

No. 754,467.

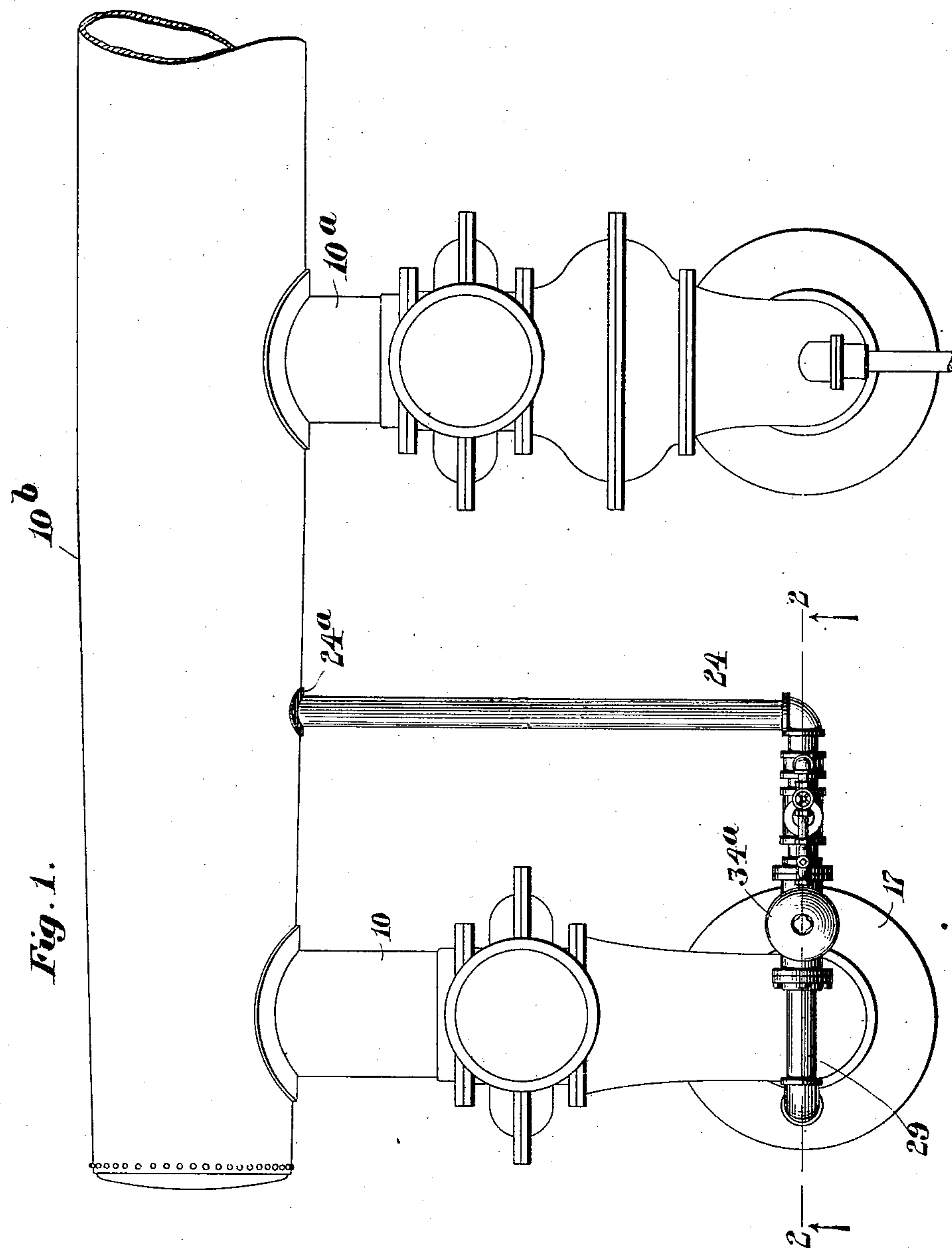
PATENTED MAR. 15, 1904.

N. LOMBARD.
RELIEF VALVE.

APPLICATION FILED AUG. 11, 1902.

NO MODEL.

4 SHEETS—SHEET 1.



Witnesses:
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Inventor:
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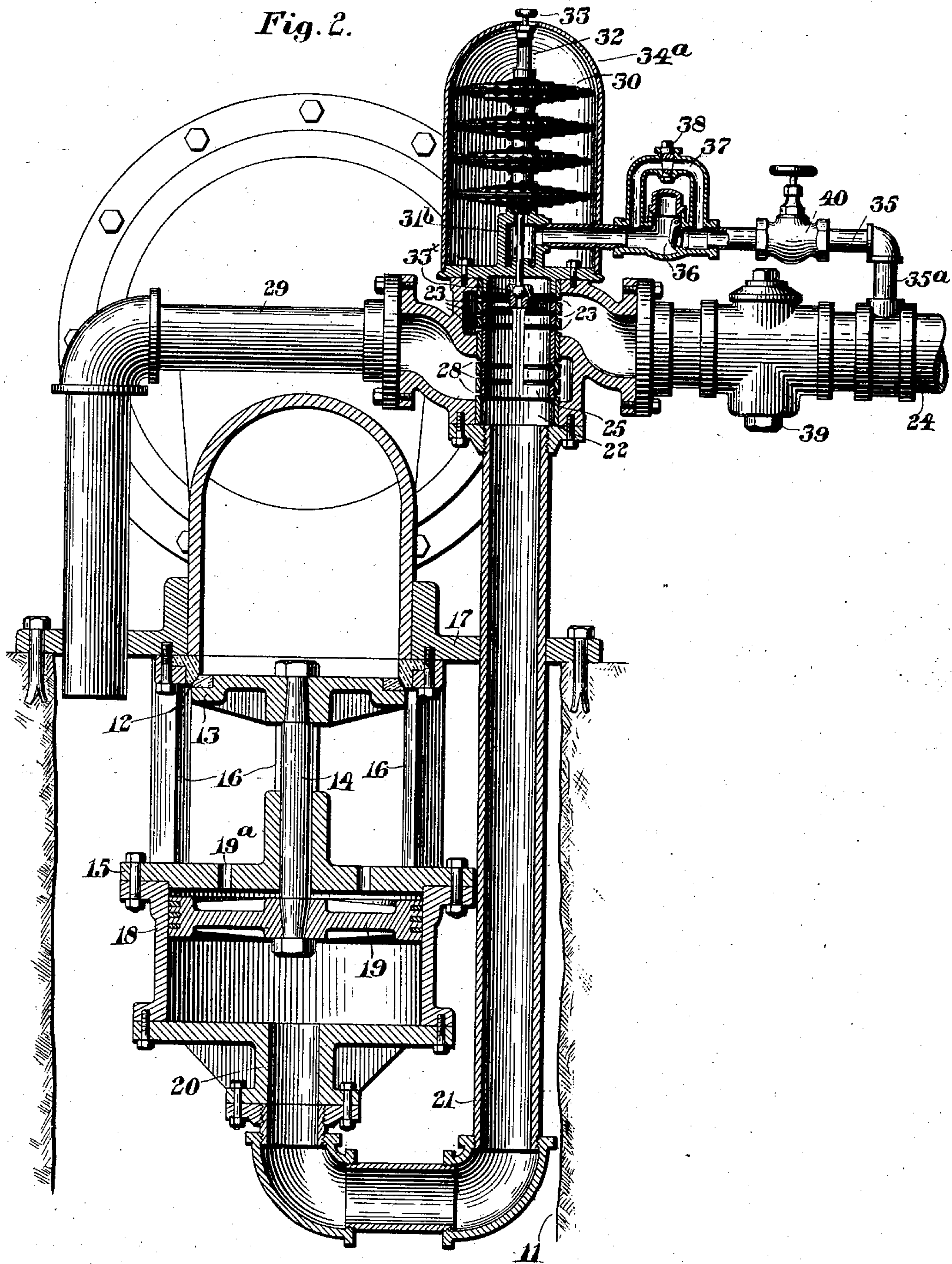
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4 SHEETS—SHEET 2.

Fig. 2.



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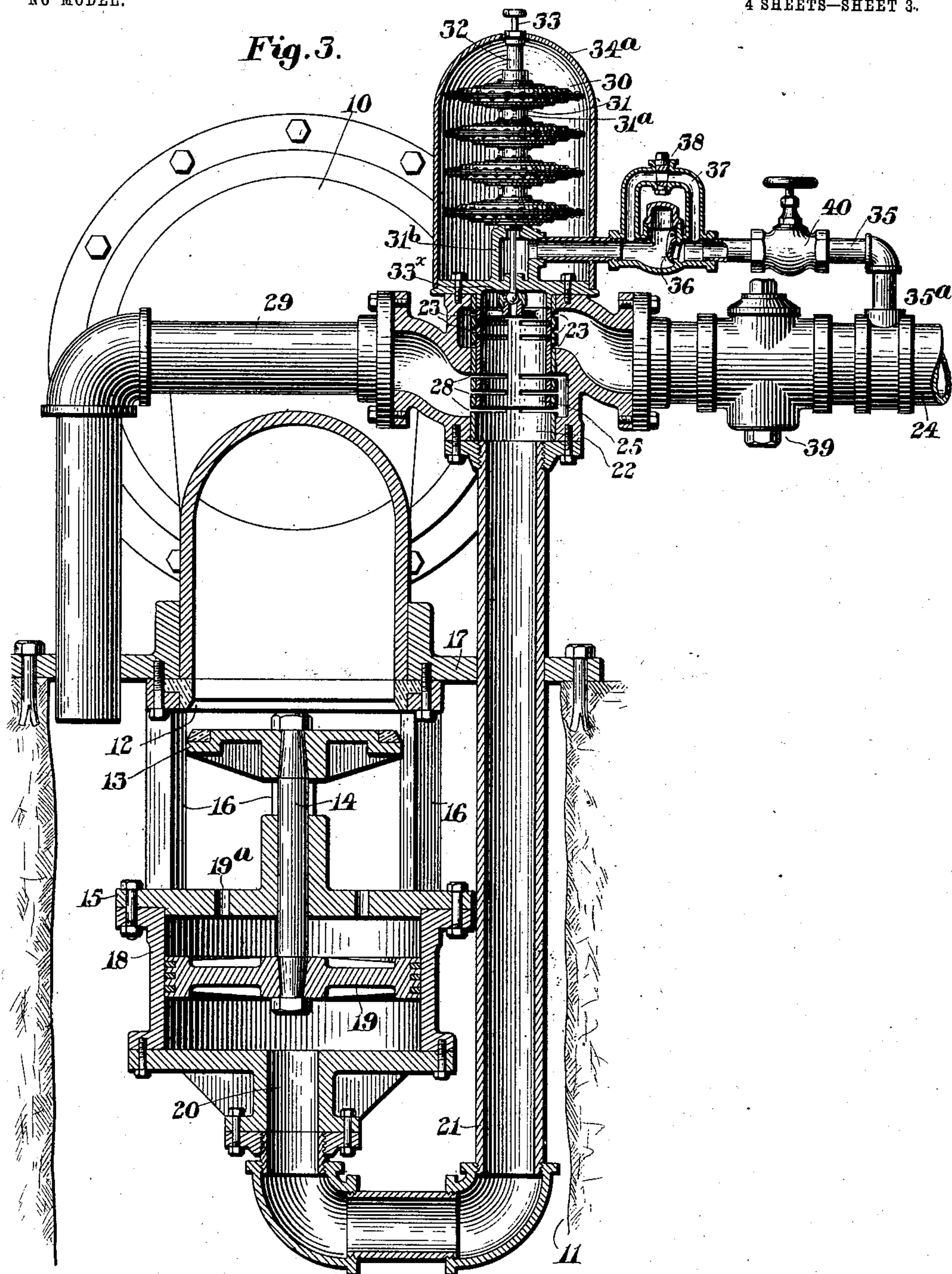
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4 SHEETS—SHEET 3.



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4 SHEETS—SHEET 4.

Fig. 4.

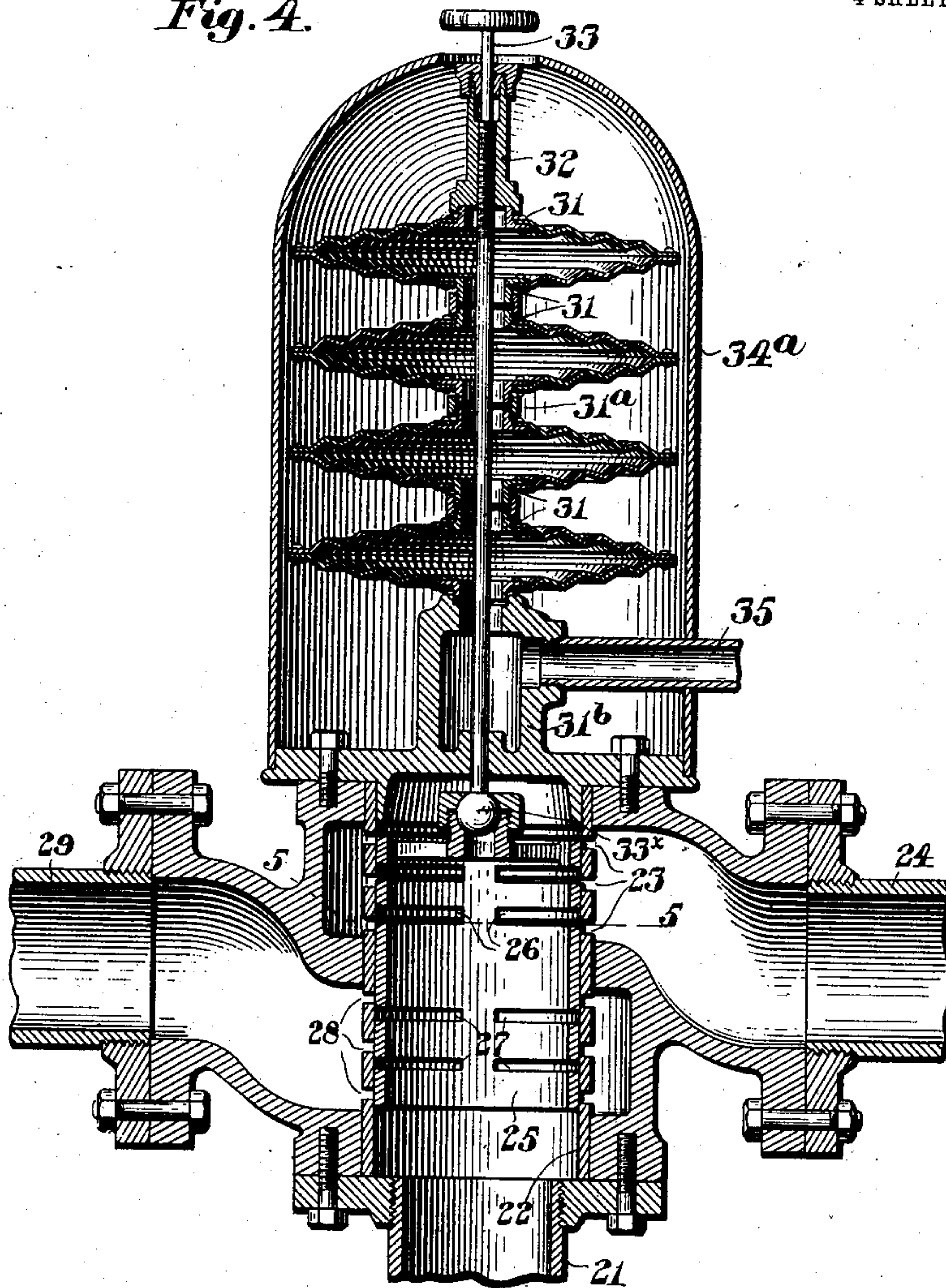
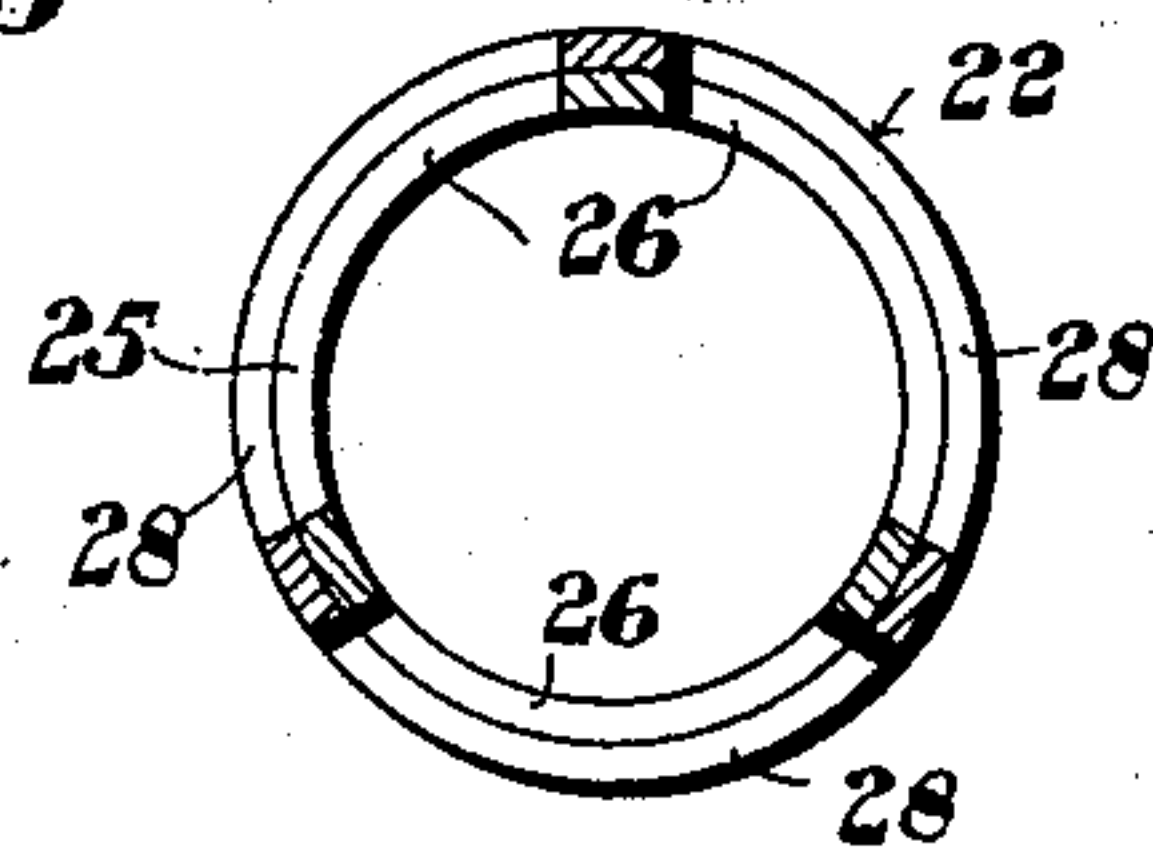


Fig. 5.



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UNITED STATES PATENT OFFICE.

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TO THE N. LOMBARD IMPROVED GOVERNOR COMPANY, OF BOSTON,
MASSACHUSETTS, A CORPORATION OF MAINE.

RELIEF-VALVE.

SPECIFICATION forming part of Letters Patent No. 754,467, dated March 15, 1904.

Application filed August 11, 1902. Serial No. 119,151. (No model.)

To all whom it may concern:

Be it known that I, NATHANIEL LOMBARD, a citizen of the United States of America, and a resident of Brookline, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in Relief-Valves, of which the following is a specification.

My invention relates to devices for relieving a fluid system of undue pressure, being particularly adapted for use in hydraulic systems to prevent the shocks or water-hammer arising from the closure of valves controlling the flow to turbines or the like in governing their speed or when shutting down.

It has for its objects the various features hereinafter described and claimed.

In the accompanying drawings, Figure 1 is a top plan view of a portion of a system to which is applied one form of my invention. Fig. 2 is an enlarged vertical section on the line 2 2 of Fig. 1, the parts being shown in their normal position. Fig. 3 is a similar view with the relief-valve open. Fig. 4 is a still further enlarged vertical sectional detail through the controlling-valve and actuator therefor, and Fig. 5 is a horizontal sectional detail on the line 5 5 of Fig. 4.

Similar characters indicate like parts throughout the several figures of the drawings.

Conduits, such as the feed-pipes of a turbine or like power system, are designated by the numerals 10 10^a, they being shown in the present instance as leading from a main conduit or penstock 10^b. One of these, here shown as 10, delivers into a passage 11, which may lead to the tail-race. Formed upon or secured to the end of this conduit is a seat 12 for the disk 13 of a relief-valve, which is arranged to open under abnormal pressure in the system. For this purpose the disk is mounted upon a spindle 14, sliding in a bearing-plate 15, supported by rods 16, depending from a plate 17, which may close the top of the passage 11 and support the end of the conduit. Upon the under side of the bearing-plate is mounted a chamber or cylinder 18, in which operates a piston 19 of greater area than the portion of the valve-

plate in normal contact with the fluid in the conduit and fast upon the spindle. Openings 19^a through the bearing-plate may be provided to permit the escape of any fluid which may leak by the edge of the piston. With an opening 20, preferably in the lower wall of the cylinder, communicates a pipe 21, which may pass upward through the plate 17 to a casing 22, through a series of circumferential openings 23, in the side of which it communicates with a supply-pipe 24, opening into the system at any convenient point, as into the penstock at 24^a. These pipes deliver the fluid-pressure to the relief-valve piston, and on account of the greater area thereof the valve will be normally held to its seat and the end of the conduit closed.

In conjunction with the casing 22 operates a controlling-valve 25, here shown as a hollow cylinder mounted for reciprocation within said casing. This valve is provided with a series of circumferential openings 26, adapted to register with openings 23 in the casing, and a second set of circumferential openings 27 in the valve may also register in certain positions with casing-openings 28, communicating with a discharge-pipe 29, conveniently terminating in the passage 11.

Above the casing is mounted an actuator for the controlling-valve, which preferably consists of diaphragm mechanism, here shown as consisting of a plurality of thin corrugated metal plates 30, secured together at their edges in pairs to form substantially water-tight expansible chambers. The adjacent chambers are connected in a communicating series by flanged collars 31, secured to the diaphragm-plates and connected by threaded collars 31^a. The diaphragm-chamber nearest the controlling-valve may be supported about an opening into a chamber or hollow base 31^b above the valve-casing. To the diaphragm farthest from the controlling-valve may be secured a sleeve 32, through which is threaded a connector or rod 33, extending through the collars 31, passing through a fluid-tight bearing in the bottom of said base and joined with the valve by some such connection as a ball

and socket 33^x. The diaphragms may be protected by a covering or casing 34^a, through an opening in the top of which the rod 33 may project to make it easily accessible for adjustment.

Into the chamber 31^a leads a pipe 35, opening into the system at any point where it may be constantly under the fluid-pressure, as at 35^a, in the supply-pipe, and in this pressure-pipe is a check-valve 36, (shown as of the swinging type,) which permits the pressure to be freely communicated to the diaphragm-chambers, but regulates the diminution of pressure by compelling the backflow to occur through a by-pass pipe 37, opening into the pressure-pipe on each side of the check-valve. In the pipe 37 is preferably a valve 38. Valves 39 and 40 may be provided to close, respectively, the supply and pressure pipe when the relief-valve is to be put out of operation.

The valves 39 and 40 being open, the position of the rod 33 will be adjusted to enable the fluid-pressure in the diaphragm-chambers to hold the passages through the openings 23 and 26 slightly open, admitting the pressure through the supply-pipe and pipe 21 to the piston-chamber and keeping the relief-valve firmly closed. At this time the valve-openings 27 lie at one side of the casing-openings 28, and connection with the discharge-pipe is therefore cut off. Now if for any cause the pressure in the system becomes abnormal it will be transmitted through the pressure-pipe to the diaphragm-chambers, which will each expand, moving the controlling-valve through a distance equal to the sum of the individual expansions. This will close the passages from the supply-pipe into the valve-casing, shutting off the pressure from the piston of the relief-valve and open those into the discharge-pipe, which will at once cause the pressure within the conduit to force down the valve-plate and permit the escape of water from the conduit into the passage 11, relieving the pressure on the system. The water behind the piston will pass out through the discharge-pipe and also escape into the passage. It is evident that there would be a tendency for the sudden release of fluid from the system to diminish the pressure upon the diaphragms and abruptly shift the controlling-valve, which would in turn because of the sudden resulting closure of the relief-valve increase the pressure upon the diaphragms, causing the valves to rapidly oscillate back and forth and set up a water-hammer, which might destroy some part of the system. This is effectually prevented by the fact that the check-valve compels any decrease of pressure upon the diaphragms to take place with comparative slowness through the by-pass, the valve therein being properly adjusted, enabling the system to gradually resume its normal condition.

It will be seen that my improved relief-valve is both simple and sensitive, acting with cer-

tainly under a slight increase of pressure and absolutely guarding against the evil cumulative effect of rapid successive diminutions of pressure arising from the action of the valve itself.

Having thus described my invention, I claim—

1. The combination with a conduit system, of a relief-valve therein, a piston for operating the relief-valve, a chamber in which the piston is contained, a casing, a pipe leading from the lower end of the casing to the piston-chamber, a supply-pipe from the conduit system delivering through openings in the side of said casing, a discharge-pipe communicating through other side openings with the casing, a hollow reciprocatory valve having openings adapted to register with those leading to the supply-pipe and discharge-pipe, an actuator for the reciprocatory valve consisting of an expansible chamber, and a connector between said actuator and said controlling-valve.

2. The combination with a conduit system, of a relief-valve therein, a piston for operating the relief-valve, a chamber in which the piston is contained, a casing provided with a series of inlet-ports, a pipe leading from the lower end of the casing to the piston-chamber, a supply-pipe from the conduit system delivering through the ports in the side of the casing, and a hollow reciprocatory valve having a corresponding number of ports adapted to register with those leading to the supply-pipe.

3. The combination with a conduit system, of a relief-valve, a piston for operating the relief-valve, a chamber in which the piston is contained, a casing provided with a series of outlet-ports, a pipe leading from the lower end of the casing to the piston-chamber, a discharge-pipe from said chamber communicating through the ports in the side of said casing, and a hollow reciprocatory valve having a corresponding number of ports adapted to register with those leading to said discharge-pipe.

4. The combination with a conduit system, of a relief-valve therein, a piston for operating the relief-valve, a chamber in which the piston is contained, a casing, a pipe leading from the end of the casing to the piston-chamber, a supply-pipe from the conduit system delivering through openings in the side of the casing, a discharge-pipe communicating through other side openings with the casing, and a hollow reciprocatory valve having openings adapted to register with those leading to the supply-pipe and discharge-pipe.

5. The combination with a conduit system, of a relief-valve therein, a piston for operating the relief-valve, a chamber in which the piston is contained, a casing, a pipe leading from the end of the casing to the piston-chamber, a supply-pipe from the conduit sys-

tem delivering through openings in the side of the casing, a discharge-pipe communicating through other side openings with the casing, a hollow reciprocatory valve having
 5 openings adapted to register with those leading to the supply-pipe and the discharge-pipe, and automatic means for reciprocating the valve.

6. The combination with a conduit, of a relief-valve therein, means for applying fluid-pressure to retain the relief-valve normally closed, a valve controlling the application of pressure, an actuator for the controlling-valve, means for admitting pressure to the ac-
 10 tuator, and a check-valve and a relatively restricted passage coöperating to regulate the diminution of pressure upon the actuator.

7. The combination with a conduit, of a relief-valve therein, means for applying fluid-pressure to retain the relief-valve normally closed, a valve controlling the application of pressure, an actuator for the controlling-valve, a pipe for admitting pressure to the ac-
 20 tuator, a check-valve in said pipe and a by-pass about the check-valve and a valve in said by-pass.

8. The combination with a conduit, of a relief-valve therein, means for applying fluid-pressure to retain the relief-valve normally closed, a valve controlling the application of pressure, an actuator for the controlling-valve, means for admitting pressure to the ac-
 30 tuator, a check-valve, a by-pass about the check-valve, and means for controlling the movement of fluid through the by-pass.

9. The combination with a conduit adapted to contain fluid under pressure, of a relief-valve therein, a piston for operating the relief-valve, a chamber in which the piston is con-
 40 tained, a pipe leading to the chamber, a valve controlling the flow through the pipe, a diaphragm forming at least one wall of a chamber, a pipe delivering to the diaphragm-chamber the fluid-pressure of the conduit, a check-
 45 valve in said pressure-pipe opening in the direction of the diaphragm-chamber and a relatively restricted passage connecting the pipe on either side of said check-valve.

10. The combination with a conduit adapted to contain fluid under pressure, of a relief-valve therein, a piston for operating the relief-valve, a chamber in which the piston is con-
 50 tained, a pipe leading to the chamber, a valve controlling the flow through the pipe, a diaphragm forming at least one wall of a chamber, a pipe delivering to the diaphragm-chamber the fluid-pressure of the conduit, a check-
 55 valve in said pressure-pipe opening in the direction of the diaphragm-chamber, and a relatively restricted pipe opening into the pressure-pipe on each side of the check-valve.

11. The combination with a conduit adapted to contain fluid under pressure, of a relief-valve therein, a piston for operating the relief-
 65 valve, a chamber in which the piston is con-

tained, a pipe leading to the chamber, a valve controlling the flow through the pipe, a diaphragm forming at least one wall of a chamber, a pipe delivering to the diaphragm-chamber the fluid-pressure of the conduit, a check-
 70 valve in said pressure-pipe opening in the direction of the diaphragm-chamber, a pipe opening into the pressure-pipe on each side of the check-valve, and a valve in this last-named pipe.

12. The combination with a conduit, of a relief-valve therein, a piston for operating the relief-valve, a chamber in which the piston is contained, a pipe leading to the chamber, a valve controlling the flow through the pipe, a
 80 plurality of diaphragms forming expansible chambers, a connection between one of the diaphragms and the controlling-valve, a supply-pipe to said diaphragm mechanism, a check-valve in said supply-pipe, and a rela-
 85 tively restricted by-pass about said check-valve.

13. The combination with a conduit, of a relief-valve therein, means for applying fluid-pressure to retain the relief-valve normally closed, a valve controlling the application of pressure, an actuator for the controlling-valve consisting of an expansible chamber, a con-
 90 nector between said actuator and said controlling-valve, a supply-pipe admitting pressure to said expansible chamber, means for permitting the free passage of fluid through the pipe to the actuator, and means for re-
 95 stricting the passage of the fluid in the opposite direction.

14. The combination of a supply-pipe, a valve-chamber for said supply-pipe, a valve in said chamber adapted to regulate the flow of fluid, an expansible chamber above said valve-
 105 chamber and separated therefrom by a partition provided with a fluid-tight bearing, a valve-rod connecting the top of said expansible chamber to said valve and passing through said bearing, and a pipe from the fluid-sup-
 110 ply leading to said expansible chamber for the admission and exit of the fluid.

15. The combination of a supply-pipe, a valve-chamber for said supply-pipe, a valve in said chamber adapted to regulate the flow of fluid, a hollow base above said valve-chamber
 115 and separated therefrom by a partition provided with a fluid-tight bearing, a valve-rod secured to said valve and passing through said bearing, an expansible chamber secured to said hollow base and communicating therewith
 120 and having its upper portion secured to the end of said valve-rod whereby said valve will be governed in its movement by the expansion and contraction of said expansible chamber, and a pipe from the fluid-supply leading
 125 to said base for the admission and exit of the fluid.

16. The combination of a supply-pipe, a valve-chamber in said supply-pipe, a valve in said chamber adapted to regulate the flow of
 130

fluid, a hollow base above said valve-chamber and separated therefrom by a partition provided with a fluid-tight bearing, a valve-rod secured to said valve and passing through said bearing, an expansible chamber secured to said hollow base and communicating therewith and having its upper portion secured to the end of said valve-rod whereby said valve will be governed in its movement by the expansion and contraction of said expansible chamber, a pipe from the fluid-supply leading to said base for the admission and exit of the fluid, and means for adjusting the position of said valve-rod relative to said expansible chamber.

17. The combination of a supply-pipe, a valve-chamber in said supply-pipe, a valve in said chamber adapted to regulate the flow of fluid, a hollow base above said valve-chamber and separated therefrom by a partition provided with a fluid-tight bearing, a valve-rod secured to said valve and passing through said bearing, a plurality of oval diaphragm-chambers, the lower of which is secured to said hollow base and communicates therewith, tubular necks connecting the same at their centers whereby they all expand in unison, means for adjustably connecting the upper diaphragm-chamber to said valve-rod which passes through said chambers and necks, and a pipe from the fluid-supply communicating with said base for the admission and exit of the fluid.

18. The combination with a conduit, of a relief-valve therein, means for applying fluid-pressure to retain the relief-valve normally closed, a supply-pipe, a valve in said supply-pipe controlling the application of pressure, a diaphragm-chamber above said valve and separated therefrom by a partition and composed of top and bottom portions riveted together at their edges, said top and bottom portions being normally curved outwardly and having an annular depression or groove at or near the outer portion thereof, a rod connecting said valve with the upper portion of said chamber and passing through a fluid-tight bearing in said partition, and a secondary fluid-passage from the fluid-supply communicating with said diaphragm-chamber.

19. The combination with a conduit, of a relief-valve therein, means for applying fluid-pressure to retain the relief-valve normally closed, a supply-pipe, a valve in said supply-pipe controlling the application of pressure, a diaphragm-chamber composed of top and bottom portions riveted together at their edges, said top and bottom portions being normally curved outwardly and having a series of annular depressions or grooves therein, a partition between said supply-pipe and said diaphragm-chamber, a rod connecting said valve with the upper portion of said chamber and provided with a fluid-tight bearing in said partition, and a pipe from the fluid-supply com-

municating with said diaphragm-chamber for the admission and exit of the fluid.

20. The combination with a conduit, of a relief-valve therein, means for applying fluid-pressure to retain the relief-valve normally closed, a supply-pipe, a hollow base, a pipe from the fluid-supply leading to said base for the admission and exit of fluid, an expansible chamber mounted upon and communicating with said hollow base, a valve-rod secured to the upper portion of said expansible chamber and passing through a fluid-tight bearing in the bottom of said hollow base, and a valve in said supply-pipe secured to said rod below said base adapted to regulate the flow of fluid to operate said relief-valve and governed in its movement by the expansion and contraction of said expansible chamber.

21. The combination with a conduit, of a relief-valve therein, means for applying fluid-pressure to retain the relief-valve normally closed, a supply-pipe, a hollow base, a pipe from the fluid-supply leading to said base for the admission and exit of the fluid, an expansible chamber mounted upon and communicating with said hollow base, a valve-rod secured to the upper portion of said expansible chamber, a partition between said supply-pipe and said expansible chamber provided with a fluid-tight bearing for said valve-rod, means for adjusting the position of said rod relative to said expansible chamber, and a valve in said supply-pipe secured to said rod adapted to regulate the flow of fluid to operate said relief-valve and governed in its movement by the expansion and contraction of said expansible chamber.

22. The combination with a conduit, of a relief-valve therein, means for applying fluid-pressure to retain the relief-valve normally closed, a supply-pipe, a valve in said supply-pipe controlling the application of pressure, a plurality of oval metallic diaphragm-chambers, the interior of each of said chambers being in communication with each other, a support for said chambers, a valve-rod passing through the communicating passages and connecting with the upper portion of the upper chamber and with the said controlling-valve, a partition between said diaphragm-chambers and said supply-pipe provided with a fluid-tight bearing for said valve-rod, and means connected with the fluid-supply for permitting the inlet of fluid-pressure to said chambers and an outlet for said fluid-pressure whereby said chambers are caused to expand or contract according to requirement.

23. The combination with a conduit, of a relief-valve therein, means for applying fluid-pressure to retain the relief-valve normally closed, a plurality of oval diaphragm-chambers, tubular necks connecting the same at their centers whereby they all expand in unison, a valve-stem depending from the top of

the uppermost chamber, means acting on the upper surface of the uppermost chamber for adjusting the position of the valve-stem, a supply-pipe, a partition between said supply-pipe and said diaphragm-chambers provided with a fluid-tight bearing for said valve-stem, a valve controlling the application of pressure carried by the lower end of said stem, said stem being passed through said chambers and necks, and a pipe from the fluid-supply communicating with said diaphragm-chambers for the admission and exit of fluid.

24. The combination with a conduit, of a relief-valve therein, means for applying fluid-pressure to retain the relief-valve normally closed, a supply-pipe therefor, a plurality of oval diaphragm-chambers, tubular necks connecting the same at their centers whereby they

all expand in unison, a valve-stem depending from the top of the uppermost chamber, means for adjusting the position of said rod, a partition between said supply-pipe and said diaphragm-chambers provided with a fluid-tight bearing for said valve-rod, a valve controlling the application of pressure carried by the lower end of said stem, said stem being passed through said chambers and necks, and a pipe from the fluid-supply communicating with said diaphragm-chambers for the admission and exit of fluid.

Signed by me at Boston, Massachusetts, this 8th day of August, 1902.

NATHANIEL LOMBARD.

Witnesses:

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WILLIAM B. WOLFENDALE.