(No Model.) 2 Sheets—Sheet 1.

F. W. FOSTER.

VALVE.

No. 548,977. Patented Oct. 29, 1895.

Fig. 1,

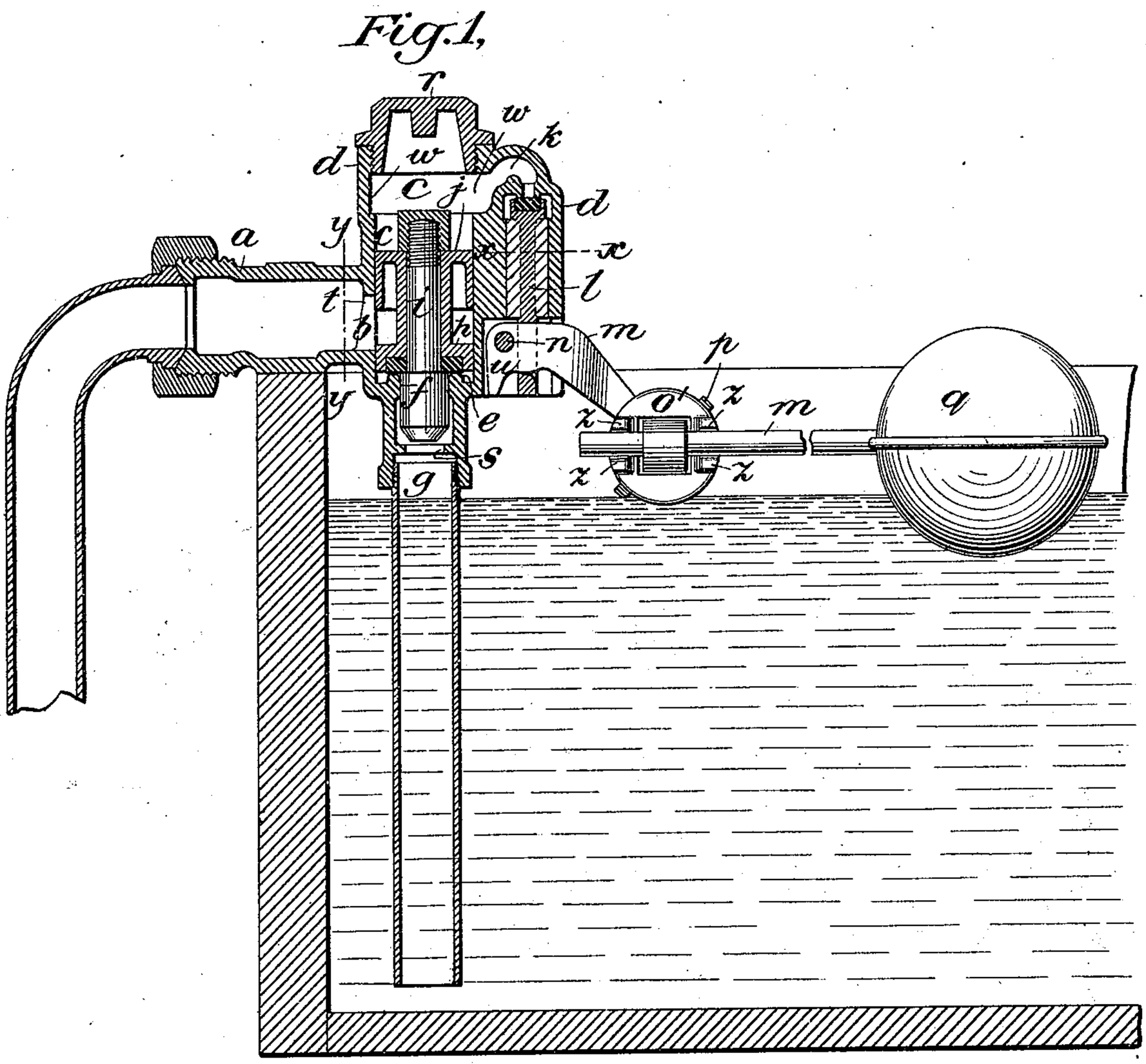

Fig. 2,

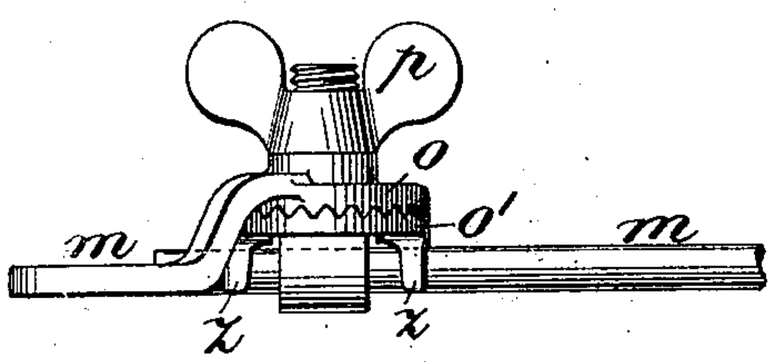

Fig. 3,

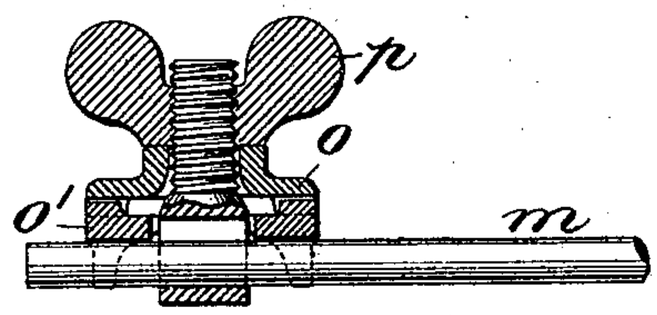

Fig. 4,

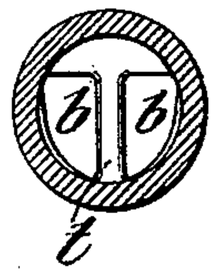

Fig. 5,

Witnesses:-

A. Mayer.
Edwin Seger.

Inventor:-

Frank W. Foster
by his attorneys
Wilkes & Kenyon

(No Model.) 2 Sheets—Sheet 2.

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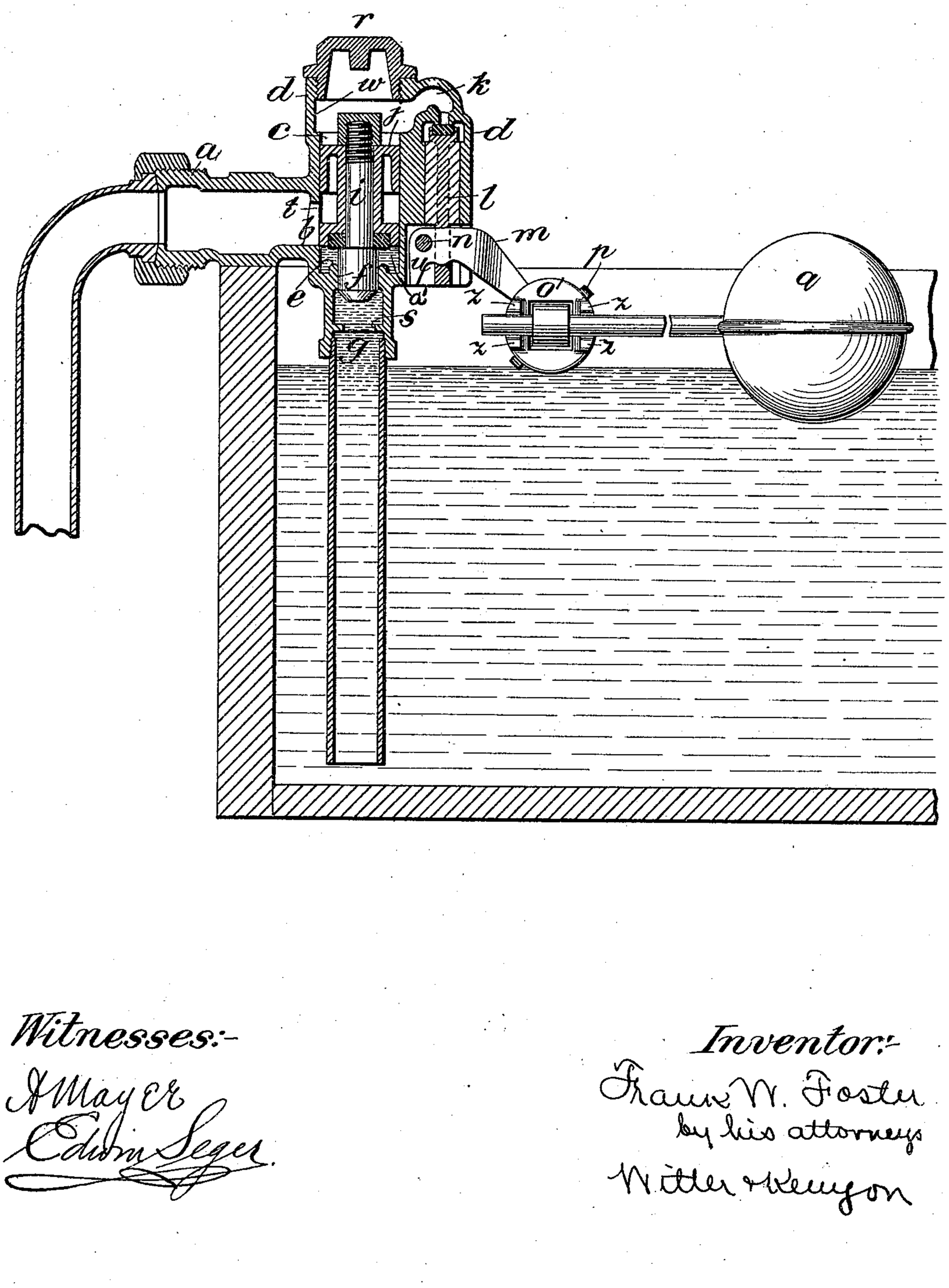
Fig. 6.



Witnesses:-

A. May Jr.

Edwin Seger.

Inventor:-

Frank W. Foster

by his attorneys

Witter & Kenyon

UNITED STATES PATENT OFFICE.

FRANK W. FOSTER, OF MELROSE, MASSACHUSETTS.

VALVE.

SPECIFICATION forming part of Letters Patent No. 548,977, dated October 29, 1895.

Application filed July 31, 1894. Serial No. 519,114. (No model.)

To all whom it may concern:

Be it known that I, FRANK W. FOSTER, a citizen of the United States, residing at Melrose, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Valves, of which the following is a full, clear, and exact specification, reference being had to the accompanying drawings, which form a part hereof.

One object of my invention is to prevent the valve proper from closing suddenly, and to do this by causing a portion of the water escaping through the valve to act as a cushion, and thus to greatly decrease or entirely do away with the water hammering, which always results where the valve is suddenly closed in a passage through which water is being forced under pressure, and also to prevent the accumulation or increase of pressure on the inlet side of the valve, such as would result from its sudden closing.

Another object of my invention is to cut off the quantity of water passing into the chamber of the valve in a constantly-decreasing amount.

Another object is to prevent what is known as the "whistling" of the water as it passes through the discharge-port at the valve-seat.

Another object is to improve the construction of the lever for controlling the auxiliary valve.

Generally speaking, it is the object of my improvement to reduce the strain upon the different parts of the valve, and thus to decrease the wear and tear upon it, while at the same time increasing the certainty and efficiency of its operation.

My invention has special reference to that class of valves in which the main valve is operated through and by means of an auxiliary valve, which is connected with some part of the main-valve chamber and which serves to release or confine the pressure in that particular part of the valve-chamber, and thereby to open or close the main valve through and by means of a suitable piston.

Another object of my invention is to increase the efficiency and accuracy of operation of the piston in such a valve and at the same time by means of the construction and arrangement of the piston to improve and perfect the cushioning action of the valve.

My invention consists, first, in so constructing the parts of the valve that while the valve is being closed a quantity of water will be caught or entrapped between two parts of the valve—as, for example, between the valve-disk and the lower part of the valve-stem—both of which parts fit closely the corresponding parts of the valve-shell, as a result of which this water will be forced out slowly, and will during this time serve as a cushion to prevent the valve from closing suddenly and to cause it to close against the valve-seat with a gradual motion. This part of my invention also contemplates such a construction of the valve as will cause the inlet-pipe to be obstructed in part or in whole prior to the beginning of the cushioning action.

My invention consists, secondly, in so constructing the inlet-opening between the inlet or supply pipe and the valve-chamber that the inflowing current of water will be cut off in gradually-decreasing quantities—that is to say, so that as the valve closes it will during the first quarter of its movement cut off a large amount of the supply, or more than a quarter of the entire volume, and during the second quarter of its movement cut off a less quantity, and during the third quarter cut off a still smaller quantity, and so on.

My invention consists, thirdly, in dividing the inlet-opening between the supply-pipe and the valve-chamber by one or more partitions for the purpose of enabling the valve-chamber to be bored out more accurately, and also for the purpose of diverting the inflowing current of water and preventing it from striking directly against the valve or valve-stem and cramping the valve in its chamber.

My invention consists, fourthly, in the combination, with a piston fitting the valve-chamber closely and an auxiliary valve controlling the pressure above the piston, or on the side of the piston away from the discharge-port, of a stem fitting the discharge-port closely, whereby the piston acts as a guide for the stem and the stem for the piston, each serving to make the operation of the other more certain and accurate and effi-

cient, and thereby improving the operation of the valve.

My invention consists, lastly, in the various combinations of parts hereinafter described and claimed.

What I believe to be the best form of my invention is illustrated in the accompanying drawings, in which—

Figure 1 is a vertical section of the valve, shown as applied to a tank and operated by a float, the valve being closed. Fig. 2 is a top or plan view of the toothed disks and their connections. Fig. 3 is a sectional view of the disks and connecting-bolt. Fig. 4 is a section on the line *y y* of Fig. 1, showing the shape of the inlet-openings between the supply-pipe and the valve-chamber. Fig. 5 is a horizontal section of the auxiliary valve on the line *x x* of Fig. 1. Fig. 6 is similar to Fig. 1, except that it shows the valve when nearly closed and at the point where the main cushioning action of the water commences.

Referring to the drawings, *a* represents the supply-pipe or inlet-pipe, which may be provided with the usual screw-threaded nipple for attachment to the source of supply.

This pipe opens into the valve-chamber *c* through and by means of the inlet-openings *b b*. These inlet-openings, in the construction shown in the drawings, are formed by dividing the inlet into two parts by means of a partition or bridge *t*, running in a direction parallel with the axis of the valve-disk, so as to divide and deflect the inflowing current and prevent it from striking directly against the valve disk or piston. These openings are made wide at the top and of gradually-decreasing size toward the bottom, with the small ends of the openings on the side nearest the discharge-port. When the valve shuts as it first passes in front of the wide end of the openings, it cuts off a large part of the inflowing current of water. As it continues to descend or close, it cuts off a less and less quantity. In this way the pressure and strain upon the valve and valve-seat are reduced gradually as the valve closes. This prevents increased pressure or water-hammer. This part or feature of my invention may be employed or secured by the use of a single inlet-opening, wide at the top and gradually decreasing in size toward the bottom.

d is the shell or casing of the valve, the walls of which form the valve-chamber and inclose the different parts of the valve.

e is the valve-seat, through which is a discharge-port *f*.

g is the outlet-pipe.

h is the valve proper or valve-disk. This is provided on its face with a suitable packing or washer, made of whatever material may be deemed best, such as rubber or other material. The valve-disk is supported upon the valve-stem *i*. This valve-stem also supports the valve-piston *j*. On the discharge side the valve-stem has a projecting or depending part adapted to fit closely the walls of the discharge-port when the valve is being closed, and yet to move freely in the discharge-port and to permit the passage of water between it and the walls of the discharge-port, and adapted to move out of its close fit in the discharge-pipe in such a way as to make a free passage through the discharge-port. In the drawings, when the valve-stem opens the passage through the discharge-port it is moved entirely outside of the discharge-port, so that the water passes between the end of the stem and the discharge-port. This particular form, however, might be varied in various ways, but so as in each case to make a free passage through the outlet-port when the valve is opened, and in each such case the valve-stem would be out of its close fit with the discharge-port within my meaning.

The valve-disk and the valve-piston are made to fit the walls of the valve-chamber closely, and yet so as to enable them to move freely in the valve-chamber and to permit the passage of a thin film or current of water between them and the wall of the valve-casing. In addition to this a hole or opening may be made through the valve-piston, if desired, to enable the water to flow into the chamber or space above the piston more rapidly.

In Fig. 1 I have shown the best method of constructing the valve-stem and the connected parts. The valve-disk and valve-piston are made in a single piece, having a central bore. In the form shown the piston and disk are separated by an intervening space. In some forms of my invention the disk and piston might be made solid—that is, continuous—but I prefer the form shown. The valve-stem is turned so as to nicely fit this bore, and is provided with an enlarged portion at its lower end and with a screw-threaded portion at its upper end. The valve-stem is preferably beveled at its outer end. The valve-disk has a recess on its under side or face to receive the packing or washer. The packing is inserted in the disk. Then the valve-stem is slipped into place and drawn up and secured by a nut bearing on the top of the valve-piston. The packing is thus not only securely held in place, but it can be easily renewed. By this method of construction the valve-stem can be kept in alignment with the valve-disk and piston easily and accurately. The upper part of the valve-chamber is enlarged by an annular recess *w*, formed in the shell or casing of the valve.

k is an auxiliary outlet leading from that end of the valve-chamber in which the valve-piston moves, preferably from the recessed portion *w*, and is preferably curved upward, as shown. This outlet-passage is controlled by an auxiliary valve *l*. The construction of this valve is shown in section in Fig. 5. In the form of device shown in the drawings the auxiliary valve is adapted to be closed by a float, as in a water-closet tank. The auxil-

iary valve is worked by the lever *m*, this lever being pivoted at one end at *n* and being connected at the other end with the float. The lever *m* is provided at its inner end with a stop or foot *u*, adapted to strike against the shell or case and thereby limit the downward motion of the float and valve. The lever *m* is made in two parts, each part being provided with a toothed or notched disk *o o'*. These disks are adapted to turn one upon the other and to be fastened in any given position or at any given angle by means of a screw-threaded bolt provided at one end with a ring or eye and the thumb-screw *p*. The disk *o* is attached firmly to the inner arm of the lever and has a central perforation to receive the bolt. The disk *o'* is provided with projections or ears *z*, to form a bearing or stop to prevent the outer arm of the lever and the bolt from turning independently of the disk. The outer arm of the lever is passed through the ring or eye in the bolt and between the projections or ears *z*, and the parts are then secured together by screwing home the thumb-screw. Other means may be employed for fastening these disks together when once adjusted.

q represents a float.

r is a screw-cap screwed into one end of the valve-case and forming the head or end of the valve-chamber.

s is an annular ring or lip formed in the outlet pipe or passage, having a central opening smaller in area than the discharge-port *f*. This ring *s* is placed at a short distance below or beyond the discharge-port.

The operation of this form of my improved valve is as follows: When both the main valve and the auxiliary valve are closed, the pressure in the upper part of the valve-chamber *c* is substantially the same as the pressure in the inlet-pipe. If the auxiliary valve *l* be opened, either by the falling of the float *q* or by any other means, the pressure in the upper part of the valve-chamber is at once relieved and reduced below the pressure in the inlet-pipe. This difference in pressure on the upper side of the valve-piston and under side of the valve-piston and valve-disk causes that piston, together with the valve-disk and valve-stem, to be lifted to its highest position in the valve-chamber, thus opening the main valve. The water is discharged through the discharge-port *f* into the chamber or space between that discharge port and the contracted opening *s* in the outlet-pipe, and from thence it passes through the opening in the annular ring or lip *s* and into the outlet-pipe *g*. When the auxiliary valve is closed by the rising of the float or by other means, the water is forced into the upper part of the valve-chamber *c*, between the valve-piston and the valve-case, until the pressures in the two parts of the valve-chamber are equalized, or substantially so. Then the valve-piston, with the valve-disk and valve-stem, is caused to move in the opposite direction, and the valve is closed. The first part of this closing motion of the valve is rapid; but the latter part of the motion is made gradual by the cushioning action of the water, which is caught or entrapped in the lower part of the valve-chamber between the valve-disk and the valve-seat and valve-stem, as shown at *a'* in Fig. 6. The lower end of the valve-stem enters the discharge-port after the lower edge of the valve-disk passes the upper edge or part of the inlet-openings *b b* and begins to cut off or obstruct the inlet-pipe. As the valve-disk fits closely the surrounding walls of the valve-chamber and the valve-stem fits closely the wall of the discharge-port, the water which is caught or entrapped in the lower part of the valve-chamber below the valve-disk is prevented from flowing out through the discharge-port quickly, as it has to pass through the narrow opening or passage between the valve-stem and the wall of the discharge-port. The motion of the valve-disk is therefore checked at this end of its stroke and made gradual instead of sudden. One result of this feature of the operation is the prevention of the usual water-hammer in the inlet-pipe. It is well known that where a valve is closed suddenly the momentum of the current flowing through it produces a severe water-hammer, which causes a great strain upon all parts of the valve and connections. The pressure immediately back of the closing-valve on the inlet side is considerably increased for the time being by this momentum, as if the water or pressure were piled up behind it. This water-hammer not only increases the wear on the valve, but produces a very disagreeable noise. My improved valve overcomes these difficulties. This slow or gradual closing of the valve is also further secured by the action or effect of the recess *w* in the upper part of the valve-chamber. The valve is enabled to close by the passing of the water between the casing and the valve-piston into the upper part of the valve-chamber. When the valve-piston is in its highest position, it projects some distance into the recess *w*. The narrow passage between the piston and the valve-casing through which the water has to pass is therefore shorter than the length of the piston. As the piston falls, the length of this narrow passage is increased. Consequently the water passes through more slowly than at first, and the closing motion of the valve is checked to some extent and made more gradual.

By making the inlet-openings *b b* in the way described—that is, wide at the top and of gradually-decreasing size toward the bottom—the water-hammer is still more effectually prevented. As the valve-disk passes in front of the wide end of these openings, it cuts off a considerable part of the inflowing current, and then in the latter part of its motion cuts off a smaller and smaller quantity. This also improves the action of the valve.

When a stream of water or other ilquid is

forced through a discharge-port, as *f*, which is smaller in area than the inlet, the water is caused to revolve or whirl rapidly around as it passes through the discharge-port. This causes what is commonly known as "whistling" in the outlet-pipe immediately below the discharge-port and also tends to cut the valve-seat. By providing the outlet-pipe *e* with the contracted opening *s*, smaller in area than the discharge-port, this whistling is prevented, for the reason that a substantial body of water is maintained in the space or chamber between the discharge-port and the ring *s*, which makes the whistling impossible, and the cutting of the valve-seat is also prevented.

By making the valve-lever in two parts, as already described, and connecting these parts by means of notched or toothed disks the arms can be adjusted at any desired angle or in any desired relation, and in this way the throw of the auxiliary valve can be enlarged or diminished.

By employing a bolt provided with an eye to receive the rod connected with the float and providing the disk *o'* with ears to prevent the rod from turning great convenience and economy are secured. Floats are usually made with rods already attached, and these rods vary in size; but any size of rod can be slipped through the eye in this bolt and secured firmly in place. The valve connections are thus adapted to fit any size of float or rod without special adjustment. The ears or lugs prevent the float-rod from turning on the disk *o'*.

I have described the valve as being used for the discharge of water. The valve may be used for the discharge of any other fluid.

The valve-piston and the valve-disk also act as guides to maintain the valve-stem and its connecting parts in their proper position in the valve-chamber. The valve-stem also acts as a guide to maintain the valve-piston in its proper position and to cause it to operate accurately. Thus the valve-piston and the valve-stem coact upon each other, making the operation of the valve more regular and reliable. It is important that the piston, which necessarily fits the valve-chamber closely, should move accurately in the chamber and should not be in the least degree tilted or cramped, for if it should be tilted it would have the effect of partially or wholly closing the thin passage between its sides and the walls of the chamber, and this would prevent the water from escaping into the part of the chamber above the piston and thus entirely prevent or seriously impair the operation of the valve, and, secondly, such tilting of the piston would cause the rapid wearing of the piston and the walls of the chamber and would soon loosen the piston and make it unsuitable for use. Such tilting or cramping might prevent the valve from operating at all. By making the stem fit the discharge-port closely the stem acts as a guide to regulate the motion of the piston and to prevent its tilting, and hence to obviate the difficulties above mentioned. It is likewise important that the stem, which necessarily fits the discharge-port closely, should not be tilted or cramped, but should move accurately, for if it should be tilted it would have the effect of preventing the valve from operating at all or of partially or wholly closing the thin passage between it and the walls of the discharge-port, and this would prevent the water in the cushion from escaping and the valve from successfully operating, and, moreover, the stem would as a result of such cramping quickly wear loose in its bearings. Hence by combining a close-fitting piston with a close-fitting stem the operation of each part is greatly improved and new and highly useful results are secured.

That part of my invention which relates to the combination, with a valve-piston and auxiliary valve, of an arrangement of parts for producing a cushioning action is not limited to a construction in which the water is entrapped between the valve proper and the valve-stem, but includes, broadly, any construction in which a body of water is so caught between some moving part of the valve which fits closely the corresponding part of the valve-shell and the valve-stem, which fits the discharge-port closely.

The recess *w* is shown in the drawings as annular in form. This form is preferred, but of course may be varied without altering the function of the recess.

Having now described my invention, what I desire to secure by Letters Patent is—

1. In a valve device, the combination of a valve chamber provided with a discharge port, an inlet pipe leading to the valve chamber, a valve piston fitting the valve chamber closely, a valve stem fitting the discharge port closely, and operating with the piston so as to open and close the discharge port, an auxiliary outlet leading from the valve chamber above the piston, and an auxiliary controlling valve therefor, substantially as and for the purposes set forth.

2. In a valve device, the combination of a valve chamber provided with a discharge port, an inlet pipe leading to the valve chamber, a valve piston fitting the valve chamber closely, a valve disk, a valve stem which fits the discharge port closely and operates with the piston and disk so as to move into and out of its close fit in the discharge port in such a way as to almost close the discharge port or to make a free passage through it, an auxiliary outlet leading from the valve chamber above the piston, and an auxiliary controlling valve therefor, the piston disk and stem being so arranged that as the valve disk moves to its seat the valve stem moves into close fit with the discharge port so as to form a water cushion between the discharge port and the inlet port, substantially as set forth.

3. In a valve device, the combination of a

valve chamber provided with a discharge port, a valve seat surrounding the discharge port, an inlet pipe leading to the valve chamber above the discharge port, a valve piston and valve disk fitting the valve chamber closely, a valve stem which fits the discharge port closely and operates with the piston and disk so as to move into and out of its close fit in the outlet port, the valve piston, valve disk and valve stem being so arranged that as the valve disk moves to its seat the inlet pipe is obstructed and the valve stem thereafter moves into close fit with the discharge port so as to form a water cushion between the discharge port and the valve disk, substantially as set forth.

4. In a valve device, the combination of a valve chamber provided with a discharge port, a valve seat surrounding the discharge port, an inlet pipe leading to the valve chamber above the discharge port, a valve piston and valve disk fitting the valve chamber closely, a valve stem which fits the discharge port closely and operates with the piston and disk so as to move into and out of its close fit in the outlet port in such a way as to make a free passage through and almost close the outlet port, an auxiliary outlet leading from the valve chamber above the piston and an auxiliary controlling valve therefor, the valve piston, valve disk and valve stem being so arranged that as the valve disk moves to its seat the inlet pipe is obstructed and the valve stem thereafter moves into close fit with the discharge port so as to form a water cushion between the discharge port and the inlet port, substantially as set forth.

5. In a valve device, the combination of a valve chamber provided with a discharge port, a valve seat surrounding the discharge port, an inlet pipe leading to the valve chamber above the discharge port, a valve piston and valve disk fitting the valve chamber closely, a valve stem which fits the discharge port closely and operates with the piston and disk so as to move into and out of its close fit in the outlet port in such a way as to make a free passage through and almost close the outlet port, an auxiliary outlet leading from the valve chamber above the piston and an auxiliary controlling valve therefor, the under side of the valve disk, when the valve is closed, being exposed to the upward pressure of the water which tends to open the valve, and being opposed by the downward pressure of the water above the piston, substantially as set forth.

6. In a valve device, the combination of a valve chamber provided with a discharge port, a valve seat surrounding the discharge port, an inlet pipe leading to the valve chamber above the discharge port, a valve piston and valve disk fitting the valve chamber closely, a valve stem which fits the discharge port closely and operates with the piston and disk so as to move into and out of its close fit in the outlet port in such a way as to make a free passage through and almost close the outlet port, an auxiliary outlet leading from the valve chamber above the piston and an auxiliary controlling valve therefor, the valve piston, valve disk and valve stem being so arranged that as the valve disk moves to its seat the inlet pipe is obstructed and the valve stem thereafter moves into close fit with the discharge port so as to form a water cushion between the discharge port and the inlet pipe, substantially as set forth.

7. In a valve device, the combination of a valve chamber provided with a discharge port, a valve seat surrounding the discharge port, an inlet pipe leading to the valve chamber above the discharge port, large at the inner end and gradually diminishing in size toward the outlet end of the valve, a valve piston and valve disk fitting the valve chamber closely, a valve stem which fits the discharge port closely and operates with the piston and disk so as to move into and out of its close fit in the outlet port in such a way as to make a free passage through and almost close the outlet port, an auxiliary outlet leading from the valve chamber above the piston and an auxiliary controlling valve therefor, the valve piston, valve disk and valve stem being so arranged that as the valve disk moves to its seat the inlet pipe is obstructed and the valve stem thereafter moves into close fit with the discharge port so as to form a water cushion between the discharge port and the inlet pipe, substantially as set forth.

8. In a valve device, the combination of a valve chamber provided with a valve seat surrounding the discharge port, an inlet pipe communicating with the valve chamber at the side and above the valve seat and provided with one or more vertical partitions, a valve disk fitting the valve chamber closely, a valve stem fitting the discharge port closely in such a way as to almost close the discharge port and adapted to move out of its close fit when the valve is open in such a way as to make a free passage through the discharge port, a discharge pipe leading from the discharge port and provided with a contracted opening of less area than the discharge port, the valve disk and valve stem being so arranged that as the valve disk moves to its seat the inlet pipe is obstructed and thereafter the valve stem comes into close fit with the discharge port so as to form a water cushion between the discharge port and inlet pipe, substantially as set forth.

9. In a valve device, the combination of an inlet pipe, a valve chamber having a recess *w* at its upper end, a valve seat surrounding the discharge port, a valve piston fitting the

inner part of the valve chamber closely and adapted to extend into the recess when the valve is open, an auxiliary outlet leading from the valve chamber above the valve piston, and an auxiliary valve to control the auxiliary outlet, substantially as set forth.

10. In a valve device, the combination of an inlet pipe, a valve chamber having a recess *w* at its upper end, a valve seat surrounding the discharge port, a valve piston fitting the inner part of the valve chamber closely and adapted to extend into the recess, when the valve is open, an auxiliary outlet leading from the valve chamber above the valve piston, an auxiliary valve to control the auxiliary outlet, a valve disk fitting the outer end of the valve chamber closely and a valve stem supporting the valve disk and the valve piston, and adapted to fit the discharge port closely, substantially as set forth.

11. In a valve device, the combination of an inlet pipe, a valve chamber, and an inlet opening between the two, divided by one or more partitions running in a direction parallel with the axis of the valve disk, whereby the inflowing current is diverted and prevented from striking directly against the valve, substantially as set forth.

12. In a valve device, the combination of an inlet pipe, a valve chamber, inlet openings connecting the two, large at their inner ends and gradually diminishing in size toward the discharge end, a piston fitting the inner end of the valve chamber closely, an auxiliary outlet connected with the valve chamber above the valve piston, an auxiliary valve controlling said outlet, a valve lever connected with the auxiliary valve, consisting of two parts provided with toothed or notched disks adapted to fit into each other and suitable means for fastening the disks together in any fixed position, said valve lever being pivoted at one end, a float attached to the valve lever, a valve seat surrounding the discharge port of the valve, a valve disk fitting the outer end of the valve chamber closely, a valve stem supporting the valve piston and valve disk and adapted at its lower end to fit the discharge port closely, and an annular ring in the outlet pipe beyond the discharge port, having an opening less in area than the area of the discharge port, forming a chamber between the discharge port and the ring, all substantially as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

FRANK W. FOSTER.

Witnesses:
JOHN E. ABBOTT,
WILLIAM A. MOORE.