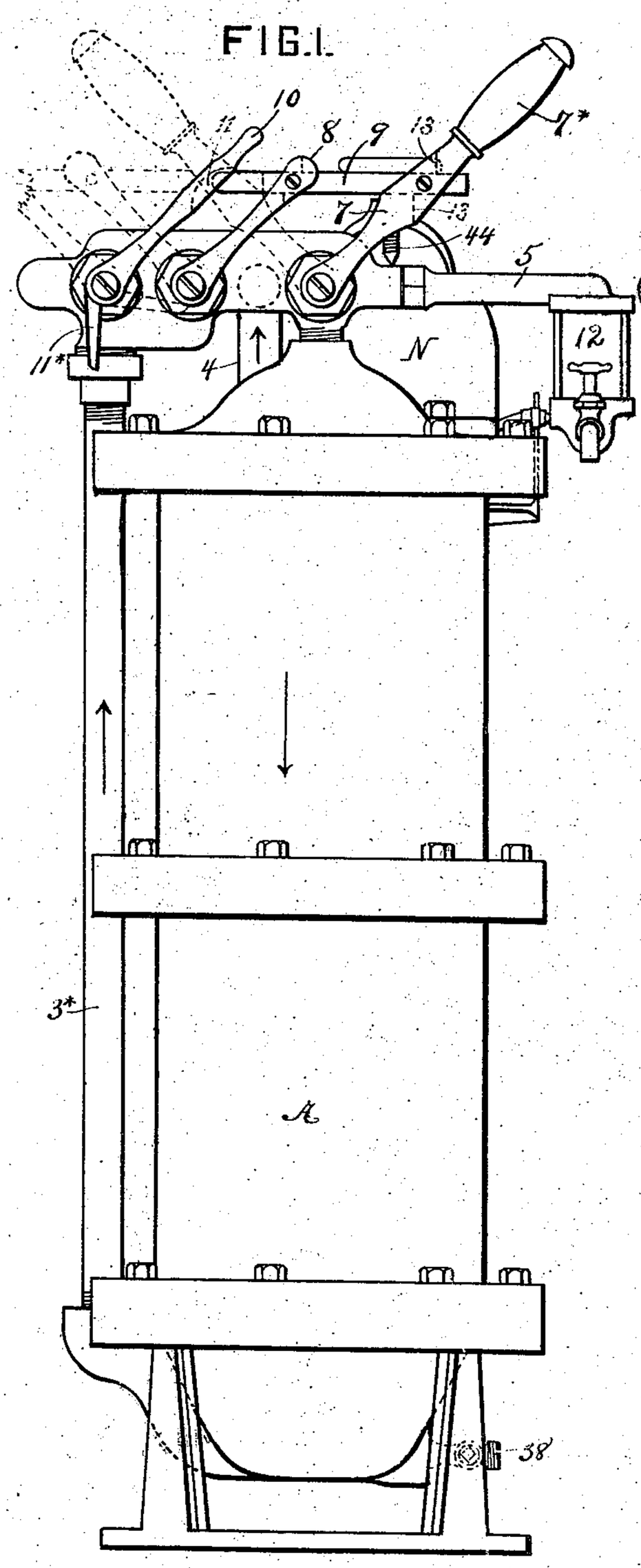


FIG. II.

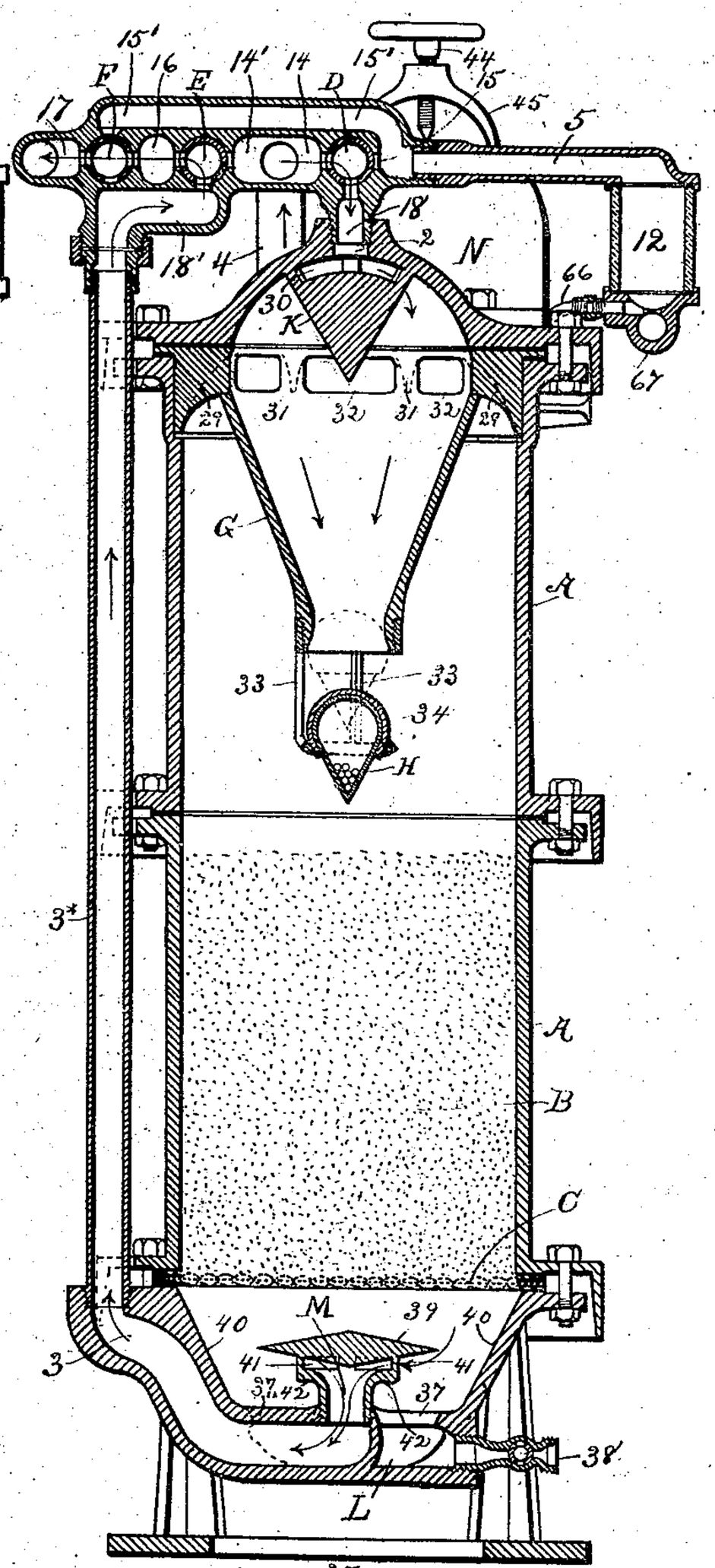


FIG. III.

FIG. XII.

Witnesses.
R. E. Auld.
Herbert Bradley.

Inventor
Joseph T. Manning
by Chas. J. Hedrick
his attorney

(No Model.) 8 Sheets—Sheet 2.

J. T. MANNING.

FILTER.

No. 594,637. Patented Nov. 30, 1897.

FIG. III.

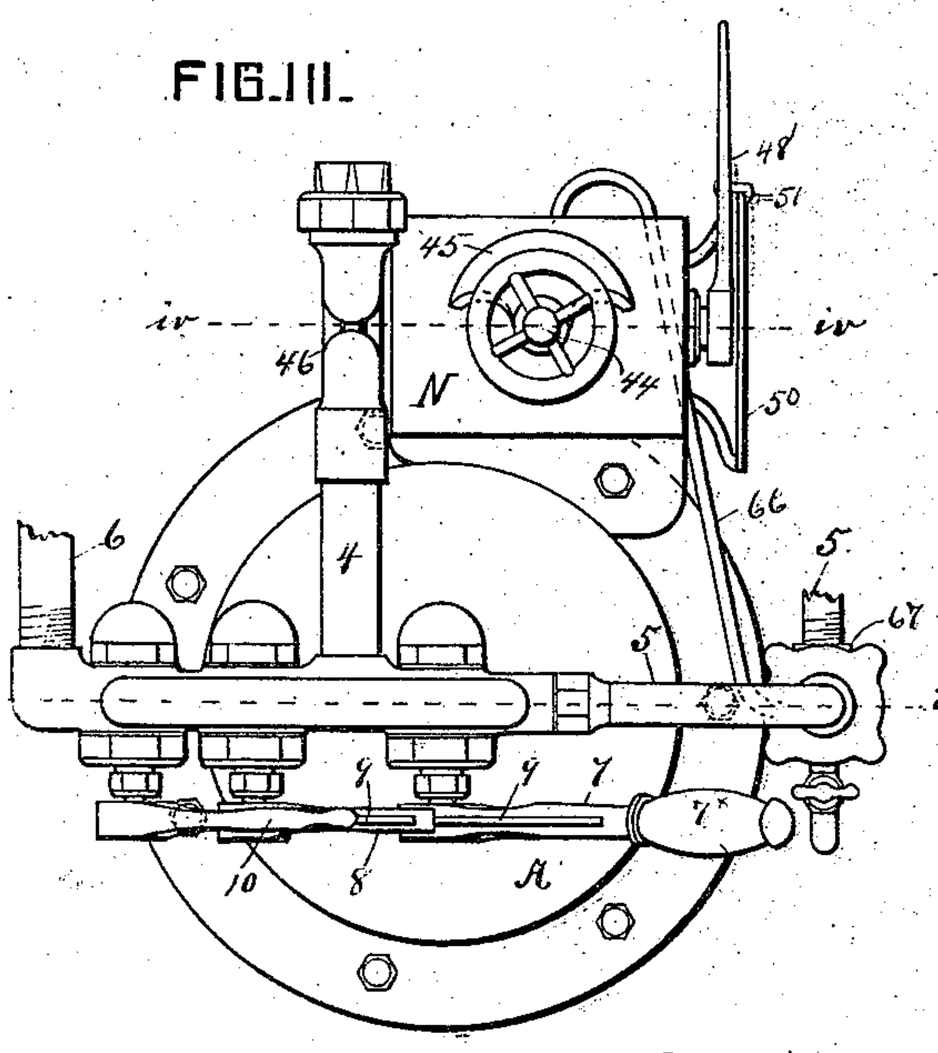


FIG. IV.

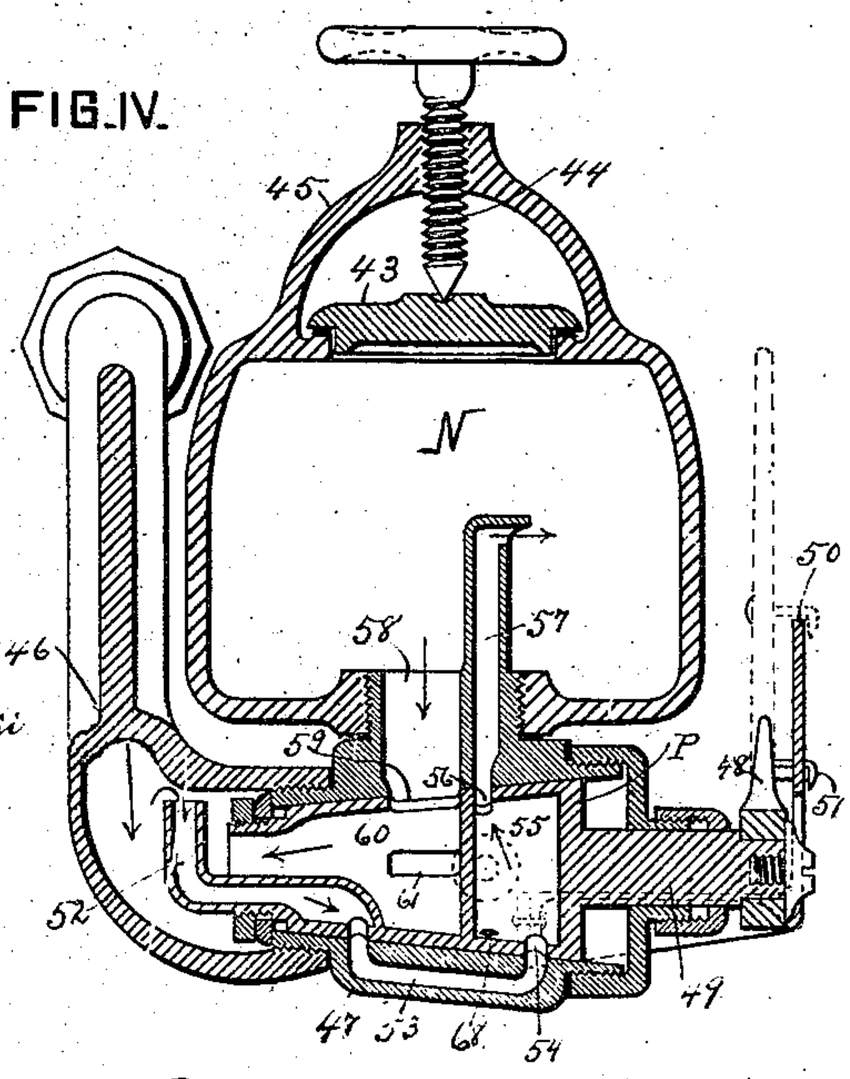


FIG. V.

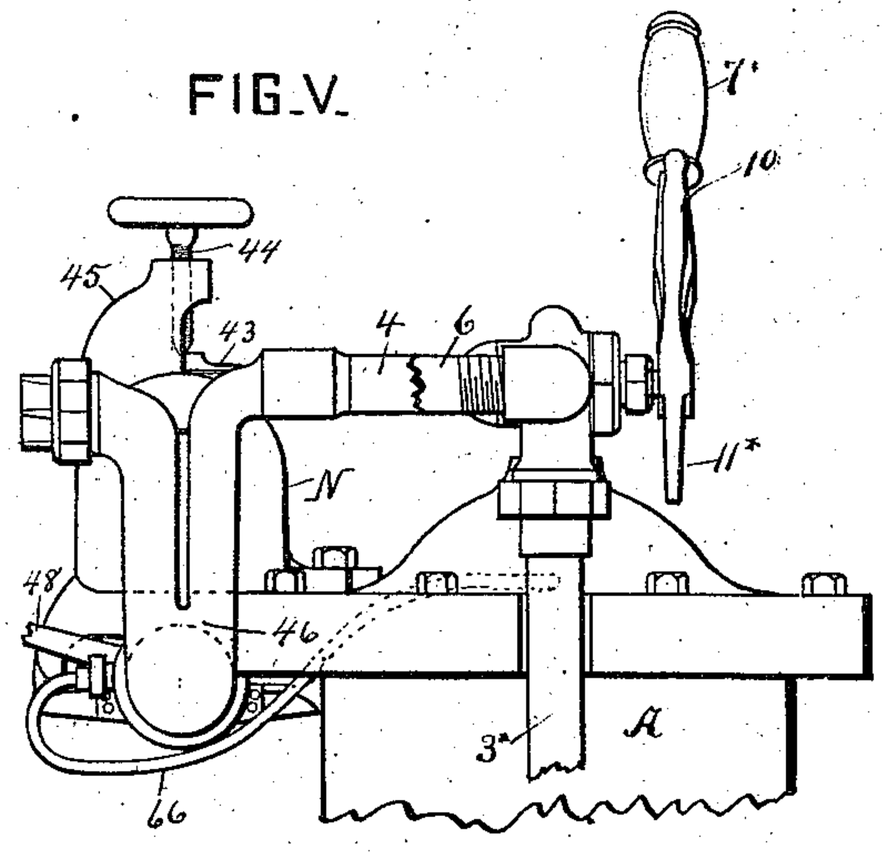
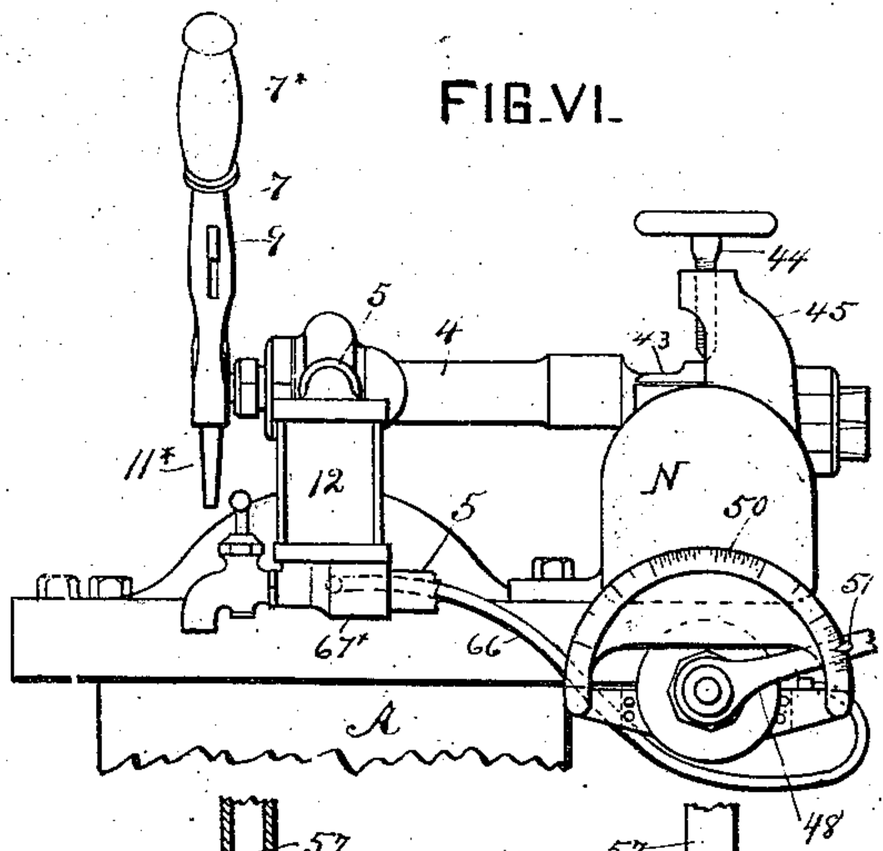


FIG. VI.



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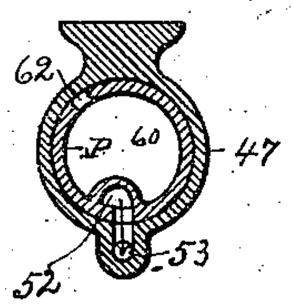

FIG. IX.

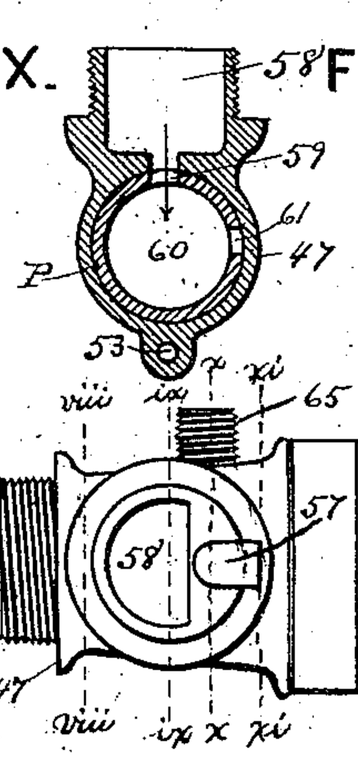

FIG. X.

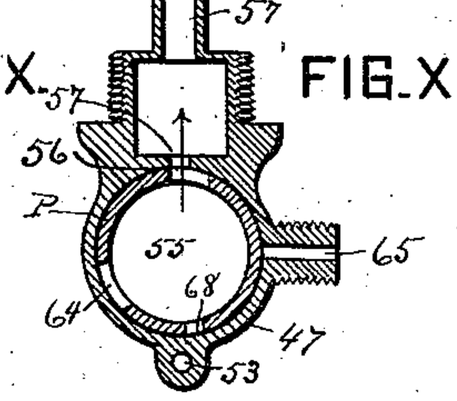

FIG. XI.

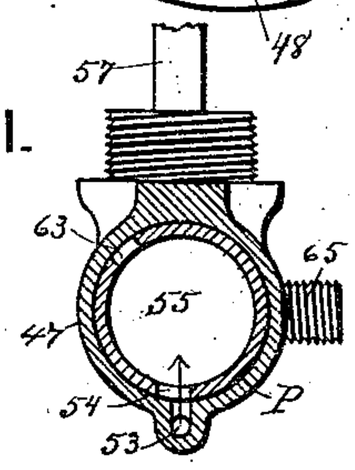

FIG. VII.

Witnesses.

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(No Model.) 8 Sheets—Sheet 3.

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FILTER.

No. 594,637. Patented Nov. 30, 1897.

FIG. XIV.

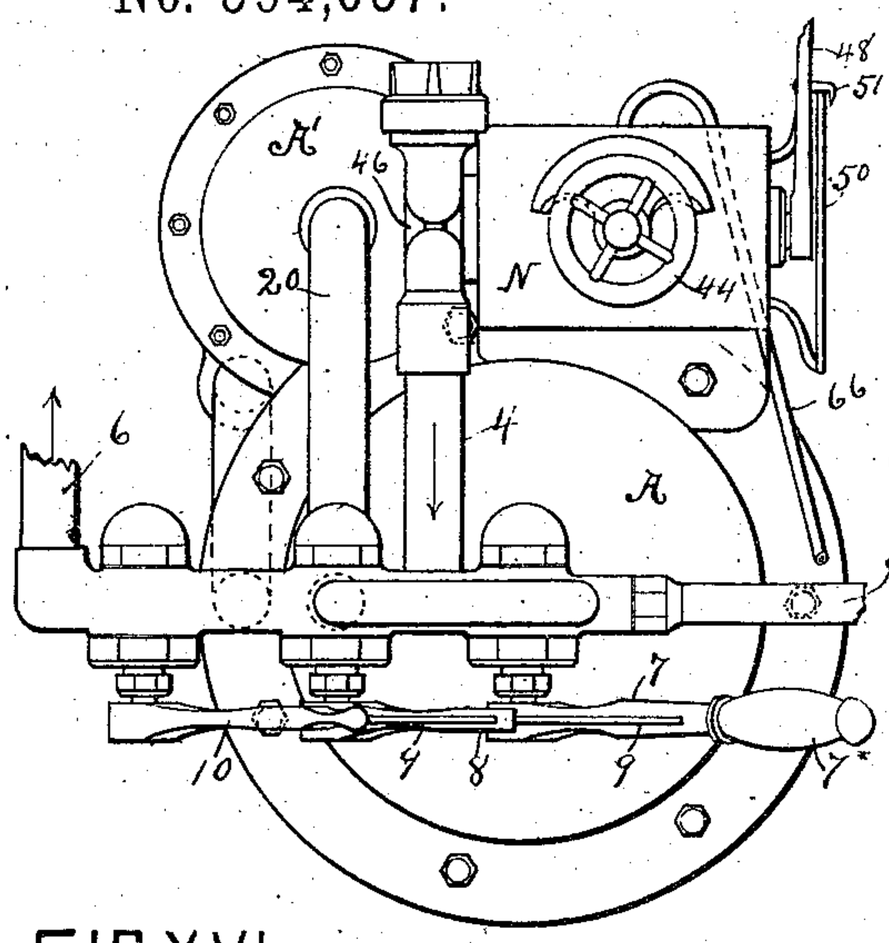


FIG. XV.

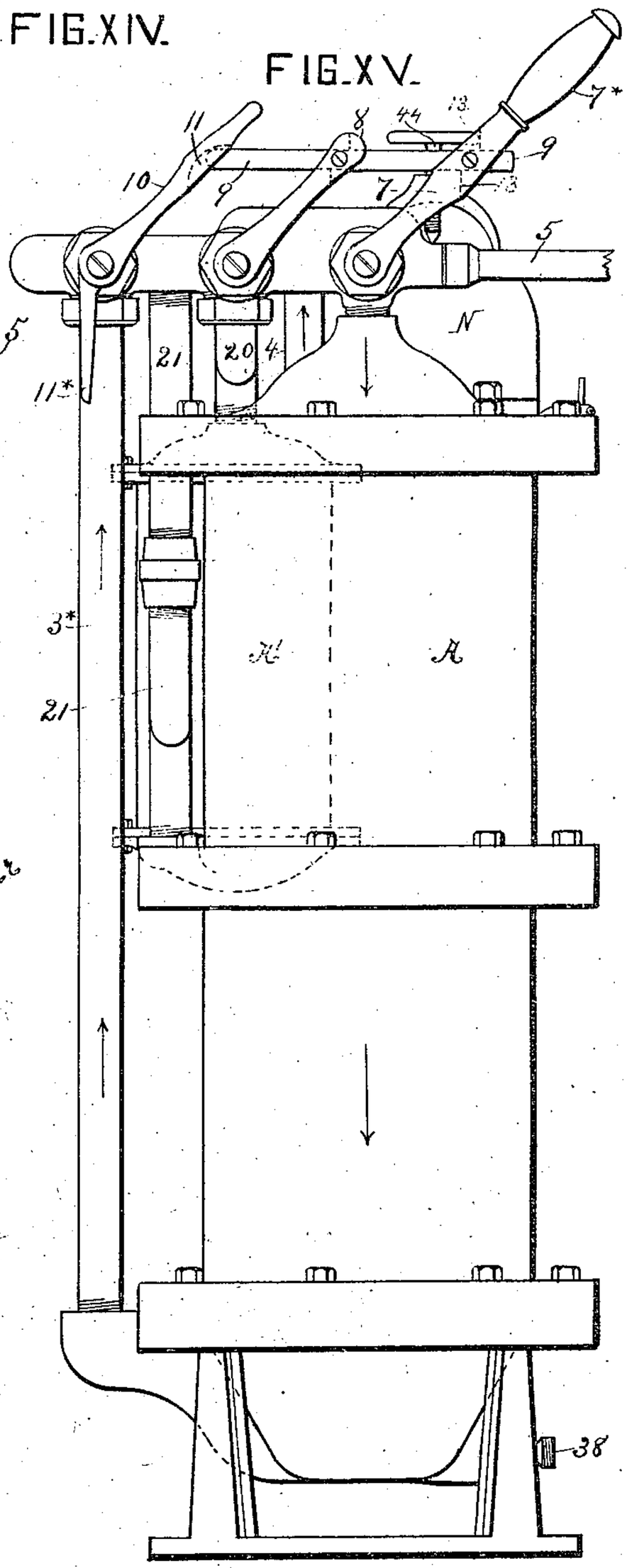
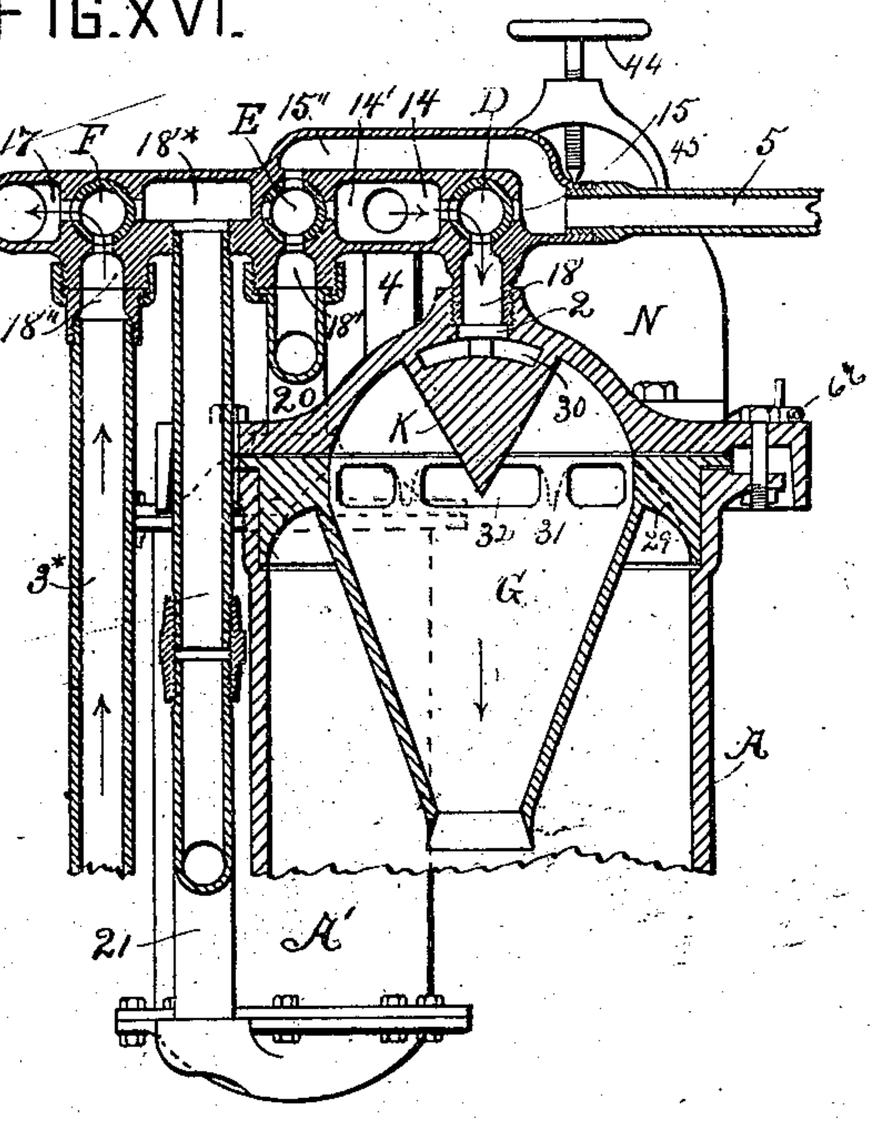


FIG. XVI.



Witnesses.

R. E. Auld.

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(No Model.)

8 Sheets—Sheet 4.

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FILTER.

No. 594,637. Patented Nov. 30, 1897.

FIG. XVII.

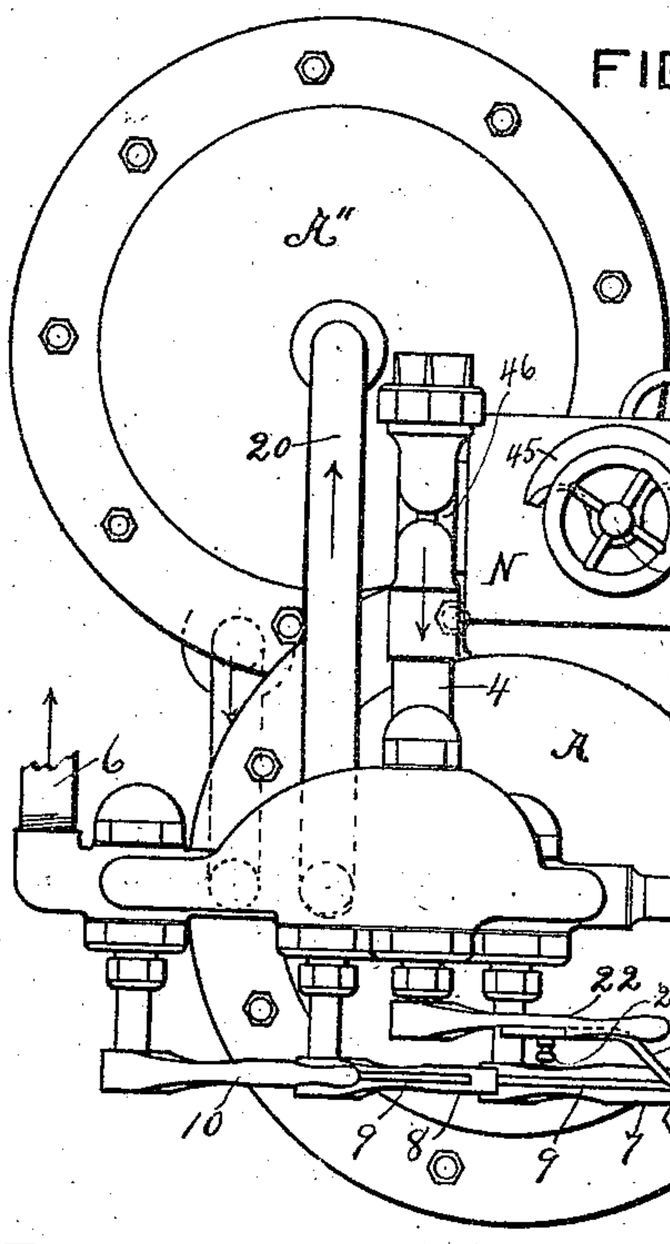

FIG. XVIII.

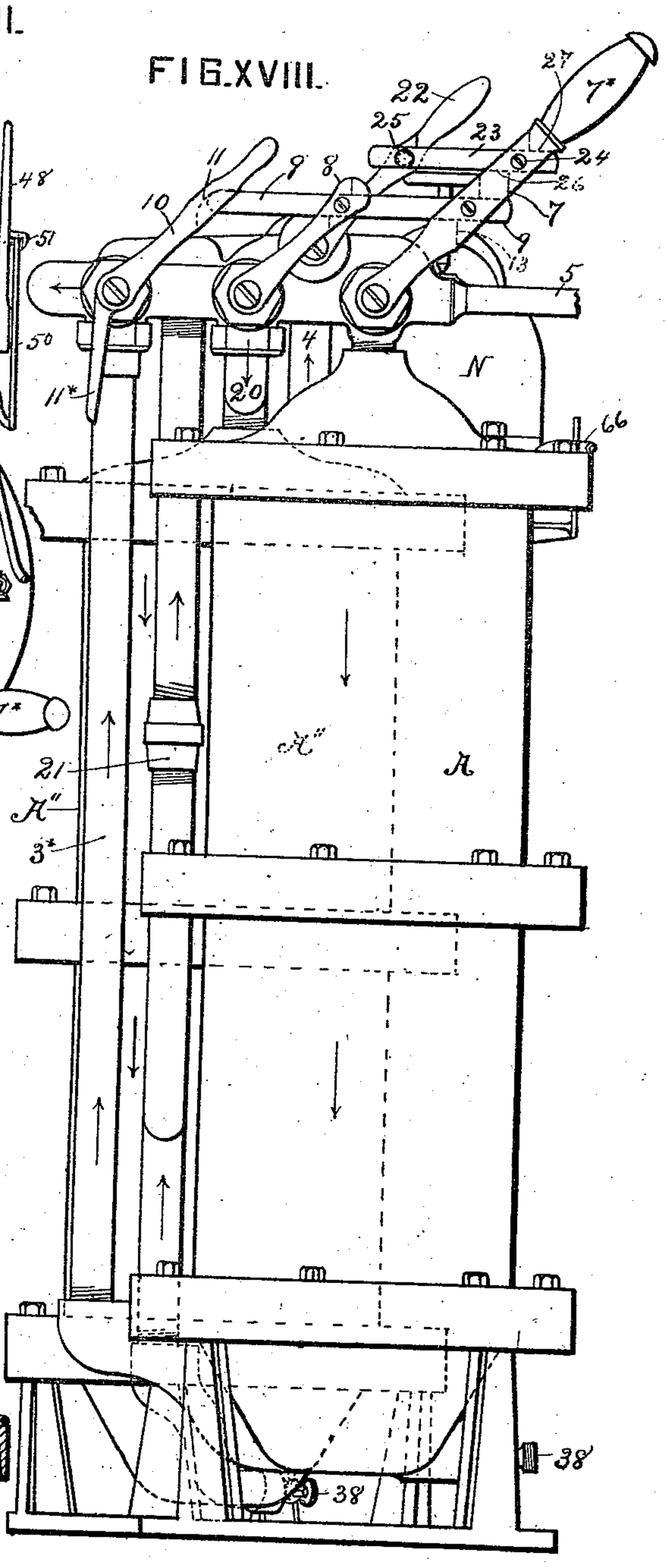

FIG. XIX.

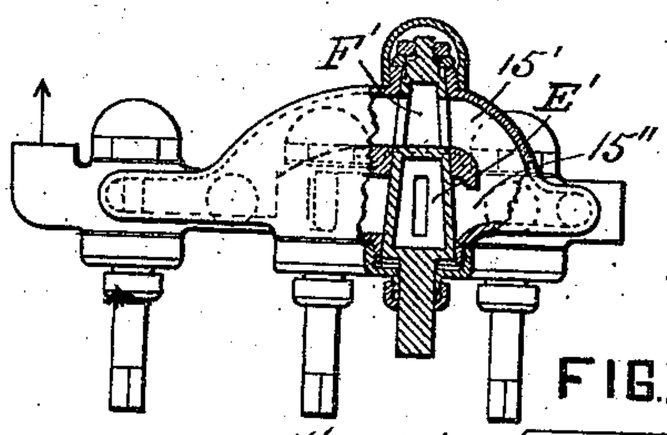

FIG. XX.

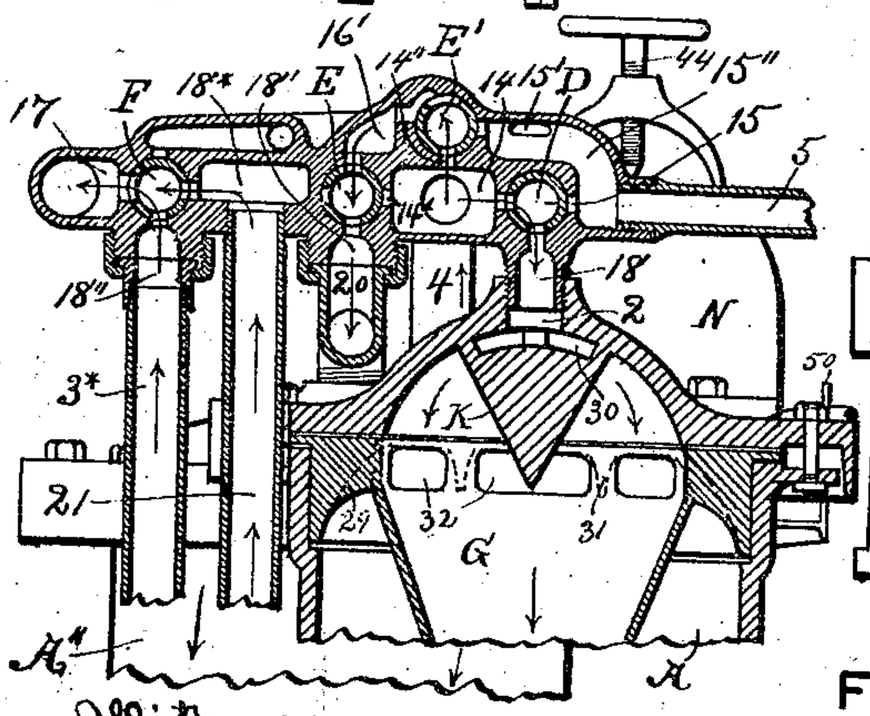

FIG. XXI.

Witnesses.
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(No Model.) 8 Sheets—Sheet 5.

J. T. MANNING.

FILTER.

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FIG. XXII.

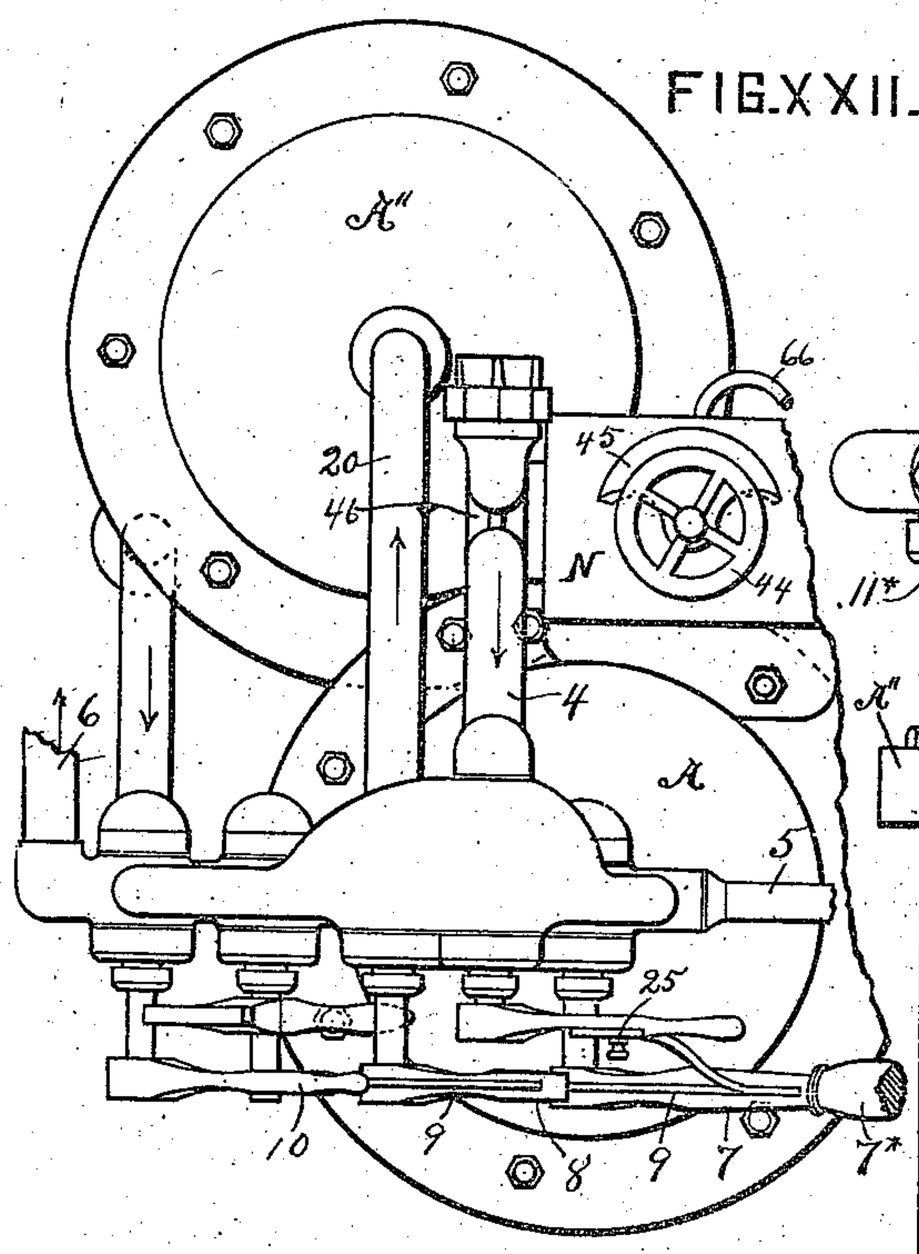

FIG. XXIII.

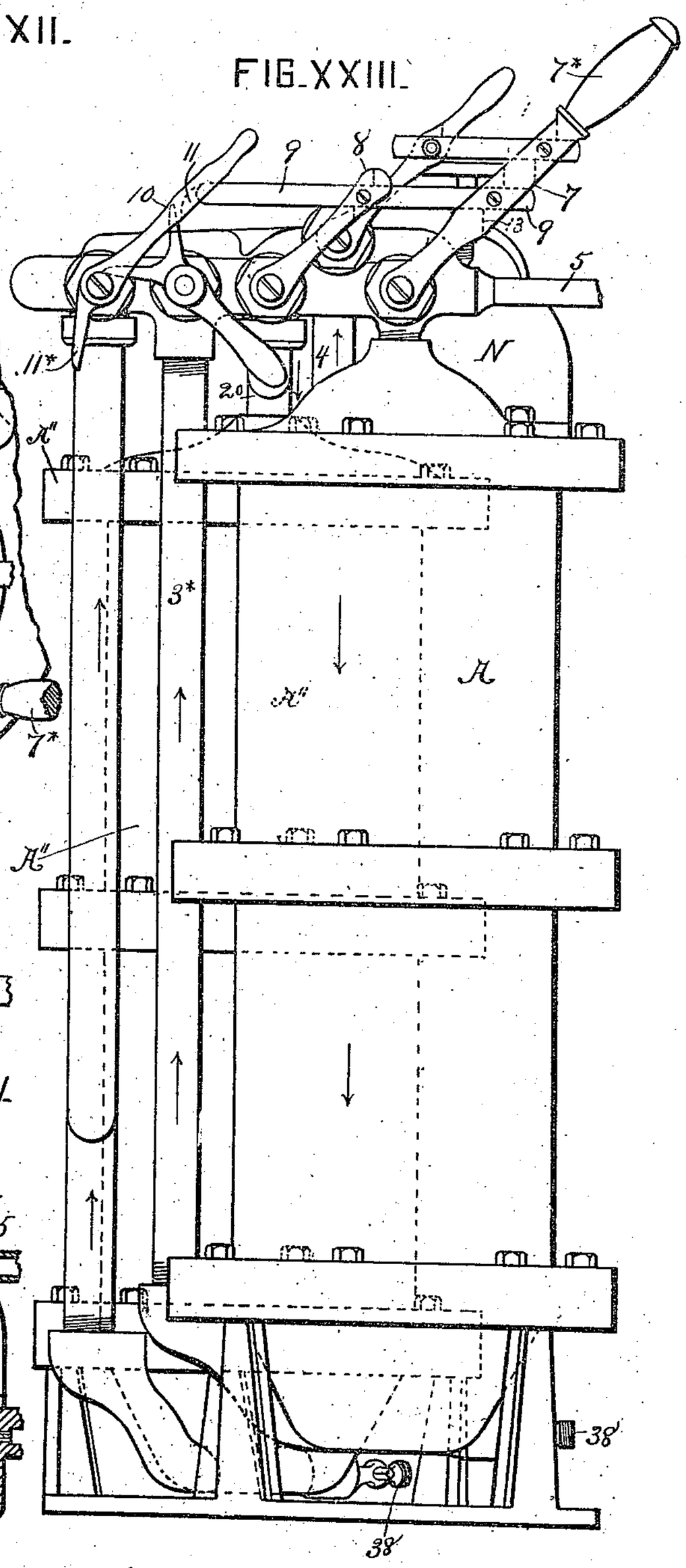

FIG. XXIV.

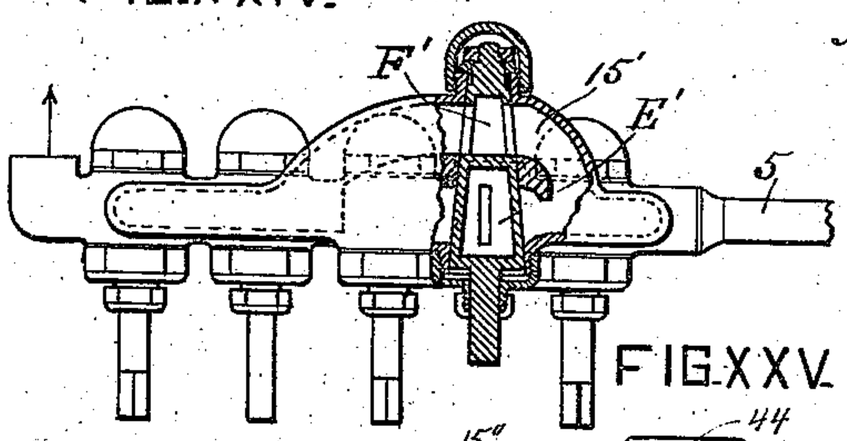

FIG. XXV.

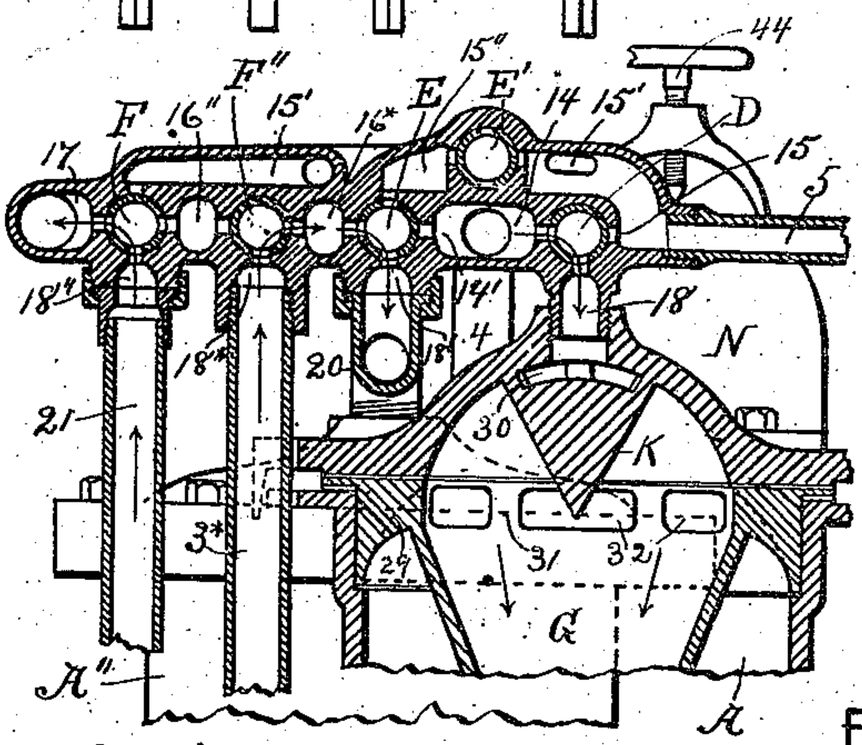

FIG. XXVI.

Witnesses.
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J. T. MANNING.

FILTER.

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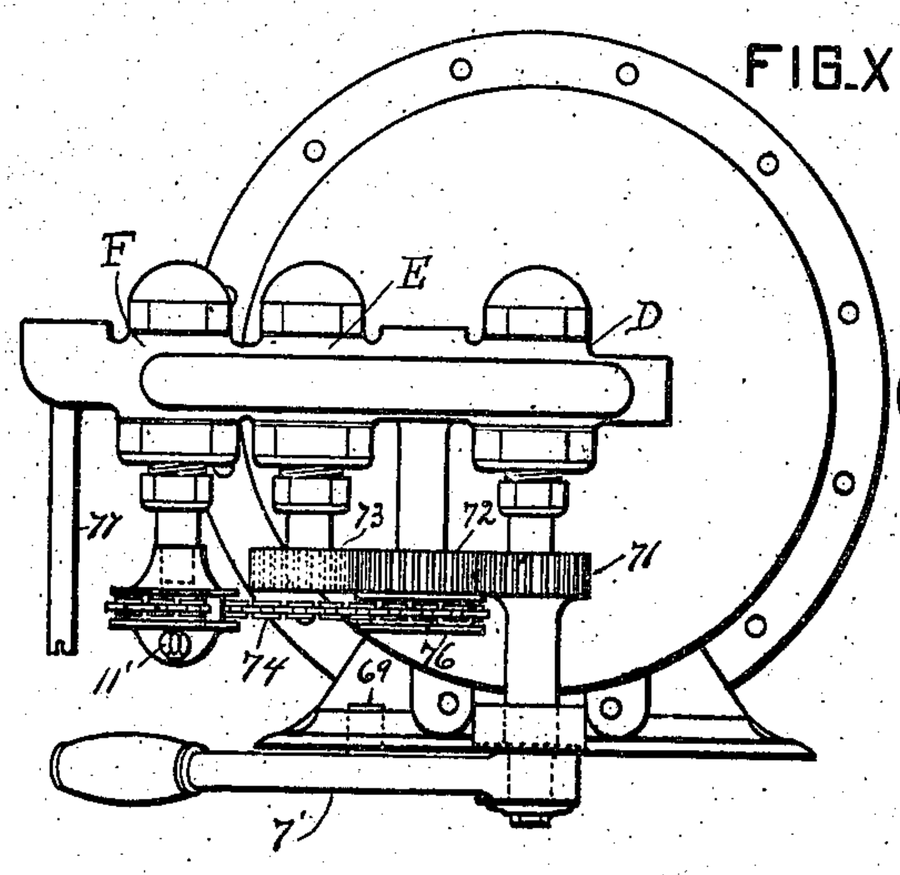
FIG. XXVII.



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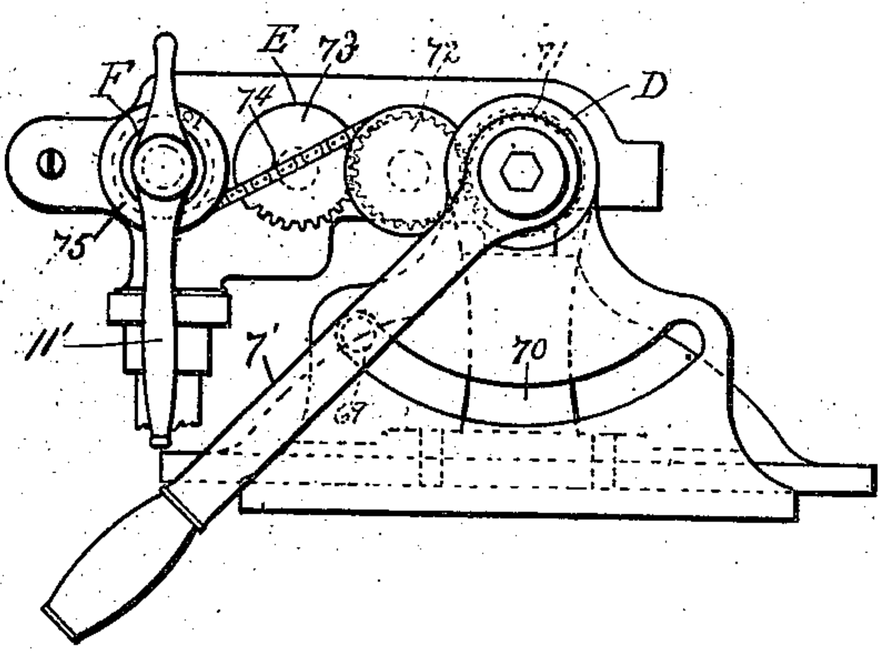
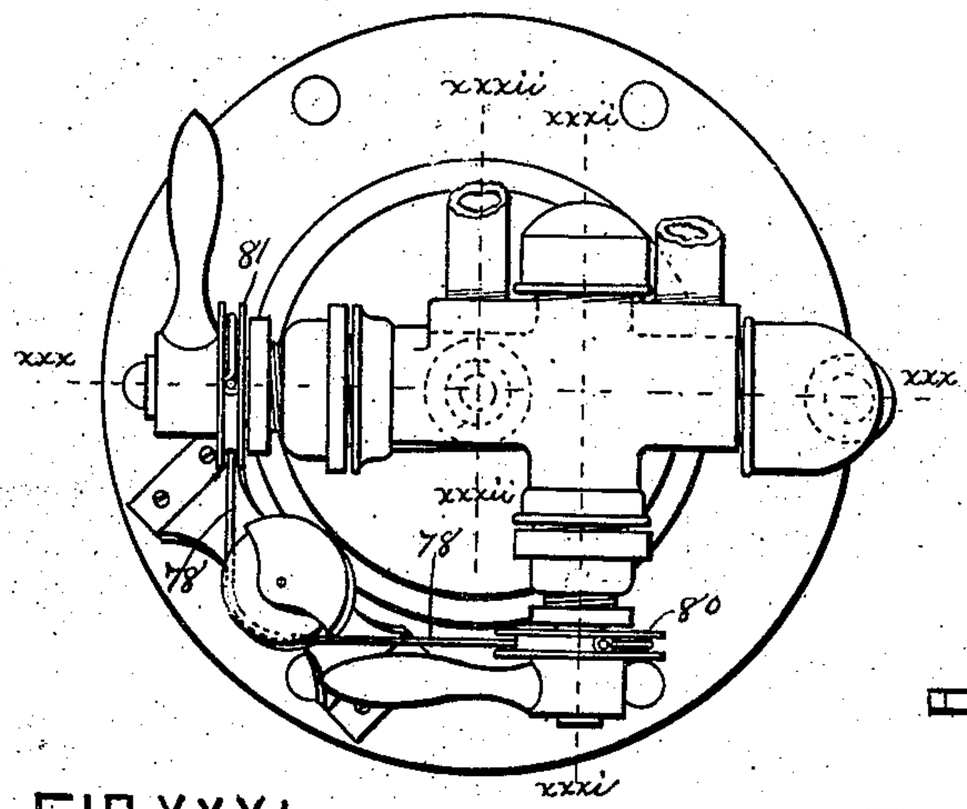


FIG. XXIX.

FIG. XXX.



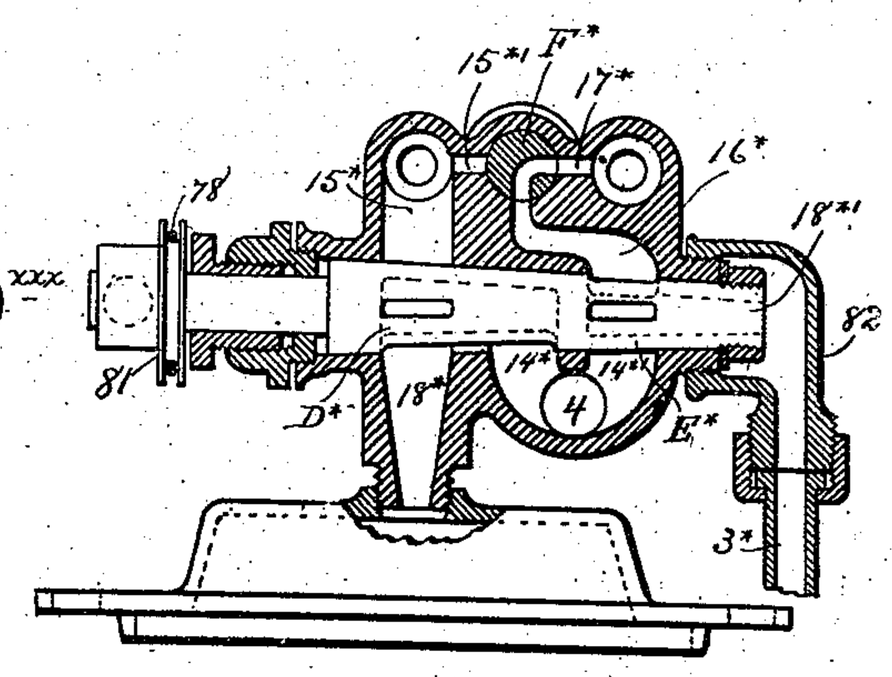


FIG. XXXI.

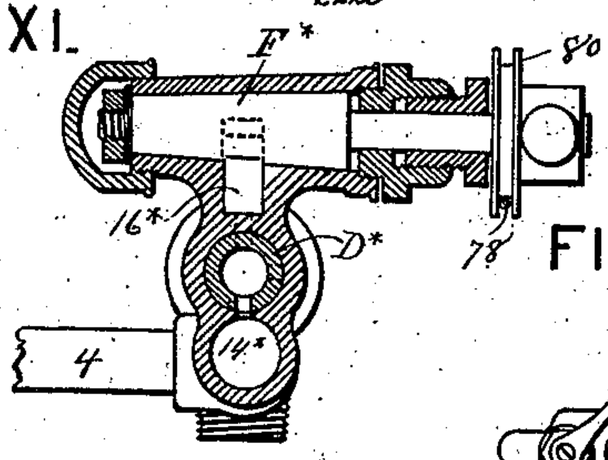


FIG. XXXII.

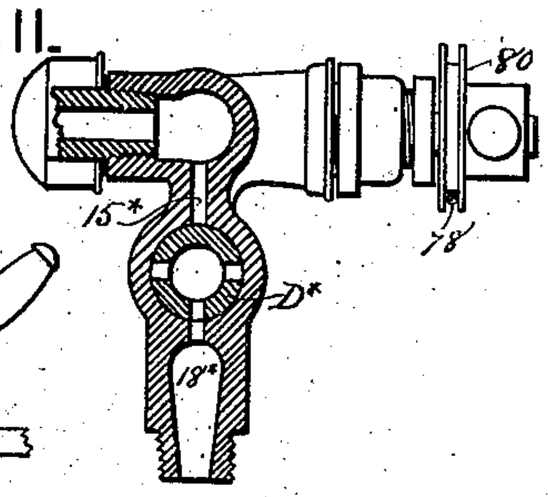
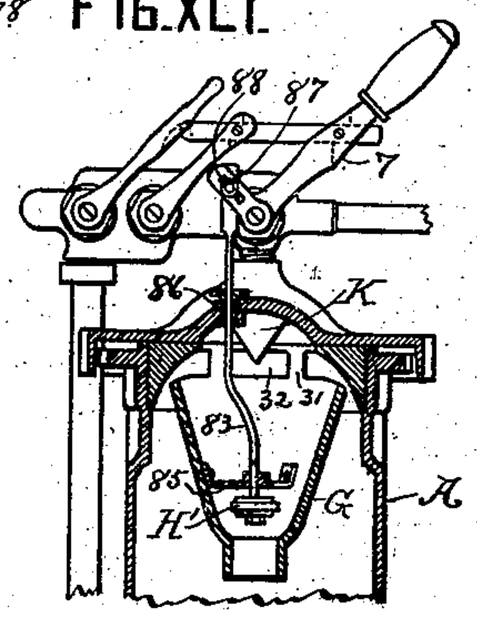


FIG. XLI.



Witnesses.

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his attorney

(No Model.)

8 Sheets—Sheet 7.

J. T. MANNING.

FILTER.

No. 594,637. Patented Nov. 30, 1897.

FIG. XXXIII.

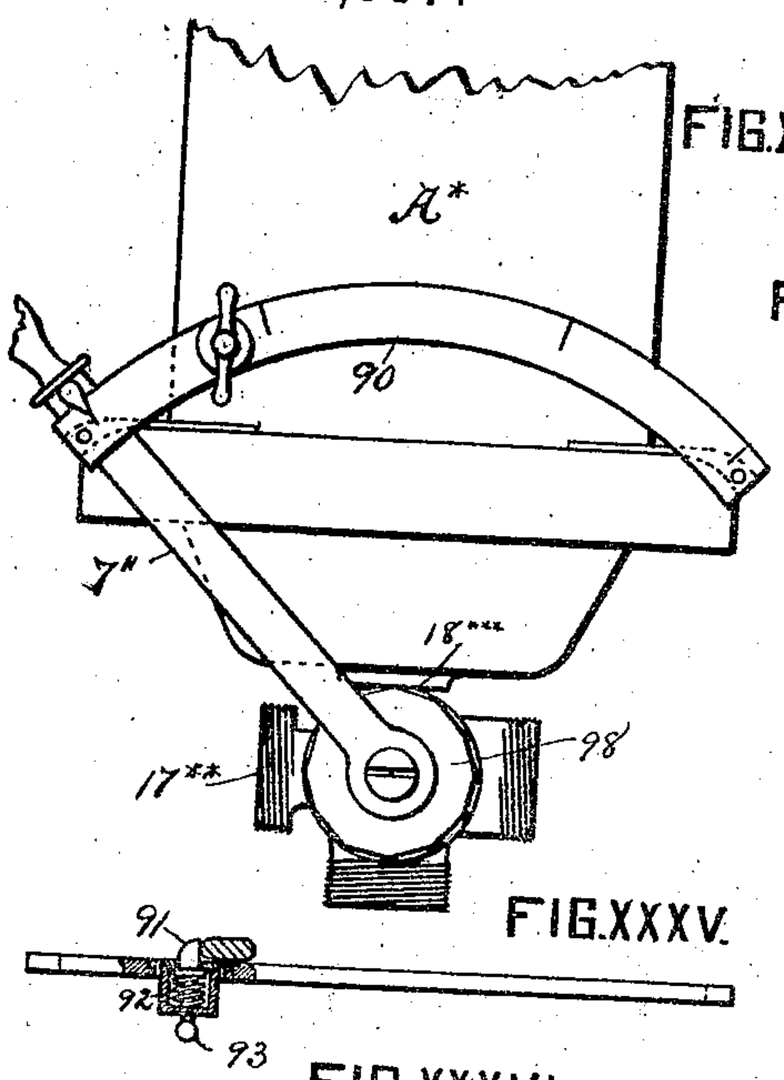


FIG. XXXIV.

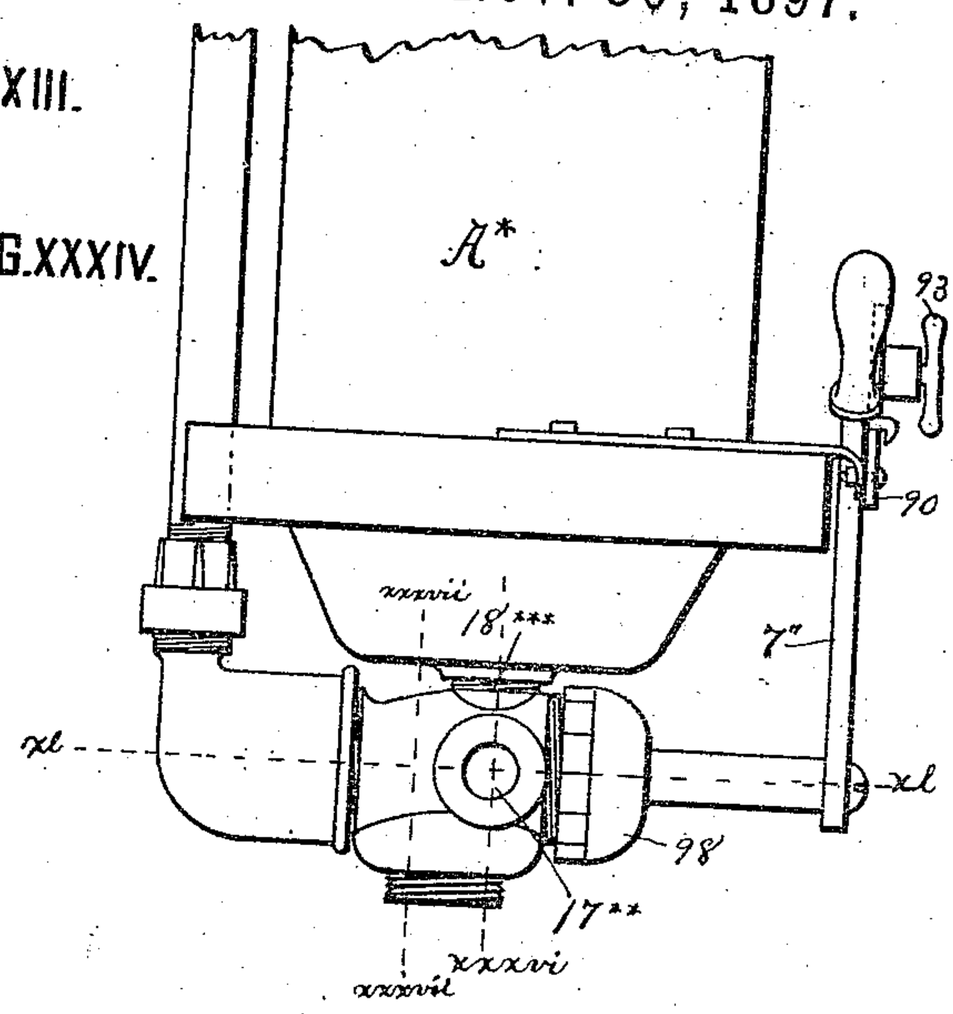


FIG. XXXV.

FIG. XXXVI.

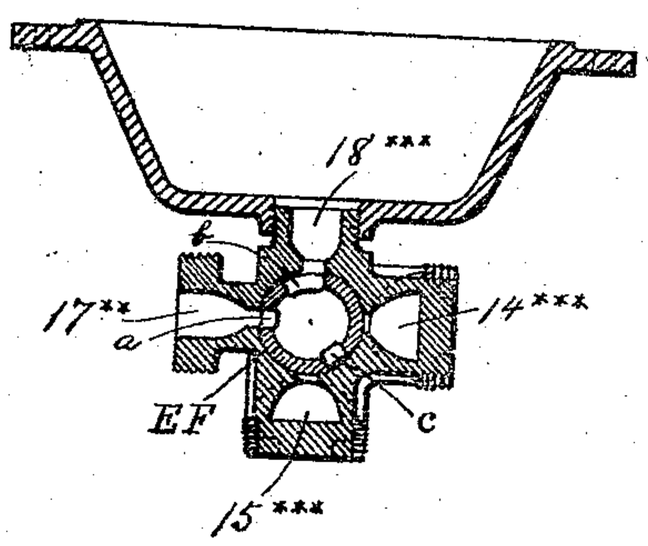


FIG. XXXVII.

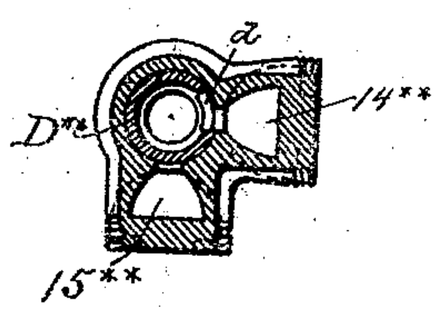


FIG. XXXVIII.

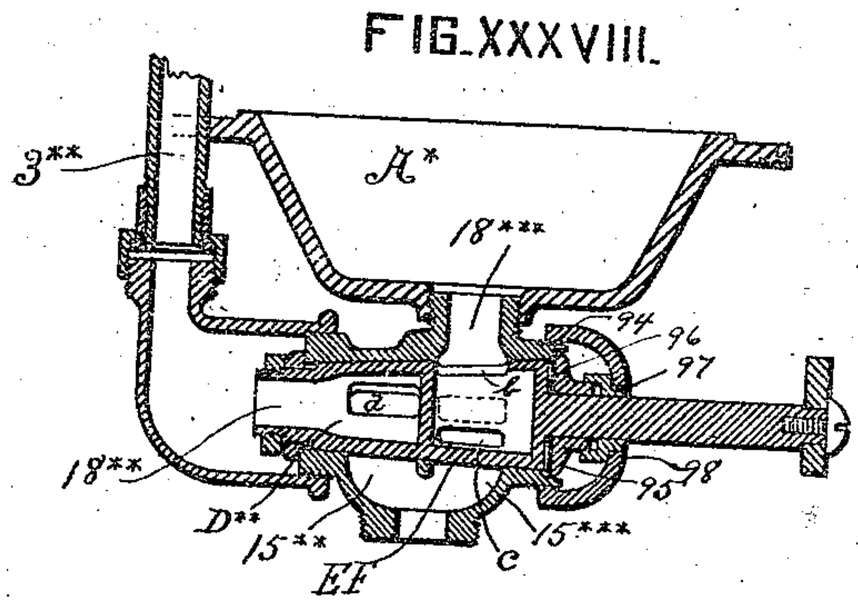


FIG. XXXIX.

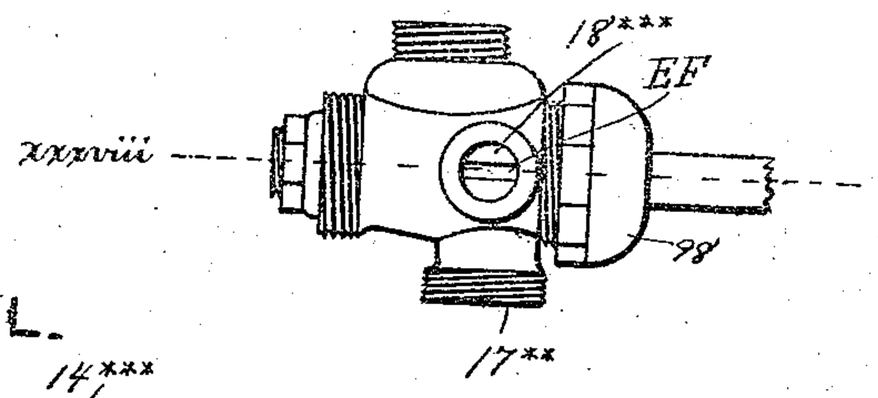
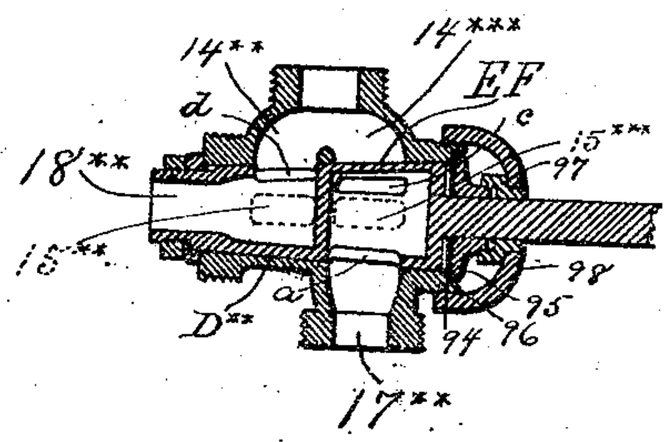


FIG. XL.



Witnesses.

R. E. Auld.

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(No Model.)

8 Sheets—Sheet 8.

J. T. MANNING.

FILTER.

No. 594,637. Patented Nov. 30, 1897.

FIG. XLII

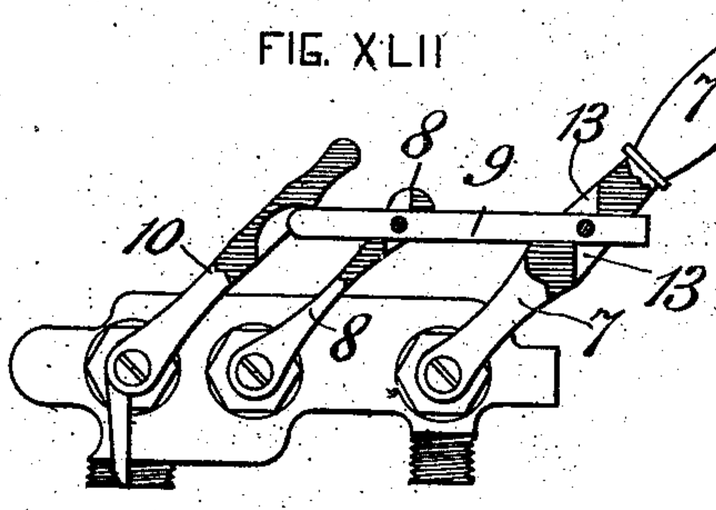


FIG. XLIII.

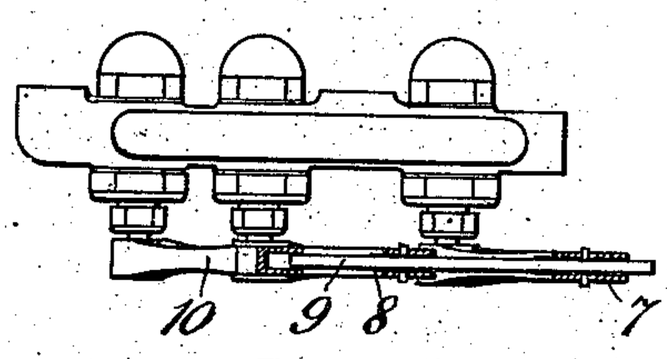


FIG. XLIV.

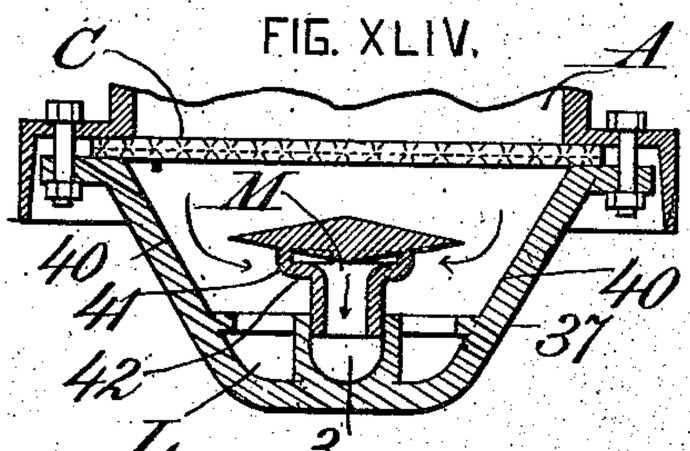


FIG. XLV.

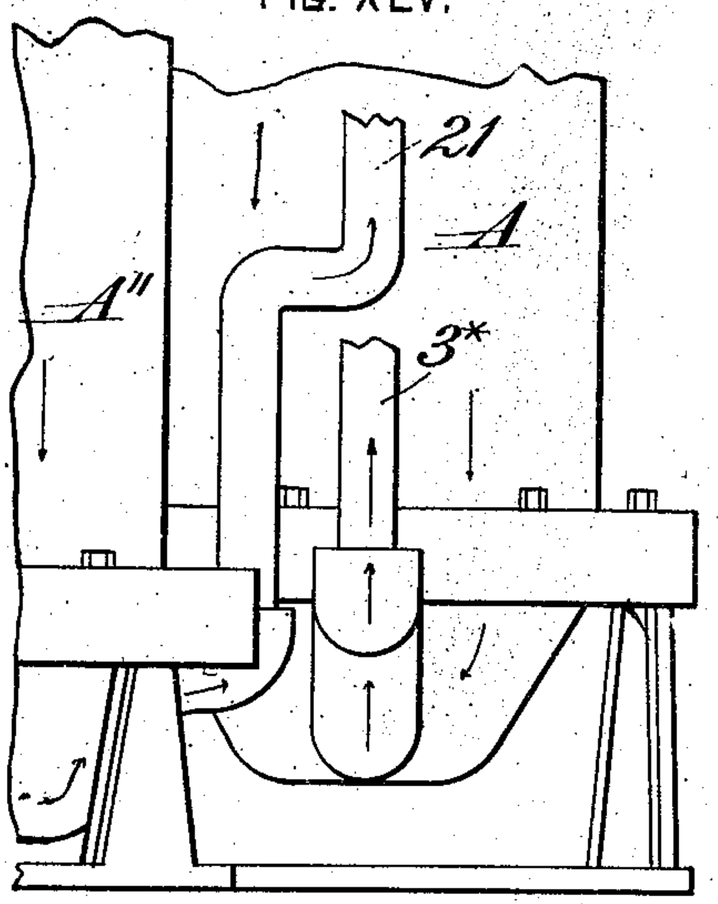


FIG. XLVI.

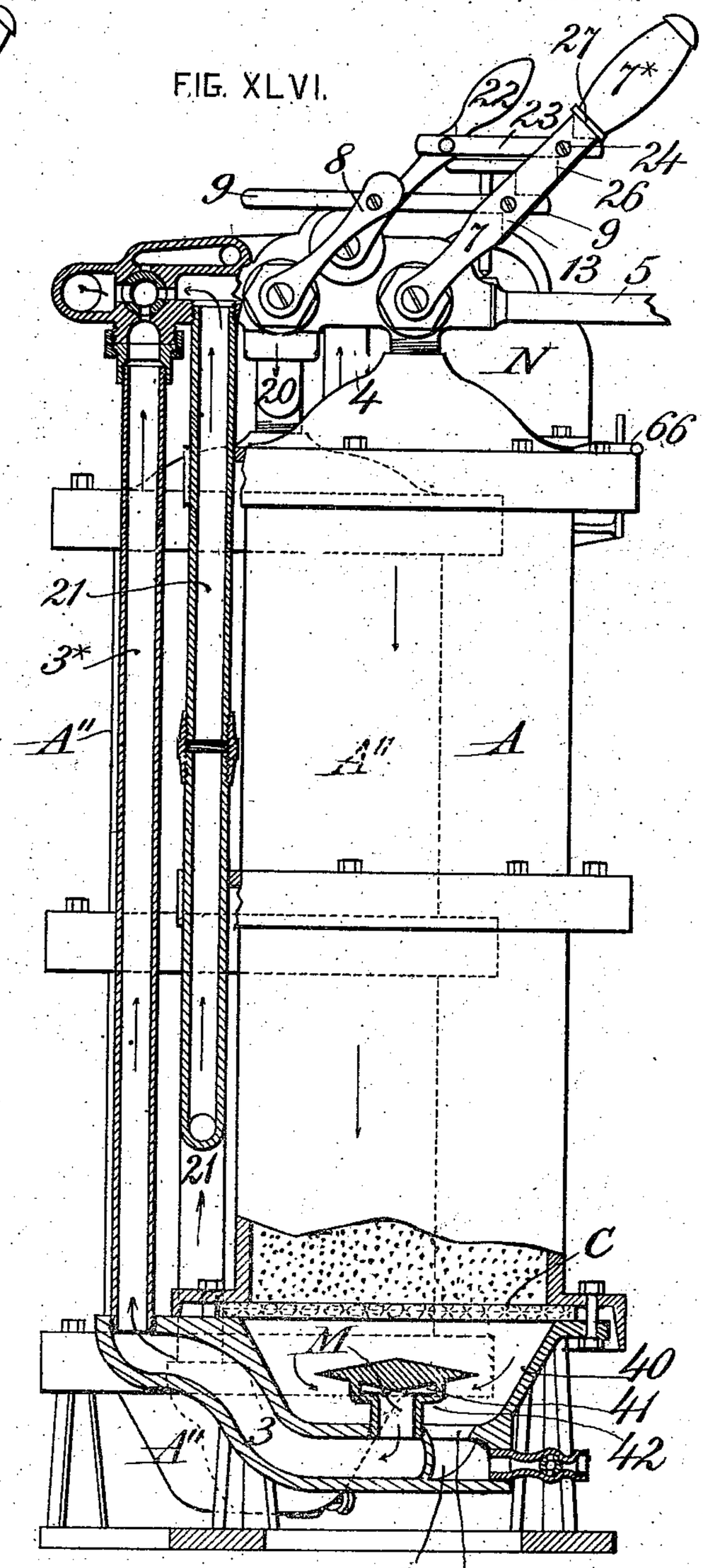
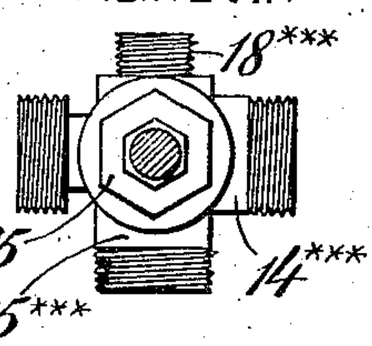


FIG. XLVII.



Witnesses.
Walter W. H. Robinson Jr
F. H. Schott

Inventor.
Joseph T. Manning
by Chas. J. Hedrick
his attorney.

UNITED STATES PATENT OFFICE.

JOSEPH T. MANNING, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE LOOMIS-MANNING FILTER COMPANY, OF SAME PLACE.

FILTER.

SPECIFICATION forming part of Letters Patent No. 594,637, dated November 30, 1897.

Application filed December 13, 1893. Serial No. 493,563. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH T. MANNING, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Filters; and I do hereby declare the following to be a full, clear, and exact description of the invention.

This invention relates more particularly to what may be briefly described as self-cleaning granular-bed filters with coagulant-supply; but each of the improvements constituting said invention is included for all the uses to which it may be adapted.

In self-cleaning granular-bed filters with coagulant-supply the water after receiving a small quantity of a material, usually alum, adapted to effect a precipitation or coagulation of impurities in such water, is passed through granular material—like sand, for example—of greater or less fineness, and from time to time this granular material is cleaned of the impurities which it has removed from the water by subjecting the said granular material to currents of water adapted to break up the bed and carry off the impurities, leaving the granular material in a fit state for another operation. It has also been customary to provide means whereby the water which is first passed through the filter in the filtering direction after a cleaning operation can be diverted into a waste instead of being allowed to pass into the outlet for the purified water. The reason for this is found in the fact that after a cleansing operation the water which for a time passes through the filtering material in the filtering direction is apt to carry with it more or less impurities. When this filtered water becomes clear, it is allowed to pass to the pure-water outlet. Sometimes means are provided to supply water which has been filtered for cleansing the granular material.

In accordance with the present invention the current-reversing valves (whether one or more in number and of any known or suitable description) for controlling the flow of water through a self-cleansing filter having one or more chambers to wash the filtering material or to be itself purified by said material are combined with a filtered-water valve (or valves, this part of the invention being general) for controlling the delivery to waste or to house (pure-water outlet) of water which has passed through the filter or a chamber or chambers thereof in the filtering direction, which filtered-water valve is so connected with the current-reversing valves as to occupy the "waste" position when these are in "washing" position, but has an independent motion when these are in "filtering" position, so as to occupy either the "house" or waste position at such times. According to one arrangement the filtered-water valve is operated through a butting or loose connection which shifts the filtered-water valve automatically in changing the current-reversing valves from the filtering to the washing position, but allows the said filtered-water valve to remain in the waste position thus given. On returning the current-reversing valves filtration recommences, but filtered water (more or less pure) passes to the waste-outlet until the filtered-water valve is returned. According to another or modified arrangement the filtered-water valve is allowed a motion independent of the current-reversing valves by allowing these to stand still or to move idly during the shifting of the filtered-water valve, while a connection between the valves causes a shifting of the filtered-water valve to the waste position prior to or in the act of changing the current-reversing valves from filtering to washing. In order to make this later arrangement still more like the former, a stop is provided which arrests or exerts a greater or less check on the shifting of the filtered-water valve from the waste to the house position, but which may and most advantageously does exert no check on the reverse change. This stop, therefore, like the butting connection, has the effect of preventing the filtered-water valve from being carelessly shifted to house position without intention on the attendant's part in restoring the current-reversing valves to the filtering position.

Further, in accordance with the invention a new or improved valve apparatus is made with current-reversing and filtered-water valves in a compound-valve casing in one piece of metal, wherein are formed the seats

and passages for said valves, so arranged that the filtered-water valve is adapted to open the house-passage independently of the current-reversing valves when these have been restored to the filtering position, whether it has an independent motion at other times or not. There is therefore no bringing of the said current-reversing valves into position to disturb again the filtering material in order to open the house-passage. The valves and their seats may be arranged in line with each other or parallel. According to different arrangements one, two, or more keys are provided for the valves.

A very convenient old arrangement of filter and filter-valves is to place the valves at one end of a filter-chamber and to connect with such end of said chamber a valve-passage adapted to admit fresh water to the filter or to carry off wash-water or filtered water, as the case may be, and to connect another valve-passage by a pipe with the other end of the filter for admitting fresh water thereto or for carrying off the filtered water or wash-water, as the case may be. The present invention comprises certain features of construction in a new or improved compound valve particularly useful in such an arrangement—that is to say, the compound-valve casing of the current-reversing valves, with or without a passage for running filtered water to waste, is provided with filter-passages terminating in openings whose axes lie in the same vertical plane, and with house and supply passages terminating in openings whose axes are horizontal and lie in a vertical plane or planes at right angles to the vertical plane or planes through the openings for the filter connections, the fifth outside opening being arranged with its axis in a vertical or in a horizontal plane, as may be preferred. This brings the various openings in desirable positions adapted to make the connections with a small number of fittings.

The cleansing of the filter may be effected with water direct from the ordinary fresh-water-inlet pipe, but it is an advantage to be able to perform the cleansing with filtered water. The invention comprises certain improvements in this connection. Two filter-chambers are employed, which are connected with each other by a pipe or conduit at their lower ends and with the water-supply and waste by passages controlled by the current-reversing valves at their upper ends, and the bottom of one at least of said filter-chambers is besides connected with the house or pure-water pipe and waste through passages controlled by a filtered-water valve, which has a motion independent of the current-reversing valves and is arranged alternately to open and close a house-passage and a waste-passage. The filtered water from said last-mentioned chamber may or may not have to pass through the other chamber before or after reaching the filtered-water valve on its way to waste or to house, the invention admitting of variations in these respects.

By connecting the bottoms of the filter-chambers with each other and their tops with the current-reversing valves the water can be directed down either chamber and up the other, and thus the water filtered in one chamber will serve to wash the other. After the filtered water runs clear from the chamber having the bottom connection with the filtered-water valve this is turned to close the waste-port and open the house-port.

It is said above that the bottom of one at least of the filter-chambers is connected with the filtered-water valve. According to one arrangement one only of the filter-chambers has such bottom connection, while in others both chambers are so provided. In the first-mentioned arrangement one filter-chamber is cut out when the house-port is opened. In the others the filter-chambers filter abreast or tandem, and filtered water from each or doubly-filtered water from both passes to house.

A further improvement consists in arranging a filtered-water valve in the connection between the bottoms of the filter-chambers.

In the arrangement with filter-chambers filtering abreast and tandem, respectively, the current-reversing valves are adapted to direct the water to be filtered simultaneously to both as well as sometimes to one and sometimes to another, and there are old valve apparatus which can be used for this purpose in carrying out certain parts of the present invention; but the latter also comprises a new combination of valves for this purpose—that is to say, two valves are provided which each have a supply-passage, a waste-passage, and a filter-passage, and are adapted to connect the latter with each of the former alternately, and in the passage from the waste-port of one of said valves is arranged an additional valve which controls the waste-passage from said valve, and an additional supply-passage is provided which is controlled by the last-mentioned valve or by the current-reversing valve, according to circumstances.

In the arrangement with filter-chambers abreast and tandem, respectively, a filtered-water valve with three passages opening into its seat is combined with one or more additional filtered-water valves, and the invention comprises certain combinations including such valves.

Unless otherwise stated, the invention extends to the described valve apparatus with one compound casing or with two or more casings connected by fittings or otherwise and with the valves independent of one another or more or less connected; but the invention includes also special features or improvements involving a compound casing and a connection of the valves, (separately and in conjunction.)

The invention further comprises new means

for making a tight joint for the valve-key around its stem.

The granular material in filters has been placed in a filter-chamber of suitable size to allow the particles of such material to be separated by the water in cleaning, so that the impurities which have been collected on the said material will be released by the separation of the said particles and will be carried off by the flow of waste water. In connection with such partially-filled filter-chamber a sand-trap is provided in the present invention, arranged to collect whatever sand might be carried along by the force of the cleansing-current, while permitting the light impurities to pass on with said current; and this sand-trap has such communication with the filter-chamber (namely, by a valved passage or opening) as that the sand collected therein may be returned to the filter-bed, without handling, by gravity or by a current of water, or both. While a sand-trap outside the filter-chamber is not excluded, the better arrangement, itself constituting a special feature of invention, is to place the sand-trap in the upper part of the filter-chamber, having at its lower end a valved passage or opening directly above the filter-bed. Various arrangements of valves could be used, (this portion of the invention extending to the use of valved openings or passages in general;) but special improvements in this regard consist in the use of a valve made automatic in its action by being adapted to be controlled by the flow of the water or by a connection with one or more of the valves or a valve-operating mechanism for controlling such flow. Thus when the current for cleansing is turned on the valve is closed automatically and the trap operates to collect the sand or heavier particles from the outflowing or cleansing current; but when the filtering-current is reestablished the valve is opened automatically and the sand or other granular filtering material which may have collected therein is returned to the filter-bed.

In a common form of granular-bed filters the filtering material rests against a screen, and this screen has been usually constituted heretofore by a fine wire-cloth interposed between two sheets of brass coarsely perforated. The fine cloth serves to prevent the passage of the finer filtering material, while the perforated brass plates support it and impart the necessary resistance to the pressure thereon of the water or the filtering material. In this connection the present invention comprises two improvements—that is to say, first, instead of using plain perforated flat sheets on opposite sides of the finer intermediate screen perforated plates, indented or roughened so as to furnish a large number of supporting-points, are provided, which touch the intermediate screen at short intervals and thus support the same, while allowing a freer passage of water than would the flat plates heretofore employed, and, secondly, instead of employing a wire-gauze for the fine screen, which gauze is apt to rot out very quickly, a perforated sheet-metal plate is provided, and in case such sheet fails to retain the particles of the filtering material (it being, in fact, preferred to use perforations of about one thirty-second of an inch in diameter) a sand-trap is provided in the path of the filtered water. A suitable outlet is provided for drawing off any sand from said trap as may be desired.

The coagulant-supply for filters consists in general of a chamber holding the coagulant—as alum, for example, or the like—so connected with the water-passage on the fresh-water-inlet side of the filter as to allow the coagulant in small quantities to enter the unfiltered water, the most usual connection being with the fresh-water pipe itself. As the filters are commonly employed in connection with water under pressure the coagulant-chamber has been tightly closed, a removable plug, cap, or door being provided for introducing the coagulant. Whenever it is desired to open the coagulant-chamber, the connection with the fresh-water pipe has been temporarily closed, and as this leaves the contents of the coagulant-chamber under pressure a valved outlet has been provided to relieve the pressure and thus to prevent the fluid in the chamber from squirting out when the chamber is opened. There is difficulty with this arrangement, however, particularly in the case of a valved pipe between the coagulant-chamber and the waste in that the opening or pipe (hereinafter termed the "coagulant-waste" outlet) is apt to become clogged by the precipitation or the crystallization of the coagulant in the outlet. To overcome this objection, there is in the present invention what may be called a "fresh-water" flush provided, whereby the coagulant-waste outlet can be washed out, and in order to make this operation automatic (which is a special improvement) the outlet-valve is combined with a flushing-valve in the same key or other device or in suitably-connected devices, so that each time the liquid charged with coagulant is discharged through the waste-outlet the same will be flushed with fresh water, and thus the clogging of the said coagulant waste is prevented.

As already stated, the coagulant is contained in a closed chamber whose contents are under the pressure of the water-service; but as the result of turning on and off the valves belonging to the filter or in the house the pressure in the coagulant-chamber is varied, and the variation has been heretofore utilized for the feeding of the coagulant from the chamber into the fresh-water supply by the aid of a body of confined air, the coagulant passing from said chamber into the water-supply as often as the pressure is lowered and fresh water passing into the coagulant-chamber as often as the pressure is increased. Another mode of feeding the coagulant to the water-supply has been independent of or less dependent upon the variations of pressure

and involves a circulation of a small current of water through the coagulant-chamber. In each of these cases the coagulant-feed has been controlled by means of a small valve, establishing a more or less free communication with the water-supply. While, however, these two modes of regulation have been employed separately heretofore, they have never, so far as I am aware, been employed in conjunction with each other, and one further part of the present invention consists in such conjoint employment.

Further, in accordance with the present invention the same valve mechanism is utilized to regulate the coagulant-feed according to one or both above-mentioned modes and also to control the coagulant waste and the flushing thereof, either or both.

The invention also comprises the additional constructions, arrangements, combinations, or improvements hereinafter set forth and claimed.

In the accompanying drawings, which form part of the specification and illustrate what is considered the best mode of carrying the invention into effect, Figure I is an elevation of a filter constructed in accordance with the said invention. Fig. II is a vertical section on line *ii* of Fig. III, being through the axis of the filter-chamber parallel with the plane of Fig. I. Fig. III is a plan view of the same filter. Fig. IV is a partial view in vertical section on line *iv* of Fig. III on a larger scale. Figs. V and VI are views in profile from opposite sides of the upper part of the filter. Fig. VII is a plan on scale of Fig. IV of the coagulant-valve detached. Figs. VIII, IX, X, and XI are sections on lines *viii*, *ix*, *x*, and *xi*, respectively, of Fig. VII. Fig. XII, Sheet I, is a sectional detail view, on a larger scale, of the new or improved filter-screen. Fig. XIII, Sheet I, is a sectional view showing a modified arrangement of the valve apparatus forming part of the invention. Figs. XIV, XV, and XVI are respectively a plan, a front elevation, and a partial view in section of an arrangement (forming part of the invention) of filter adapted to be cleansed by filtered water. Figs. XVII, XVIII, XIX, XX, and XXI are respectively a plan, a front elevation, a partial view in horizontal section, and partial views in vertical section of an arrangement (forming part of the invention) of filter adapted to be cleansed by filtered water and having chambers to serve together for filtering abreast. Figs. XXII, XXIII, XXIV, XXV, and XXVI are respectively a plan, a front elevation, a partial view in horizontal section, and partial views in vertical section of an arrangement (forming part of the invention) of filter-chambers adapted to be cleansed by filtered water and to serve together in filtering in tandem. Figs. XXVII and XXVIII are respectively a plan and partial front elevation of a filter sufficient to illustrate a modified form (forming part of the invention) of mechanism for operating the filter-valves. Figs. XXIX, XXX, XXXI, and XXXII are respectively a plan and sections on lines *xxx*, *xxxi*, and *xxxii* of said Fig. XXIX, illustrating a modified arrangement of filter-valve forming part of the invention. Figs. XXXIII, XXXIV, XXXV, XXXVI, XXXVII, XXXVIII, XXXIX, and XL illustrate a modified arrangement of valve apparatus, (also forming part of the invention,) Figs. XXXIII and XXXIV being partial elevations in planes at right angles to each other of a filter provided with such modified valve apparatus, Fig. XXXV a detail of the stop and arc used therewith, Figs. XXXVI, XXXVII, and XXXVIII vertical sections of the valve apparatus on lines *xxxvi*, *xxxvii*, and *xxxviii*, respectively, Fig. XXXIX a plan of the same, and Fig. XL a horizontal section on line *xl* of Fig. XXXIV; and Fig. XLI, Sheet VI, is a partial elevation, partly in section, on slightly different planes, illustrating a modified arrangement of automatic sand-trap valve forming part of the invention. Fig. XLII, Sheet VIII, is an elevation, partly in section, of the valve apparatus of Fig. I detached. Fig. XLIII is a plan, partly in section, of the same. Fig. XLIV is a sectional view of the lower part of the filter of Fig. II in a plane at right angles to that of said figure. Fig. XLV is a partial view in elevation of the double filter of Figs. XVII to XX. Fig. XLVI is a view similar to Fig. XVIII with certain parts in section, and Fig. XLVII is an end view of the valve of Figs. XXXIII to XL with the cap and follower removed.

Referring to Figs. I to VI, in the filter-chamber A is the granular filtering material B, partly filling said chamber and forming a bed upon the screen C. As shown, the water enters and leaves the filter-chamber by the ports 2 and 3. During filtering the water enters by the port 2, passes through the filtering material B and screen C, and escapes by the port 3 and pipe 3*. In cleansing the water enters by the port 3, passes through the screen C into the filtering material B, lifting it and separating its particles, and carries off the impure matter through the port 2.

D and E are the current-reversing valves, the valve D putting the top of the filter-chamber in communication with the fresh-water pipe 4 or with the waste-pipe 5, according to position of said valve, and the valve E putting the bottom of the filter-chamber in communication with the fresh-water pipe 4 or with the house-pipe 6.

At F is the filtered-water valve for diverting the filtered water or water from the bottom of the filter-chamber into the waste-pipe 5 or for allowing it to pass into the house-pipe 6.

The current-reversing valves D and E have operating-arms 7 and 8, connected with each other by the link 9, and one of them provided with a handle 7*, and there is a loose or butting connection between the said oper-

ating means and the arm 10 for operating the filtered-water valve F, the connection shown being between the end of link 9 and the bottom of a recess 11 in the arm 10. The current-reversing valves are shown in Figs. I and II in the filtering position and the filtered-water valve F in the house position. When the valves D and E are turned to the left, (the washing position,) the same movement shifts the filtered-water valve F to the waste position; but when, after such shifting, the current-reversing valves D and E are returned by the handle 7* the butting or loose connection at 11 allows the filtered-water valve F to remain in the position to divert the water to the waste-pipe 5. When the water has become clear, as may be seen through the glass 12 in the said waste-pipe 5, the valve F is to be turned back to house position by hand, so as to allow the filtered water to pass to the house-pipe 6.

At 11* is a tailpiece which acts as a stop to limit the motion of the filtered-water valve or of all the valves. The link 9, as shown, (see Figs. VI, XLII, and XLIII,) passes through and is pivoted in the lever-arms 7 and 8, and the shoulders at 13 of the arm 7 act as stops to limit the motion by contact with the link 9. The same arrangement is shown in Figs. XV, XVIII, and XXIII, the part being similarly marked. There may be also similar arrangements for certain additional valves, Figs. XVIII and XXIII.

Instead of using separate castings for valves D E F, connected by the ordinary pipe-fittings, with which of course the operating mechanism could be used, the said valves are arranged in one compound casing having supply, filter, waste, and house passages formed therein, so arranged that the filtered-water valve F opens the house-passage after the current-reversing valves have been restored to the filtering position without bringing them again into the cleansing position.

As shown in Fig. II, there are supply-passages 14 and 14′, waste-passages 15 and 15′, intermediate passage 16, a house-passage 17, and filter-passages 18 and 18′. In the position shown of the valves the water from pipe 4 goes by way of supply-passage 14, valve D, to filter-passage 18, and the water escapes by filter-passage 18′, intermediate passage 16, and house-passage 17 to house-pipe 6. When the current-reversing and filtered-water valves D E F are turned to the left, the supply goes by supply-passage 14′, valve E, to filter-passage 18′, and from filter-passage 18 by valve D and waste-passage 15 to waste-pipe 5. When the current-reversing valves are restored, leaving the valve F turned to the left, water goes by supply-passage 14 and valve D to filter-passage 18, and from filter-passage 18′ by valve E, intermediate passage 16, and waste-passage 15′ to waste-pipe 5. In this position the filtered-water valve F can be turned to the right and made to open the house-passage 17 without changing the direction of the current through the filter-chamber.

In Fig. XIII and also in Figs. XVI, XX, and XXV the supply-passages are marked 14 with or without an additional character, the waste-passages 15 in like manner, the intermediate passages 16 similarly, the house-passage 17 only, and the filter-passages 18 with or without an additional character. In Figs. XX and XXV there are also additional valves E′ F′ F″, the operation of which will be explained later.

In Fig. XIII the passages 15″ and 18″ correspond with the passages 15′ and 18′ of Fig. II, and the control of the filter-current and of the filtered water is substantially the same.

In Fig. XIII the intermediate passage 16 forms a continuation of the waste-passage 15″ in filtering to waste and of the supply-passage 14′ in washing, whereas in Fig. II it forms part of the waste-passage 15′ in filtering to waste or of the house-passage 17 in filtering to house.

In all the figures the filtered-water valve F is controllable independently of the current-reversing valves D E when these are in the filtering position, and the same is true of certain additional valves in Figs. XX and XXV, as explained below.

It will be observed that in all the figures of Sheets I to V there is one or more passages to waste extending across the current-reversing valve E to join the waste-passage 15 within the casing. Such arrangement is advantageous in this form of compound-valve apparatus.

The waste-passages terminate in one outside opening and the supply-passage in one. There are also one outside opening from the house and as many as may be necessary for the filter-passages. These outside openings are adapted to be coupled to outside pipes or fittings. As shown, the filter-passages terminate in outside openings whose axes are vertical, while two of the openings for the other pipes have their axes horizontal in vertical planes at right angles to the plane through the axes of the filter-passage openings. As shown in Figs. II, XIII, XVII, XIX, and XXIV, moreover, the filter-passage openings are at the bottom and the openings for the supply and house pipes at the back of the valve-casing. Thus the pipes 4 and 6 can be connected directly from the back with said valve-casing and the use of elbows avoided, these being made by the arrangement of the passages in the valve-casing.

Referring to Figs. XIV to XVI, two filter-chambers A and A′ are shown, and the filter-passages 18 and 18′ are connected with the tops of the filter-chambers, (the passage 18′ with the top of filter-chamber A′ through the pipe 20,) while the bottoms of the chambers are connected with the filter-passages 18″ and 18*, respectively, by pipes 3* and 21 and have between them a connecting-conduit,

formed in this instance by the pipes 3* and 21, passages 18″ and 18*, and the valve F. In the filtering position shown the fresh water enters the filter-chamber A by supply-passage 14, valve D, filter-passage 18, and leaves the same by filter-passage 18″, valve F, and house-passage 17. By throwing the three valves to the left the water will enter the bottom of filter-chamber A after first passing through the chamber A′ in the filtering direction. Its course would be by the supply-passage 14′, valve E, filter-passage 18′, pipe 20, filter-chamber A′, pipe 21, passage 18*, valve F, and pipe 3*. The wash-water from the top of chamber A would go by passage 15 to waste-pipe 5. By returning valves D E, leaving valve F in the waste (left) position, the water after passing through chamber A in the filtering direction would go to waste by pipe 3*, passage 18″, valve F, passage 18*, pipe 21, filter-chamber A′, (in the washing direction,) pipe 20, valve E, and waste-passage 15″ to waste-pipe 5. Thus the filter A′ will be washed ready for a new filtration. The filtered-water valve F can now be returned without altering the current in filter-chamber A and will direct the filtered water from pipe 3* and passage 18″ to house by the passage 17 and house-pipe 6. There is an advantage in having the valve F in the connecting-conduit between the bottoms of the filters, both to close such conduit in filtering to house and also to apply other features.

Referring to Figs. XVII to XXI and XLV and XLVI, two filter-chambers A and A″ are shown with their tops and bottoms connected as described for A and A′ in Figs. XIV to XVI. In this apparatus valves and passages are arranged for the two chambers to filter abreast—that is, to divide the water from the pipe 4, passing part through the chamber A″ and then sending the streams from both into the house-pipe 6—as well as for washing each with water filtered by the other. The normal position or positions for filtering abreast is shown. The water enters the chamber A by the supply-passage 14, valve D, and passage 18, and the filtered water therefrom goes to house by the pipe 3*, passage 18″, valve F, and house-passage 17, while the water enters the chamber A″ by the passage 14″, valve E′, passage 16′, valve E, passage 18′, and pipe 20, and the filtered water from it passes to house by way of pipe 21, passage 18*, valve F, and house-passage 17. By turning all the valves to the left the water filtered by chamber A″ is supplied to wash the filter A. The unfiltered water passes by supply-passage 14′, valve E, passage 18′, and pipe 20 to chamber A″, (in the filtering direction,) and the filtered water from chamber A″ passes by pipe 21, passage 18*, valve F, passage 18″, and pipe 3* to the bottom of the chamber A, which it ascends in the washing direction to escape by passage 18 valve D, and passage 15 to waste. When the water reaches the valve F, it is prevented from escaping through the passage 15′ by the additional valve F′, which, being turned to the left, closes said passage 15′. By returning all the valves but F the water will pass in the filtering direction through both filters, as in the normal position, but the filtered water will pass to waste through passage 15′. The chamber A″ is washed with water filtered through the chamber A by turning the valves E′ F′ to the left, leaving the valve F in the waste position. The water then, after reaching the valve F by way of the chamber A, (in the filtering direction,) passes to the chamber A″ in the washing direction by way of the passage 18* and pipe 21, and the wash-water from the chamber A″ escapes to waste by the pipe 20, passage 18′, valve E, passage 16′, valve E′, and passage 15″. On restoring valves E′ F′ the filtered water from both chambers goes to waste by passage 15′, and on then restoring valve F the water from both goes to house by passage 17.

In order to make the manipulation for washing simpler to the attendant, the valves F′ and E′ are combined in one key, and the lever 22 of this key is detachably connected with lever 7 by the link 23 and pins 24 and 25, the latter being detachable. The shoulders 26 and 27 keep the link horizontal when the pin 25 is detached. The valves E′ F′ could be operated by a butting or loose connection, (as could the valve F in these or in other figures by a detachable connection, each form of connection being to effect a conjoint operation while allowing independent motion;) but the detachable connection is considered more advantageous for the valves E′ F′, because in washing the filter-chamber A it permits the filtered water on reversing the circulation to pass to waste without going through the other filter-chamber, or, in other words, cuts out such latter filter-chamber at this time and allows one filter-chamber to be thoroughly cleansed before reversing the current in the other. By using a butting connection for the valves F′ E′ the passage 15′ would remain closed and the passage 16′ open to waste by passage 15″ when the valves D E were restored. In that case the filtered water from the chamber A would pass by passage 18* and pipe 21 to chamber A″ in the washing direction and the vibration of the valves D E would alter the current precisely as in the arrangement of Figs. XIV, XV, and XVI. Then on restoring the valves F′ E′ the filtered water from each chamber would go to waste, and on restoring the valve F the filtered water from both would go to house.

Referring to Figs. XXII to XXVI, the filter-chambers A and A″ are shown with their tops connected, as the two filter-chambers are in the preceding figures; but their bottom connections are altered, the bottom of chamber A being connected with the passage 18* and the bottom of chamber A″ with passage 18″. In this arrangement valves and passages are arranged for the two chambers to filter tandem—that is, for the filtered water

from one chamber to be filtered again through the other—as well as for washing each with water filtered by the other. The valves D, E, F, E′, and F′ are shown connected with the handle 7*, as in the preceding arrangement—that is to say, the valves D and E by a permanent connection, the valve F by a butting or loose connection between its operating-arm 10 and the end of link 9, and the valves E′ F′ by a detachable connection through a removable pin 25. The valves E′ F′ are made in one key. The additional valve F″ is, as shown, an independent valve. Its operating-arm is turned down, so that when said arm is moved to the left the valve F″ is turned in the direction in which the hands of a watch move, whereas when the operating-arms of the other valves are moved to the left the valves are turned oppositely to the hands of a watch. The normal position or positions for filtering tandem is shown. The water enters the chamber A by the supply-passage 14, valve D, and passage 18, and the filtered water therefrom passes through pipe 3*, passage 18*, valve F″, intermediate passage 16*, valve E, passage 18′, and pipe 20 to top of chamber A″, through which it is filtered, and the now twice-filtered water passes by pipe 21, passage 18″, valve F, passage 17, and pipe 6 to house. By shifting the handle 7* to the left, which moves all the valves except F″, and then moving the arm of valve F″ in the same direction the water filtered by chamber A″ is supplied to filter-chamber A. The unfiltered water passes by supply-passage 14′, valve E, passage 18′, pipe 20 to chamber A″, (in the filtering direction,) and the filtered water from chamber A″ goes by pipe 21, passage 18″, valve F, passage 16″, valve F″, passage 18*, and pipe 3* to the bottom of chamber A for washing the same, the wash-water escaping by passage 18, valve D, and passage 15 to waste. On shifting the handle 7* to the right and thus returning all the valves but the valves F and F″ the water passes in the filtering direction through the chamber A and escapes to waste through pipe 3*, passage 18*, valve F″, passage 16″, valve F, and passage 15′. By operating valves D E E′ F′ back and forth the water will be made to flow alternately in opposite directions through the chamber A until its filtering material has been thoroughly cleansed. On now removing the pin 25 and turning valves D E to the right and E′ F′, with their operating-arms, to the left, leaving the valves F and F″ in the left-hand position, the water passes through the chamber A in the filtering direction, and the filtered water therefore goes by pipe 3*, passage 18*, valve F″, passage 16″, valve F, passage 18″, and pipe 21 to the bottom of chamber A″, up which it passes in the washing direction to escape by pipe 20, passage 18′, valve E, passage 15″, and valve E′ to waste. By returning the operating-arms of valves E″ F′ F″′ to the right the filtered water from chamber A passes through the chamber A″ in the filtering direction, and thence by pipe 21, passage 18″, valve F, passage 15′, and valve F′ to waste. By moving the operating-arms of the valves E′ F′ F″ alternately left and right the current is passed alternately up and down the chamber A″ until the filtering material is well cleaned. On returning the operating-arms of all the valves to the right the doubly-filtered water goes to house.

The valve F″ instead of being independent may be operated by a loose or a detachable connection from the operating mechanism of the other valves. A similar loose connection would be a chain arranged as shown in Figs. XXVII and XXVIII and hereinafter described with reference thereto—that is to say, the chain being wrapped at one end partly around and secured to a hub on the stem of valve D and at the other wrapped partly around and secured to a hub on the stem of valve F″, after the same manner as the chain is in Figs. XXVII and XXVIII.

It is desirable to connect the filter-chambers A A′ or A A″ together. As shown, use is made of the flanges at the ends of tubular sections of the filter, which are lapped and secured by bolts to each other.

The sand-trap G (shown arranged within the upper part of the filter-chamber A directly above the filter-bed, but to be used also in chambers A′ A″) is provided with a valve H, controlling the outlet to the filter-bed. In washing this valve is closed, and the wash-water-outlet port 2 is so placed that the washing-current which enter the filter-chamber by pipe 3* and flows through the filter-bed in the direction to loosen up the same and carry off the sediment flows over or through the upper part of the sand-trap and deposits the heavy or comparatively heavy particles of any of the granular filtering material carried by said current in the still (or comparatively still) water of the said trap, while the lighter particles of the impurities or sediment collected from the water in the previous filtration are borne along to the wash-water outlet. In order to increase the effect of the sand-trap, the baffle K is arranged in the wash-water current, so that the movement of the heavy particles is arrested or checked by contact with said baffle, and they separate themselves more readily from the flowing water. As shown, the baffle is arranged under the port 2, and there are guides or deflectors 29 to direct the wash-water against the baffle K. There are holes 30 above the baffle. The sand-trap is shown supported by peripherical flanges 31 and provided with openings 32 for the passage of the water. The port 2 for the fresh water to be filtered is arranged above the said trap, so that the direct course of the water to be filtered is through the outlet at the bottom of the sand-trap. It therefore assists in carrying whatever of the filter-

ing material may collect in the trap back to the filter-bed and keeping the valve and valve-seat clean.

The valve II is adapted to be opened and closed automatically by the water. It is preferably of a specific gravity somewhat greater than water, so that it tends to stay open when the water is at rest, as shown in full lines, Fig. II. At 33 is a cage which holds it in the open position and permits the water to pass.

When the valves D and E are turned into washing position, the upward current of water lifts the sand-trap valve II into the position shown in dotted lines, Fig. II, and is compelled then to pass over the outside of the said trap through the holes 32, against the deflectors 29, against the baffle K, and out by holes 30 and port 2.

At 34 is shown a cap of packing material (as felt or rubber) on the top of valve II. Should sufficient sand deposit on the valve to open it against the upflowing current, the sand would run out and relieve the valve, so that it would close again. On restoring the valves D E to filtering position the current assists in opening the valve II.

The screen C for the filtering material, as shown, consists of a brass sheet perforated with holes of suitable size, say one thirty-second of an inch in diameter, more or less, and this sheet is placed between the sheets 35 and 36 of stronger brass, more coarsely perforated, the latter being indented or roughened, so as to form numerous projections and depressions, and thus to support the screen C at points which are separated to allow the free flow of water, but are yet close enough to give adequate support to the screen C.

At the bottom of the filter-chamber is a sand-trap L. It communicates with the interior of the filter-chamber through slots 37 and has a draw-off 38. Its contents are protected from the direct action of water-currents by the overhanging margin of button 39, the deflecting-walls 40 of the filter-chamber, the arrangement of the holes 41 above the mouth of the sand-trap, and the overhanging portions 42 of the fitting M. Should any of the finer particles of the filtering material pass through the screen, they will collect in the trap L instead of passing out with the filtered water. They can be drawn off from time to time at 38. A screen of wire-cloth could be used between the roughened supporting-plates of perforated sheet metal, but the screen of perforated sheet-brass is more advantageous, as less apt to rot out. The use of the sand-trap allows a screen of larger perforations to be used, because it is not then necessary to guard so carefully against the passage of filtering particles through the screen. The larger perforations are desirable, particularly for washing, as admitting the washing-current more freely into the filtering material.

The coagulant-chamber N, as shown, is supported on the filter-chamber A and has a tight-fitting cover 43 with holding-screw 44, the latter being tapped through the yoke 45 on the coagulant-chamber. In the fresh-water pipe 4 is a U-trap 46, with the lower bend of which the bottom of the coagulant-chamber is connected by the casing 47, Fig. IV, of the coagulant valve or valves. As shown, a coagulant-waste valve, a coagulant-flush valve, and two coagulant-feed valves are combined, as explained below, in the key P, seated in the casing 47 and operated by a handle 48 on the stem 49.

At 50 is a graduated or marked arc on which the pointer 51 indicates the position of the valve-key.

The passage 58, Figs. IV and IX, is for connecting the bottom of the coagulant-chamber with the trap 46 of pipe 4. The passage 53, Figs. IV and VIII to XI, is for connecting the front with the rear portion of the key. The passage 57 is for connecting the middle of the coagulant-chamber with the rear portion of the key. The passage 65 leads from said rear portion by a pipe 66, Figs. III, V, and VI, into the waste-pipe 5. The key P, according to its position, opens one or more of these passages or closes them all. It has, as shown, six principal positions—namely, a "circulation-feed" position, an "all-closed" position, a "regurgitation-feed" position, another "all-closed" position, a "coagulant-flush" position, and a "coagulant-waste" position. In the drawings the circulation-feed position is represented, the key being turned to the extreme right, and by turning the handle 51 to the left the other positions will be assumed successively in the order named.

The valve for the circulation feed is formed by the ports 59, 152, 54, and 56, and in the circulation-feed position these ports all register with their appropriate passages. (See Fig. IV.) The fresh water from U-trap 46 enters the passage 52 in the key P, passes through the registering passage 53 in the valve-casing, enters through the port 54 into chamber 55 of key P, and passes thence by port 56 and passage 57 into the coagulant-chamber, where it becomes saturated with the coagulant of greater specific gravity, and whence it flows through the feed-passage 58 and feed-port 59 and chamber 60 of key P into the water in the trap, to be carried with such water into the filter. By turning the key P the feed-port 59 gradually closes until the feed is entirely cut off. The passage 57 is formed, as shown, in a tubular projection of the valve-casing extending into the middle of the coagulant-chamber. In reference to the circulation feed there is an advantage in this prolongation of the passage 57 in giving a longer unbalanced column, and consequently a stronger circulation.

The passage 57, with those which in Fig. IV lead to the lower end of said passage 57, illustrates the valved circulation-passage,

which in general is a passage additional to a coagulant-feed passage, as passage 58, for example, and serves to conduct water into the coagulant-chamber N as the coagulant solution flows out by the said feed-passage. As will be explained below in the apparatus shown, the passages 53 and 57 in other positions of the valve register separately with a waste pipe or passage, so that the conduits which at one time make the circulation-passage form part of waste-passages in other positions of the valve. The passage 52 makes the inlet of the circulation-passage higher than the mouth (left-hand end) of the key-chamber 60, where the feed-passage 58 opens into the fresh-water-supply pipe. By turning the key P so that the port 59 no longer registers with the passage 58 nor the ports 152 and 54 with the passage 53, the port 56 being also removed from registering with the passage 57, the said key occupies an all-closed position. On turning the key to the left the feed-port 61 comes gradually opposite the feed opening or passage 58, and as at this time the passages 53 and 57 are closed by the solid part of the key the coagulant is fed by reason of the variations of pressure in the coagulant-chamber. This is the regurgitation-feed position, the regurgitation-feed valve being formed by the port 61, Fig. IX. For this mode of feeding to work a body of air should be confined in the top of said chamber, whereas with the circulation before mentioned this is less important. When, as shown, the circulation-passage, as well as the feed-passage, is open between the supply-pipe and a coagulant-chamber which has a body of air confined therein, the coagulant solution is fed both by circulation (that is, by a flow in at the circulation-passage and out at the feed-passage) and by regurgitation, (that is, a flow in and out at the same feed-passage.) To adapt the apparatus for working thus by both modes, the circulation-passage 57, as well as the feed-passage 58, should terminate at its inner end far enough below the top of the coagulant-chamber to leave therein a volume of air whose condensation under an increasing pressure in the fresh-water-supply pipe 4 will allow water to enter the coagulant-chamber by the feed-passage 58 and whose expansion under a decrease of the water-pressure will force the coagulant solution out through said passage. Further turning of the key P to the left gradually closes the feed-passage 58, and after it has cut it off altogether the key P assumes the other all-closed position. A still further turn to the left brings the key to the coagulant-flush position, the ports 152, 63, and 64 forming the coagulant-flush valve. In this position, passage 57 still being closed, the flush-ports 62 and 63 register with the ends of passage 53, while at the same time the waste-port 64 registers with a passage or opening 65 in the valve-casing, from which a small waste-pipe 66 leads to the casting 67 at the bottom of the glass 12 in the main waste-pipe 5. The fresh water flushes this pipe. By a further movement of key P to the left the coagulant-waste position is reached, the coagulant-waste valve being formed by the ports 68 and 64, Fig. X. In this position the passage 53 is closed and the relief-port 68 registers with passage 57 while the waste-port 64 is open. The fluid in the coagulant-chamber being under pressure escapes into waste-pipe 5 until atmospheric pressure is obtained therein. In this connection the upward extension of passage 57 is advantageous, as serving to retain a large part of the coagulant liquid in the chamber, and its termination below the top of chamber N insures that a body of air will be present therein when feeding is resumed. At this time the coagulant-feed opening or passage 58 is closed, as before stated, by the solid part of key P. The contents of chamber N being now at atmospheric pressure said chamber can be opened, examined, and refilled. In refilling with solid alum the liquid will be raised above the top of passage 57, and more or less of the liquid escapes, and when the flush-ports 62 and 63 are opened by the return movement the coagulant waste 65 is flushed and left clean. There is therefore no danger of such waste becoming clogged by the accumulation of coagulating material therein. Further movements of the key P to the right bring the variable-pressure feed and the circulation-feed successively into action, each being made adjustable by proper turning of the key P.

A valved passage, which serves to draw off the water from the vicinity of the coagulant-feeding passage 58, as does the passage 65 when the flush-ports 62 and 63 are open, can also be utilized for keeping open the said feed-passage 58 by the aid of a body of confined air (such as hereinabove referred to) in the following manner: Such valved draw-off leads from a point outside the coagulant-feed valve, (formed by either of the ports 59 or 61, for example,) which controls the said feed-passage 58, while the body of confined air is on the opposite side of said valve—namely, in the upper part of the coagulant-chamber N. When the fresh water is running to waste through the passage 58, the feed-passage 58 is closed; but by proper manipulation of the valves the said passage 58 can be opened directly the draw-off is closed. By so doing the strong pressure developed in the vicinity of said passage 58 by the sudden arrest of the water will be exerted in forcing water violently into the chamber N, through the feed-passage 58, and compressing the confined body of air. When the effect of this water-hammer has ceased, the air will expand again and make a strong flow out through the feed-passage 58. This violent inflow and outflow will sweep away particles which might otherwise clog the said passage 58. In a similar manner water may be forced by momentum through the passage 57.

The operation as a whole of the new or improved filter with coagulant-supply is as follows: The key P being at the extreme left, the chamber N is supplied with coagulant and closed. The key P is then adjusted to allow the coagulant to feed, according to whichever mode is thought best, into the U-trap 46, forming part of the fresh-water pipe 4, through which and the valve-passages 14 and 18 and port 2 (or passages 14, 14′, 18, and 18′, port 2, and pipe 20 of Fig. XX) the fresh water, properly dosed with coagulant, enters the filter-chamber A, (filter-chambers A A″ of Fig. XX.) After passing through the filter-bed B and screen C of one or more filter-chambers the now filtered water escapes to the pure-water or house pipe 6. To clean the filtering material, the valves are operated as before described, (with or without cutting off the coagulant feed to trap 46.) The current in each filter-chamber in washing passes up through the screen C and filter-bed B, washing the filtering material and carrying off the impurities. As the current automatically closes the valve H the dirty water passes over the sand-trap, carrying with it perhaps some filtering material. In passing out it strikes the baffle K and the filtering material drops into the sand-trap G. The wash-water passes through valve-passages to the waste-pipe 5, as before described. When the wash-water appears clear or sufficiently so in the glass 12, the valves are further operated, and when the water running to waste after passing through one or more filter-chambers in the filtering direction appears clear at the glass 12 the filtered-water valve or valves are turned, allowing the filtered water to pass to the house-pipe 6. If the coagulant-feed has been cut off in cleansing, it is restored before or after shifting the current-reversing valves or the filtered-water valve or valves, as may be thought desirable.

Referring to Figs. XXVII and XXVIII, the operating-lever 7′ of valve D is turned down and is provided with a stop-pin 69, moving in a curved slot 70. The valve E is operated through the partial gear 71, fast on the stem of valve D, meshing with the idler 72, which in turn meshes with the partial gear 73, fast on the stem of valve E, and the valve F is operated through the chain 74, having one end wrapped about and fastened to a disk 75, which is fast on stem of valve F, and the other end wrapped about and fastened to the hub 76 of idler 72. The parts are shown in the filtering position. In shifting the lever 7′ to the other end of its course the valves D, E, and F are simultaneously operated, so as to bring the valves D and E into washing position and the valve F into the waste position. The pin 77 acts as a stop to the tail of lever 11′ of the valve F. After washing, when the lever 7′ is returned, the valves D and E are shifted back, but the valve F, having a loose connection operating in one direction only, remains in position until it is restored by hand.

Referring to Figs. XXIX, XXX, XXXI, and XXXII, instead of connecting the current-reversing valves D* E* for controlling the flow of water through the filter by a link or gearing they are connected by being formed in one key, and the supply, waste, intermediate, house, and filter passages 14*, 14*′, 15*, 15*′, 16*, 17*, 18*, and 18*′, while differently shaped, correspond with the passages of Figs. I to VI, (indicated by similar numbers without the asterisk,) and the filtered-water valve F* is operated in one direction by a flexible connection 78 (as a wire rope or chain) around and fastened to the disk 80, fast on the stem of valve F*, and the other wrapped about and fastened to the disk 81, fast on the stem of valves D* and E*. An elbow 82 is shown to connect the pipe 3* with the valve-casing. The valve F* is returned by hand.

Referring to Figs. XXXIII to XL, the current-reversing and the filtered-water valves D** and E F are formed in one key, and the supply, waste, house, and filter passages are marked 14**, 14***, 15**, 15***, 17**, 18**, and 18***. The valve D** has only one movable port *d*, which is alternately put in communication with the supply-passage 14** or the waste-passage 15**, the filter-passage 18** being formed in the key and connected by the pipe 3** with the top of the filter. The double valve E F has ports *a*, *b*, and *c* and serves to connect the filter-passage 18*** with the house-passage 17**, the waste-passage 15***, or the supply-passage 14***, according to its position. As shown, the ports are in the "filtering-to-house" position. The water goes by passage 14**, valve D**, passage 18**, and pipe 3** to the top of the filter-chamber A*, flows through the same in the filtering direction, and then goes to house by way of passage 18***, ports *b* *a*, and passage 17**. By turning the key through the lever 7″ to the extreme right the water will enter the filter A* at the bottom, pass upward through the same in the washing direction, enter the valve D** by pipe 3**, and go to waste by the passage 15**. By bringing the key to a proper intermediate position the original connections of the current-reversing means will be reëstablished and the water will go through the chamber A* in the filtering direction, but the filtered water will pass from passage 18***, through ports *b* and *c* and passage 15***, to waste. Whenever the filtered water shows clear, the key is turned again to the extreme left, whereupon the filtered water goes to house by passage 17**. By omitting the port *b* or the port *c* the key would consist simply of current-reversing valves; but the use of the additional port makes of said key also a filtered-water valve. In order to permit the last-mentioned valve to be shifted to change the direction of the filtered water from waste to house without altering the direction of the

filter-current, the ports *b* and *d* are enlarged, so as to allow an idle motion to the current-reversing valves in shifting the filtered-water valve. The connection of the valves by making them in one key causes the house connection to be cut off automatically (as the loose or butting connection for the filtered-water valves of preceding figures) prior to the reversal of the filter-current. By making the ports *c* and *b* register with the passages 17** and 14*** a by-pass is formed, the filter being cut off and the water supplied by passage 14***, passing directly to the house-passage 17**. This would occur whether the port *c* registered with the end of the supply-passage 14*** or whether the said port *c* registered with the end of the house-passage 17**. With the valve apparatus arranged below the filter, as shown, the waste-passage 15** would be open to the filter through the port *d* and pipe 3**, Figs. XXXVII and XXXVIII, when the by-pass is established by bringing the port *c* in registry with the end of the house-passage 17**. This would relieve the filter of pressure and would drain the pipe 3**. By making the port *c* register with the filter-passage 18*** the filter can be emptied through the waste-passage 15***, since in this position of the key D E F the supply-passages are both cut off from the filter. Having been given this filter-draining position, the arrangement of ports shown allows the by-pass to be reëstablished by turning the key D E F either to the right or to the left without filling the filter again with water.

As shown in Fig. XXXIII, the pins which attach the arc 90 to the filter act as stops to limit the arm 7″ to an angular movement of ninety degrees; but the said arc 90 is an accessory device and not of the essence of the valves, like their keys and casings, and it may obviously be made as long as the user of the apparatus may desire, or it can be omitted altogether. In the arc 90 is a stop 91, consisting of a spring-pressed pin, with its nose beveled on one end. When the lever 7″ is to the left of the stop, this latter does not interfere with the motion of the lever to the right, since the lever acts upon the bevel to push back the pin against the pressure of the spring 92. When, however, the lever is to the right of the stop, this latter checks it if an attempt be made to move the lever past the stop without first withdrawing it. The head 93 of the pin is adapted to allow its withdrawal when desired. The stop is placed to arrest the key in the "filtering-to-waste" position. Thus, as in the case of the butting or loose connection arrangement, the attendant when it is wished to clean the filter can throw all the valves at once to the right, and by moving the operating-lever back and forth can alternately change the filter-current without sending dirty water to house and without requiring care to be taken by him to avoid such a result. When, however, it is desired to send the water to house, an additional operation, consisting of the removal of the stop and further movement of lever 7″, (or the independent movement by hand of the lever of the filtered-water valve in the preceding arrangements,) enables this to be done. The use of a double valve like E F is not limited to a one-key arrangement, but could be used otherwise. For example, it could, with a suitable change in one passage, replace the valves E and F in separate keys employed, say, in Fig. II. In the apparatus of Figs. XXXIII to XL improvements are shown in packing the valve-stem, applicable also to the stem of any of the keys. Around the key is a shoulder 94, and the disk 95 bears against the same, with a packing-ring 96 interposed, and has means for pressing it against the shoulder. Further, a stuffing-box is formed by and between the disk 95 and the follower 97 around the valve-stem. This follower could be screwed or otherwise forced down directly on the disk 95, thus tightening at one operation the stuffing-box and the packed joint at 96. It is advantageous, however, to screw this down indirectly by means of a screw-cap 98 or other holding means having a swivel connection with the follower, and this latter is held from turning by any suitable means—as, for example, making it and the disk 95 with hexagonal or other angular or irregular figure and having them fit in correspondingly-shaped sockets. With this arrangement the turning of the key has no tendency to loosen the stuffing-box. The follower held from turning and provided with a swiveled screw-cap could be used in other connections—as, for example, with a nut in place of the disk and packing-ring.

Referring to Fig. XLI, the sand-trap valve H′ is carried by a rod 83, passing through a guide 85, supported in the sand-trap by arms, so as not to interfere with the passage of water and sand, and also through a stuffing-box 86, and it is operated through a connection with operating-lever 7, said connection consisting of a pin 87 on the rod 83, working through a slot in an arm 88 of lever 7. In the filtering position the sand-trap valve is held open, as shown. When the valves D and E are thrown over to change the current for washing, the rod 83 is forced down and the valve H′ is made to close the sand-trap outlet.

In conformity with the requirement of the Patent Office for division certain claims to the valve arrangement of Figs. XXXIII to XL have been made in a divisional application—to wit, in my application, Serial No. 642,143, filed as a continuation hereof June 24, 1897.

I claim as my invention or discovery—

1. The combination with a filter, and current-reversing valves having circumferentially-disposed ports in the key portion of said valves, of a filtered-water valve which is arranged to put the filtered-water outlet or bottom of the filter in communication with

a house-pipe when said valve is in one position and with a waste-pipe when it is in another position and which has a port-controlling connection with said current-reversing valves so that its waste position is insured when these are in the washing position and is also permitted or insured during their return to the filtering position, substantially as described.

2. In combination with a filter, and current-reversing valves having distinct sets of circumferentially-disposed ports in the key portion of said valves, a filtered-water valve which is arranged to put the filtered-water outlet or bottom of the filter in communication with a house-pipe when said valve is in one position and with a waste-pipe when it is in another position and which has a port-controlling connection with said current-reversing valves so that its waste position is insured when these are in the washing position and is also permitted or insured during their return to the filtering position, substantially as described.

3. The combination with a filter, and current-reversing valves therefor, of a filtered-water valve which is arranged to put the filtered-water outlet or bottom of the filter in communication with a house-pipe when said valve is in one position and with a waste-pipe when it is in another position and which has a port-controlling connection with said current-reversing valves whereby the waste position of said filtered-water valve is insured when the first-mentioned valves are in the washing position, the said filtered-water valve being movable independently of them when these are in the filtering position, and provision being made against the careless movement of said filtered-water valve to the house position in restoring the current-reversing valves to the filtering position, substantially as described.

4. The combination with a filter, and current-reversing valves therefor, of a filtered-water valve having a butting or loose connection with the first-mentioned valves arranged to shift automatically the said filtered-water valve to the waste position, leaving it to be returned independently, substantially as described.

5. In combination with a filter, a valve apparatus arranged at one end of said filter and comprising current-reversing and filtered-water valves of the rotary-key class provided with circumferentially-disposed ports and turning in a compound casing in one piece of metal with supply, waste, house and filter passages formed in said casing, a valve-controlling connection being provided between the filtered-water and the current-reversing valves, and said valves being so arranged that the house-passage may be opened only when the current-reversing valves are in the filtering position and that such opening may be effected independently of the communications established through the filter by the said current-reversing valves, substantially as described.

6. In combination with a filter, a valve apparatus at the end of said filter comprising current-reversing and filtered-water valves of the rotary-key class provided with sets of circumferentially-disposed ports in a compound casing in one piece of metal with supply-passages extending from one outside opening to different valve-seats, waste-passages leading from different valve-seats to one outside opening, filter-passages with outside openings, and a house-passage leading to an outside opening from a valve-seat from which a waste-passage extends, substantially as described.

7. In combination with a filter, a valve apparatus arranged at one end of said filter comprising current-reversing and filtered-water valves composed of rotary keys with circumferentially-disposed ports in a compound casing in one piece of metal with supply, waste, house and filter passages formed in said casing, said filtered-water valve being formed in a separate key from the current-reversing valves and having with the latter a port-controlling connection which is arranged to permit the independent operation of the filtered-water valve when said current-reversing valves are in the filtering position, substantially as described.

8. In combination with a filter, an elongated valve apparatus arranged at one end of said filter at right angles to the axis of the latter and comprising current-reversing and filtered-water valves composed of rotary keys provided with circumferentially-disposed ports in a compound-valve casing in one piece of metal, said keys being transverse to the length of said casing and said casing being provided in addition to other passages with a branched waste-passage one branch of which extends from the waste-opening at one end of said casing to an adjacent valve-seat while the other branch extends from the same waste-opening over a valve-key to the seat of a key nearer to the other end of said casing, substantially as described.

9. In combination with a filter, a valve apparatus at one end of said filter comprising rotary keys with three sets of circumferentially-disposed ports and a compound casing in one piece of metal with valve-seats and passages as follows, namely supply-passages leading directly to two seats from an outside opening, waste-passages leading from two seats to an outside opening, house and filter passages each leading from a valve-seat to an outside opening, and a passage for connecting two valve-seats with each other, substantially as described.

10. In combination with a filter, a valve apparatus at one end of said filter, comprising a rotary-key portion with filtered-water ports in addition to two sets of circumferentially-disposed current-reversing ports and a compound casing in one piece of metal with key-seats and passages as follows, namely sup-

ply-passages leading directly to the seats belonging to both sets of current-reversing ports from an outside opening, waste-passages leading from both said seats to an outside opening, filter-passages leading to outside openings, one from each of said seats, and a house-passage leading from the seat corresponding with the filtered-water ports, said filtered-water ports being arranged for closure of the house-passage when the current-reversing ports are in the washing position and for opening the house-passage independently of the current-reversing ports when these are in the filtering position, substantially as described.

11. Two filter-chambers having their bottoms connected with each other, in combination with supply, waste and house pipes, current-reversing valves controlling the connection of the tops of the chambers with the water-supply and waste alternately, and a filtered-water valve having ports arranged to register with the house and waste pipes alternately, the said house-pipe leading from said filtered-water valve independently both of the waste-pipe and of the connection between the filter-chambers, substantially as described.

12. Two filter-chambers having their bottoms connected with each other and their tops with the filter-passages of current-reversing valves, in combination with said current-reversing valves arranged to control the connection of said passages with the supply and waste, and a filtered-water valve at the termination of passages from the bottoms of both chambers and also of two additional passages leading from said valve to waste and house respectively, said filtered-water valve being provided with movable ports for delivering the water from the filter-chambers to either of said additional passages, substantially as described.

13. In combination with a filter of two chambers, current-reversing valves having separate waste-passages and being arranged respectively at the terminations of filter and supply and waste passages, and an additional valve in one of said separate waste-passages for controlling it independently, substantially as described.

14. In combination with a filter of two chambers, current-reversing valves, a filtered-water valve seated at the terminations of house and waste as well as of filter passages, the said house and waste passages terminating at separate openings in the valve-seat, and an additional valve in the said waste-passage, substantially as described.

15. In a two-chamber filter having valves, which in one position direct water so that both chambers are filtering and in other positions so that each chamber is washed with filtered water from the other chamber, in combination with the connected filter-chambers A and B, of valves of the aforesaid description connected for joint operation by means which allow an independent motion and arranged when shifted together from the position in which both chambers are filtering to cause chamber A to be washed with filtered water from chamber B and when shifted in part only from said position to cause chamber B to be washed with filtered water from chamber A, substantially as described.

16. In combination with a filter of two chambers connected at the bottoms, connected current-reversing valves arranged to control the passages leading to the tops respectively of said chambers, and a filtered-water valve which is arranged to direct the filtered water to house when in one position and to a waste-passage when in another position and which has such a port-controlling connection with said current-reversing valves as insures the waste connection in washing while allowing an independent motion when the current-reversing valves are in the filtering position, substantially as described.

17. In combination with a filter of two chambers having the bottoms connected, current-reversing valves, arranged to control the passages leading to the tops respectively of said chambers and composed of separate keys having with each other a connection for conjoint operation while allowing an independent motion, and filtered-water valves one or more of which have such a port-controlling connection with said current-reversing valves as insures the waste position in washing while allowing an independent motion when the current-reversing valves are in the filtering position, substantially as described.

18. The combination with a valve-key and its casing, of a packing around the valve-stem, a larger packing at the mouth of the valve-casing, a pressure-held disk interposed between the said two packings, a follower arranged beyond the valve-stem packing, and means which engage the said casing and press the said follower inward, the pressure being transmitted by the follower to the disk through the said valve-stem packing, substantially as described.

19. The combination with a valve-key, and its casing, of a pressure-held disk of greater diameter than the valve-key arranged to close the key-space and to bear upon the surrounding casing with a packing-ring between the disk and casing, a follower, a stuffing-box between the follower and disk, and holding means extending from the follower to the casing and having a swivel connection with said follower, substantially as described.

20. The combination with a valve-key, and its casing, of a non-rotatable pressure-held disk of greater diameter than the valve-key arranged to close the key-space and to bear upon the surrounding casing with a packing-ring between the disk and casing, a follower held from turning by positive means as opposed to mere friction, a stuffing-box between the follower and disk, and a holding means having a swivel connection with said follower, substantially as described.

21. The combination with a valve-key, a closure for the key-space, a follower held from turning by positive means as opposed to mere friction, a stuffing-box between the follower and closure, and a holding means having a swivel connection with said follower, substantially as described.

22. In combination with a filter-chamber, and a granular filter-bed partly filling the filter-chamber, and current-reversing valves, a sand-trap communicating with said chamber above the filter-bed and provided with a valved passage leading back to the filter-bed, substantially as described.

23. In combination with a filter-chamber, and a granular filter-bed partly filling the filter-chamber, and current-reversing valves, a sand-trap communicating with said chamber above the filter-bed and provided with a passage leading back to the filter-bed, said trap and passage arranged for the automatic return of the sand from the trap to the filter-bed, substantially as described.

24. In combination with a filter-chamber, and a granular filter-bed partly filling the filter-chamber, and current-reversing valves, a sand-trap arranged between the fresh-water inlet and wash-water outlet and the filter-bed, substantially as described.

25. In combination with a filter-chamber, a granular filter-bed partly filling the said chamber, and current-reversing valves, a sand-trap arranged within the said chamber and communicating with the said chamber above the filter-bed and provided with a passage leading back to the filter-bed, substantially as described.

26. In combination with a filter-chamber, and a granular filter-bed partly filling the filter-chamber, and current-reversing valves, a sand-trap communicating with said chamber above the filter-bed and provided with a valved passage leading back to the filter-bed, the fresh-water-inlet port being arranged above said trap so that the water to be filtered passes through the trap, substantially as described.

27. In combination with a filter-chamber, and a granular filter-bed partly filling the filter-chamber, and current-reversing valves, a sand-trap communicating with said chamber above the filter-bed and provided with a passage leading back to the filter-bed, and a baffle above said trap, substantially as described.

28. In combination with a filter-chamber, and a granular filter-bed partly filling the filter-chamber, and current-reversing valves for controlling the flow of water through the said bed to make it self-cleaning, a sand-trap communicating with said chamber above the filter-bed and provided with a passage leading back to the filter-bed, a baffle above said trap, and deflectors around the mouth of said trap arranged to deliver horizontally the water entering the trap from the filter-chamber, substantially as described.

29. In combination with a filter-chamber, and a granular filter-bed partly filling the filter-chamber, and current-reversing valves, a sand-trap communicating with said chamber above the filter-bed and provided with a passage leading back to the filter-bed, and an automatic valve for said passage arranged to be opened and closed automatically in changing the current from the washing to the filtering direction and the reverse, substantially as described.

30. In combination with a filter-chamber, and a granular filter-bed partly filling the said chamber, and current-reversing valves, a sand-trap communicating with said chamber above the filter-bed and provided with a passage leading back to the filter-bed, and an automatic valve for said passage arranged to be controlled automatically by the water-current, substantially as described.

31. In combination with a filter-chamber, and a granular filter-bed, and current-reversing valves, a sand-trap for the washing-current provided with a passage leading back to the filter-bed, and an automatic valve for said passage, substantially as described.

32. In combination with a filter-chamber, and granular filtering material, a screen, and a more coarsely perforated screen-supporting sheet roughened or indented to form supporting-points, said plate being perforated at short intervals over its whole area and being upheld by the edges above the bottom of the filter-chamber, substantially as described.

33. In combination with a filter-chamber, and granular filtering material, a screen of perforated sheet metal, and a more coarsely perforated screen-supporting sheet indented or roughened, said plate being perforated at short intervals over its whole area and being upheld by the edges above the bottom of the filter-chamber, substantially as described.

34. In combination with a filter-chamber provided with granular filtering material supported by a screen and having a filtered-water outlet below the said screen, a sand-trap below the filtered-water outlet, and deflectors whose upper surfaces are above the said trap and below the said outlet and are arranged to deflect the current horizontally across and above the said trap, substantially as described.

35. In combination with a filter-chamber, granular filtering material, and current-reversing valves, a screen interposed between the said material and the wash-water inlet and filtered-water outlet, and more coarsely perforated sheets on opposite sides of said screen, each sheet being roughened or indented to form screen-supporting points, and perforated at short intervals over its whole area, and the two sheets with interposed screen being upheld at the edges above the bottom of the filter, substantially as described.

36. In combination with a filter-chamber provided with a granular filter-bed supported by a screen and a sand-trap below said screen, and also provided with a filtered-water out-

let above the sand-trap and below the said screen, deflectors at different levels between the outlet and the sand-trap, namely an overhanging deflector next the outlet whose under surface is arranged to deflect the rising water horizontally outward and deflectors nearer the said trap whose upper surfaces are arranged to deflect the descending water horizontally inward across and above the said sand-trap, substantially as described.

37. A filter-chamber provided below the granular filter-bed with a water-outlet port, and a sand-trap below said port, and deflectors intermediate the sand-trap and said port and also above said port for protecting the trap against direct water-currents, substantially as described.

38. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a valved waste-passage from said chamber, and a valved passage outside the coagulant-chamber connecting said waste with a supply of flush-water, the valves for said passages being outside the fresh-water-supply pipe, substantially as described.

39. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a valved feed-passage from said chamber, a valved waste-passage from said chamber with its inner end at a point above said feed-passage, and a valved passage connecting said waste with a supply of flush-water, substantially as described.

40. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a valved feed-passage, and a valved circulation-passage, both passages terminating at about or below the middle of said chamber so as to form an air-space therein, substantially as described.

41. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a valved feed-passage, and a valved circulation-passage, both passages terminating at about or below the middle of said chamber so as to form an air-space therein, the feed-passage terminating below the circulation-passage so as to form unbalanced columns, substantially as described.

42. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a valved feed-passage, a valved circulation-passage, and a valved waste-passage, both the latter terminating at the middle portion of the chamber, substantially as described.

43. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a valved feed-passage, a passage communicating with said chamber at a point above the feed-passage and at a suitable distance below the top of the chamber to leave an air-space, and a valved fresh-water passage and a valved waste-passage both connecting with said second-mentioned passage, substantially as described.

44. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a valved feed-passage, a valved waste-passage connecting with said chamber, and a valved fresh-water passage outside the coagulant-chamber connecting with the said chamber and with said waste-passage, the valves for said feed, waste and supply passages being outside of the fresh-water-supply pipe, substantially as described.

45. In combination with a water-supply pipe, a filter-chamber, and filtering material, a closed coagulant-chamber, a valved feed-passage at the base of said coagulant-chamber between it and said pipe, and a valved circulation-passage opening at one end into said pipe at the base of said chamber at a higher level than said feed-passage and terminating above said feed-passage within the coagulant-chamber at about the middle thereof, substantially as described.

46. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a valved feed-passage, a valved circulation-passage, a valved coagulant-waste passage, and a valved passage between the said waste-passage and a supply of flush-water, substantially as described.

47. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a coagulant-waste passage, a passage connecting the said waste with a supply of flush-water, and a valve or key having relief and flushing ports, substantially as described.

48. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a feed-passage, a circulation-passage, and a valve or key having ports for both passages arranged to open the feed and circulation passages together and to close said circulation-passage while opening the feed-passage for variable-pressure feeding, substantially as described.

49. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a feed-passage, a coagulant-waste passage, and a valve or key having feed and relief ports arranged to open the feed-passage when the waste-passage is closed and to open the latter when the former is closed, substantially as described.

50. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a feed-passage, a circulation-passage, a coagulant-waste passage, and a valve or key having ports for circulation feed and for said waste, substantially as described.

51. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber provided with a confined-air space, a feed-passage, a circulation-passage, a coagulant-waste passage, and a valve or key having a relief-port and ports for circulation feed and for opening the feed-passage when the circulation-passage is closed, substantially as described.

52. In combination with a filter-chamber,

and filtering material, a closed coagulant-chamber, a feed-passage, a coagulant-waste passage, a flush-water passage, and a valve or key having feeding, relief and flushing ports, substantially as described

53. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a valve or key, a feed-passage between the said chamber and the valve, a fresh-water passage between the filter-supply and the valve or key, a waste-passage leading from the valve or key seat, and an additional passage between the key or valve and said chamber, said key or valve being provided with circulation-feed, relief and flushing ports, substantially as described.

54. In combination with a filter-chamber, and filtering material, a closed coagulant-chamber, a valve or key, a feed-passage between the said chamber and the valve or key, a fresh-water passage between the filter-supply and the valve or key, a coagulant-waste passage leading from the valve or key seat, and an additional passage between the key or valve and said chamber, said key or valve being provided with variable-pressure-feed, circulation-feed, relief and flushing ports, substantially as described.

55. The herein-described self-cleaning granular-bed filter with coagulant-supply, the same comprising a filter chamber or chambers with granular filter-bed therein, a valve apparatus comprising mechanically-connected current-reversing and filtered-water valves with independent control of the filtered water when the current-reversing valves are in filtering position and an integral compound casing with supply, waste, house and filter passages, and a coagulant-chamber connected with the conduit between the fresh-water pipe and said chamber, and provided with a compound valve and casing having feed, waste and flushing passages and a key with feed, relief and flushing ports, substantially as set forth.

56. In combination with a filter of two chambers provided with current-reversing valves and filter-passages therefor connected with the tops of said chambers and also provided with a passage between the chamber-bottoms, a valve in said last-named passage having a butting or loose connection with said current-reversing valves, substantially as described.

57. In combination with a filter of two chambers provided with current-reversing valves and with waste and filter passages therefor, the filter-passages being connected with the tops of said chambers, a valved passage separate from the waste of said current-reversing valves arranged within the same casing as said current-reversing valves between the bottom of one chamber and the filter-passage leading to the top of another, substantially as described.

58. In combination with a filter of two chambers provided with current-reversing valves and with waste and filter passages therefor, the filter-passages being connected with the tops of said chambers, a valved passage separate from the waste of said current-reversing valves arranged within the same casing as said current-reversing valves between the bottom of one chamber and the top of another, and a valved passage also within said casing between the bottoms of said chambers, substantially as described.

59. In combination with a filter of two chambers provided with current-reversing valves and with waste and filter passages therefor, the filter-passages being connected with the tops of said chambers, a passage separate from the waste of said current-reversing valves between the bottom of one chamber and the top of the other, another separate passage between the chamber-bottoms, and a valve arranged to control both said separate passages by closing the one in opening the other, said passages being all within the same valve-casing, substantially as described.

60. In combination with a filter of two chambers provided with current-reversing valves and with waste and filter passages therefor, the filter-passages being connected with the tops of said chambers, a passage separate from the waste of said current-reversing valves between the bottom of one chamber and the top of the other, another separate passage between the chamber-bottoms, a valve arranged to control both said separate passages by closing the one in opening the other, an additional valve in the passage between the chamber-bottoms, and additional waste and house passages terminating separately in the seat of said last-named valve, substantially as described.

61. The combination with a valve-key, and its casing, of a pressure-held disk of angular or irregular form and of greater diameter than the valve-key arranged to close the key-space and to bear upon the surrounding casing with a packing-ring interposed, said disk carrying a stuffing-box for the valve-stem, substantially as described.

62. In combination with a water-supply pipe having an opening in the wall thereof, a closed coagulant-chamber, a valve-casing connected by screw-joints directly with said pipe and with said chamber so that the said chamber and pipe may communicate with each other through the said opening in the wall of said pipe, and a valve in said casing outside of said pipe so as to leave the bore of this latter clear, substantially as described.

63. A closed coagulant-chamber provided with a confined-air space, in combination with a valved coagulant-waste passage, and means for admitting fresh water to said chamber by the passage through which said waste-passage communicates with said chamber, substantially as described.

64. A closed coagulant-chamber provided with a confined-air space, in combination with a valved coagulant-waste passage, and means

for admitting fresh water to said chamber by the passage through which said waste-passage communicates with said chamber and for supplying flush-water to said waste-passage, substantially as described.

65. A closed coagulant-chamber provided with a confined-air space, in combination with a valved feed-passage, and a valved passage outside the coagulant-chamber for running fresh water to waste from the vicinity of said feed-passage, substantially as described.

66. A closed coagulant-chamber provided with a confined-air space, in combination with a valved feed-passage, and a valved passage for running fresh water to waste from the vicinity of said feed-passage, the valves for said passages having an operative connection so that one movement of the operator can close the second-mentioned and open the first-mentioned passage, substantially as described.

67. A closed coagulant-chamber provided with a confined-air space, in combination with a valved coagulant-waste passage, means for admitting fresh water to said chamber by the passage through which said waste-passage communicates with said chamber, and a valved passage for running fresh water to waste from the vicinity of said passage, substantially as described.

68. A closed coagulant-chamber, in combination with a valved coagulant-waste passage, means for admitting fresh water to said chamber by the passage through which said waste-passage communicates with said chamber, and a valved passage for running fresh water to waste from the vicinity of said passage, the valves for said passages having an operative connection, substantially as described.

69. A closed coagulant-chamber, in combination with a valved feed-passage, a valved coagulant-waste passage communicating with said chamber at a point above the inner end of said feed-passage, means for admitting fresh water to said chamber by the passage through which said waste-passage communicates with said chamber, and a valved passage for running water to waste from the vicinity of said feed-passage and the passage through which the said coagulant waste communicates with said chamber, substantially as described.

70. A closed coagulant-chamber, in combination with a valved feed-passage, a valved coagulant-waste passage communicating with said chamber at a point above the inner end of said feed-passage, means for admitting fresh water to said chamber by the passage through which said waste-passage communicates with said chamber, and a valved passage for running water to waste from the vicinity of said feed-passage and the passage through which the said coagulant waste communicates with said chamber, the valves for said passages having an operative connection, substantially as described.

71. A filter-chamber provided below its granular filter-bed with a sand-trap and a water-outlet above said trap, and having also a fitting M composed of an overhanging enlargement 42 with the outlet-holes 41 in said enlargement and a further-enlarged top 39 which overhangs said holes, substantially as described.

72. A filter-chamber provided below its granular filter-bed with a sand-trap and a water-outlet above said trap, and deflectors 37 intermediate the said outlet and trap and having also a fitting M composed of an overhanging enlargement 42 above said deflectors with the outlet-holes 41 in said enlargement and a further-enlarged top 39 which overhangs said holes, substantially as described.

73. In combination with a water-supply pipe, a filter-chamber, and filtering material, a closed coagulant-chamber, a valve-casing with passages therein screwed to said pipe at the side thereof so as to leave the pipe-bore clear and to the bottom of said coagulant-chamber and having a pipe extension up into said chamber, and a valve-key in said casing for controlling the passages between said pipe and coagulant-chamber, substantially as described.

74. In combination with a filter, a valve apparatus comprising a supply-passage, a house-passage, filter-passages, and a waste-passage together with current-reversing and filtered-water ports mechanically connected with one another and circumferentially disposed in the movable key portion of the valve apparatus, said ports being arranged to close the house-passage while the current-reversing ports are in the washing position and are returning therefrom to the filtering position, and the terminal openings of the house and waste passages being arranged to register alternately with a filtered-water port when the current-reversing ports are in said filtering position, substantially as described.

75. A valve-casing provided with a non-rotatable disk for closing the key-chamber, and a rotatable coupling engaging said casing for clamping said disk, the latter carrying a stuffing-box for the valve-stem and being held from rotation by positive means, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

JOS. T. MANNING.

Witnesses:
PHILIP MAURO,
REECE LEWIS.