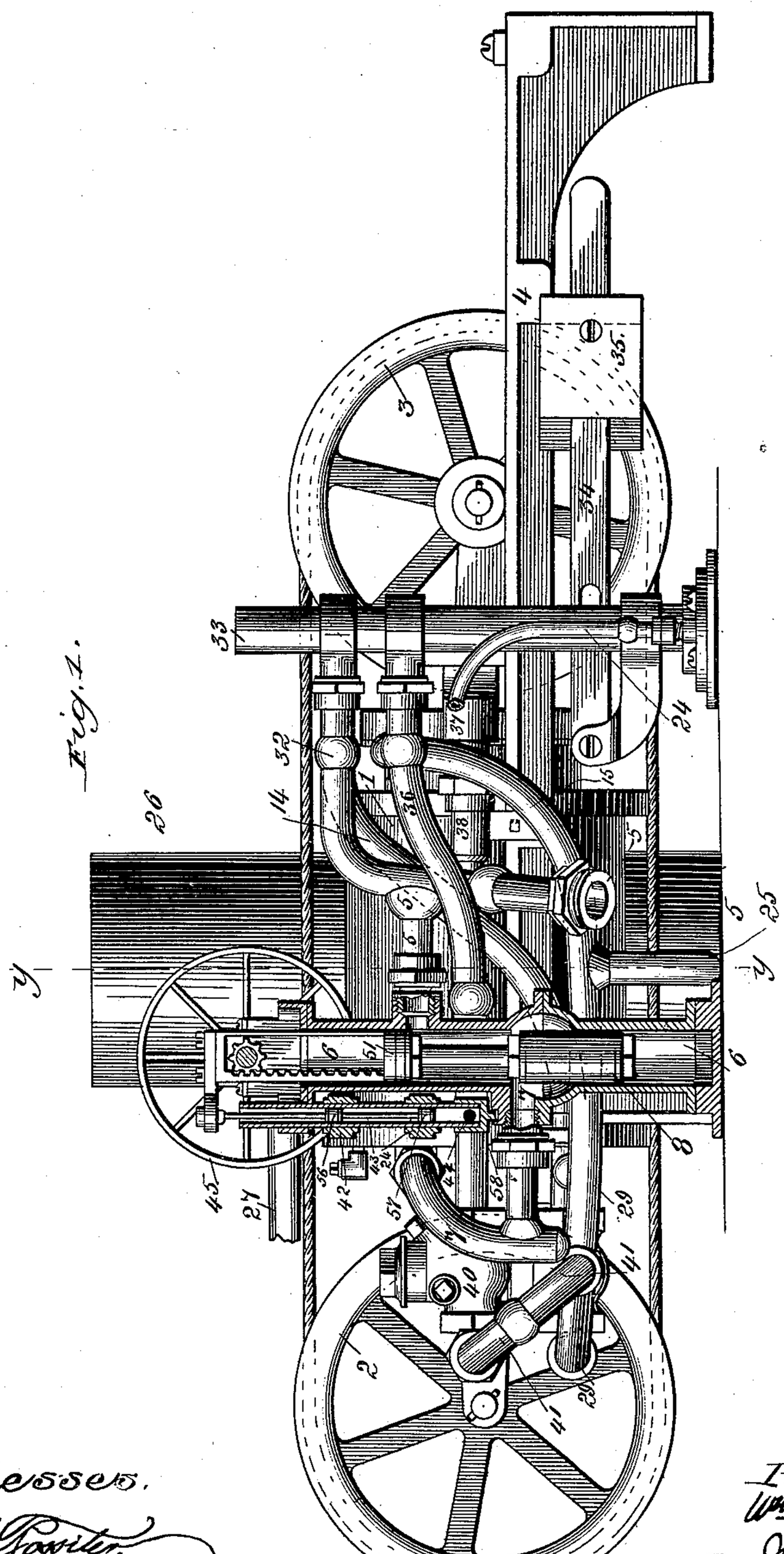
(No Model.) 6 Sheets—Sheet 1.

W. T. FOX.

HYDRAULIC ELEVATOR.

No. 384,436. Patented June 12, 1888.

Fig. 1.



Witnesses.
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(No Model.) 6 Sheets—Sheet 2.

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HYDRAULIC ELEVATOR.

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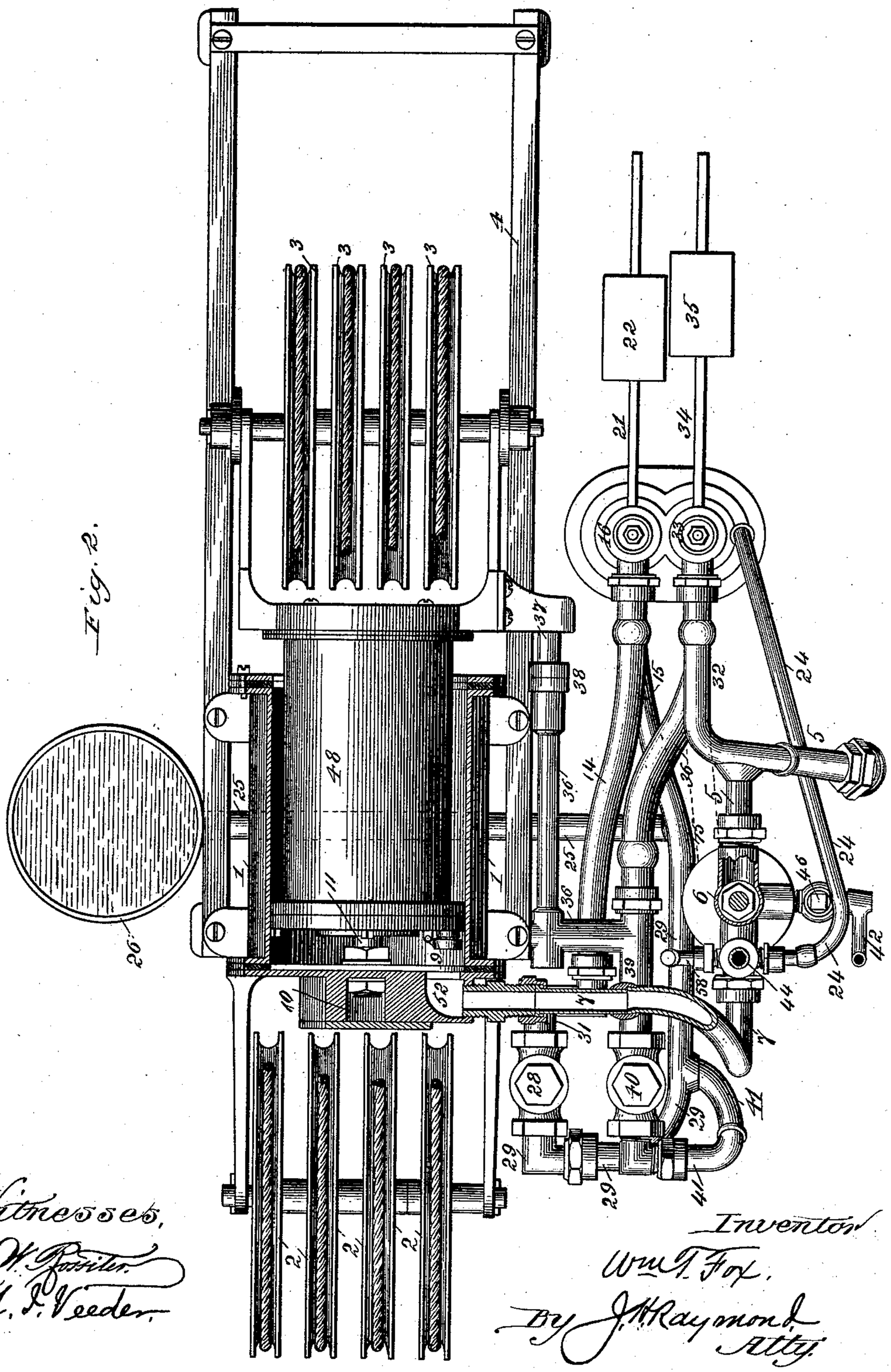
Fig. 2.



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(No Model.) W. T. FOX. 6 Sheets—Sheet 3.

HYDRAULIC ELEVATOR.

No. 384,436. Patented June 12, 1888.

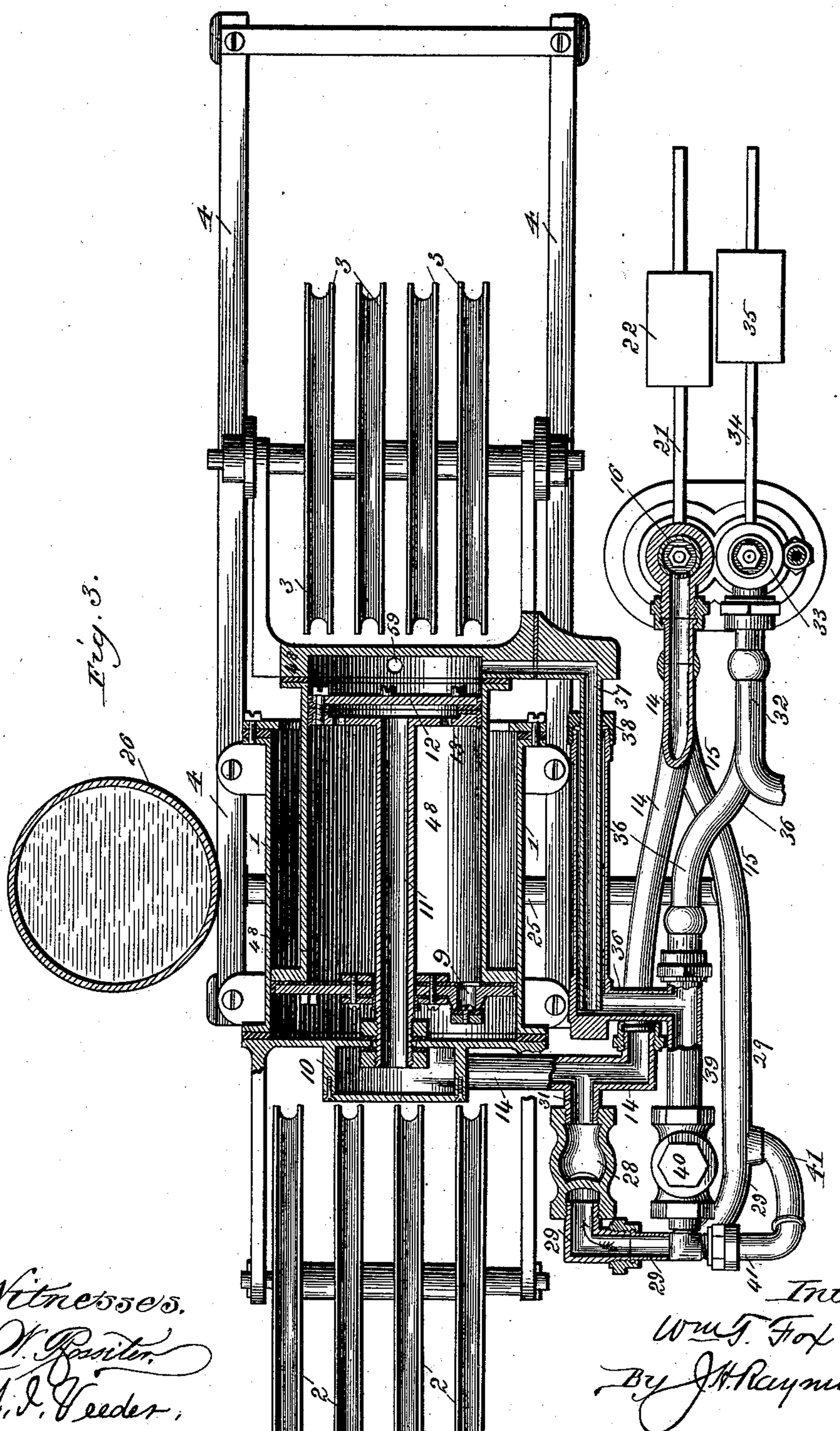

Fig. 3.

Witnesses.
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HYDRAULIC ELEVATOR.

No. 384,436. Patented June 12, 1888.

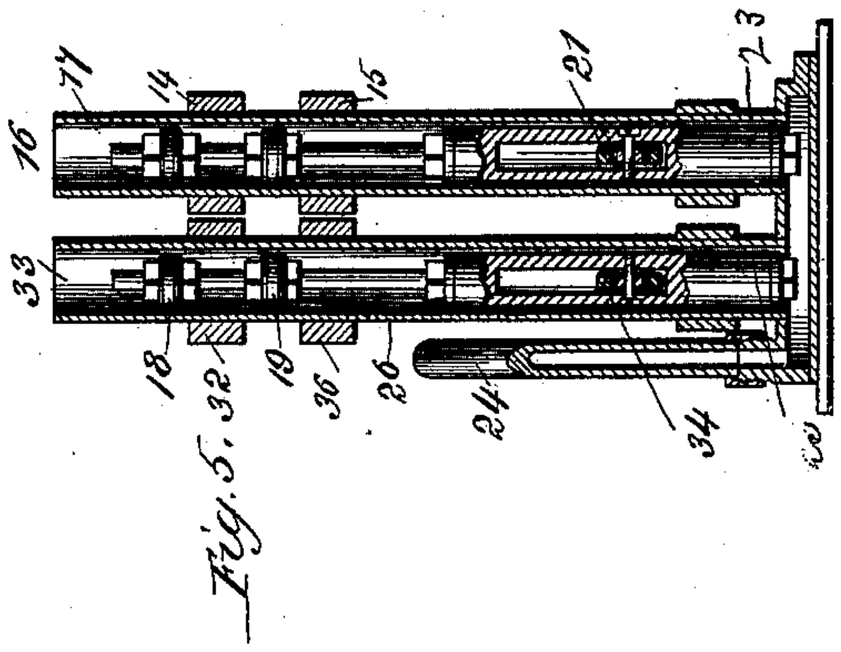


Fig. 5.

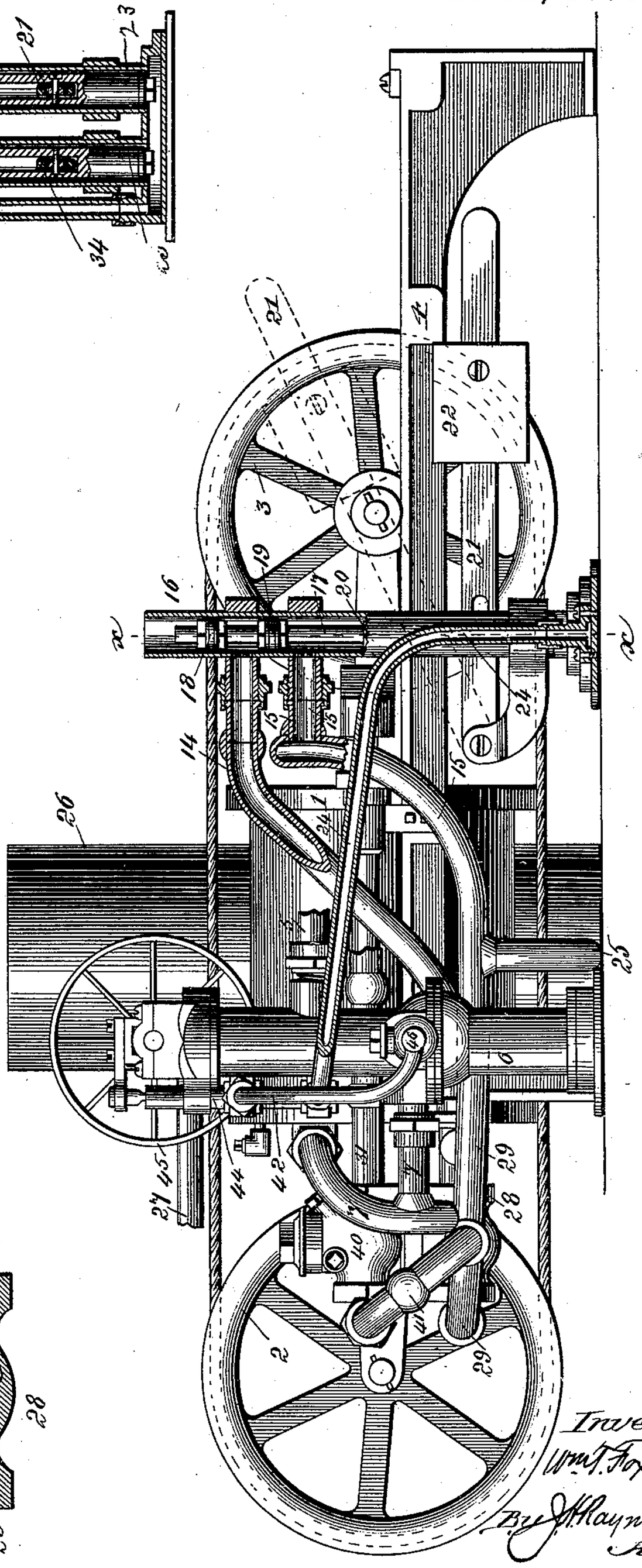
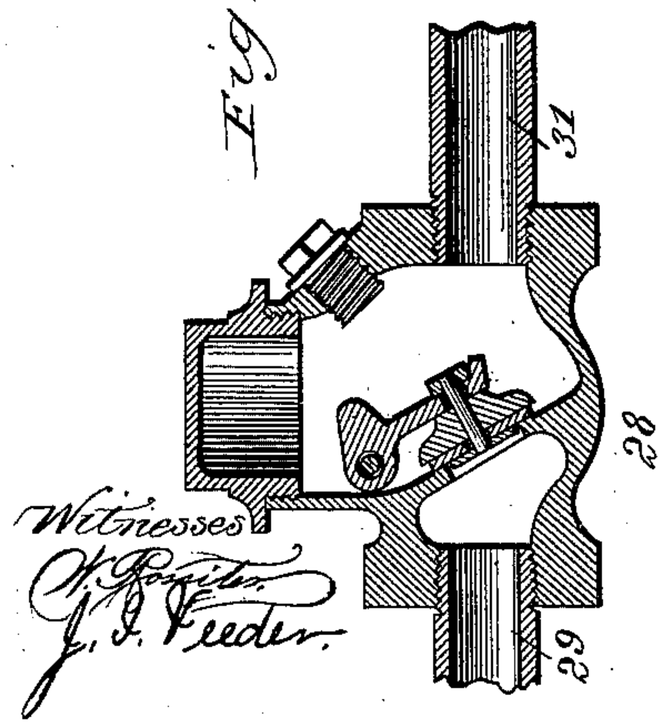


Fig. 4.

Fig. 6.



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6 Sheets—Sheet 5.

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HYDRAULIC ELEVATOR.

No. 384,436. Patented June 12, 1888.

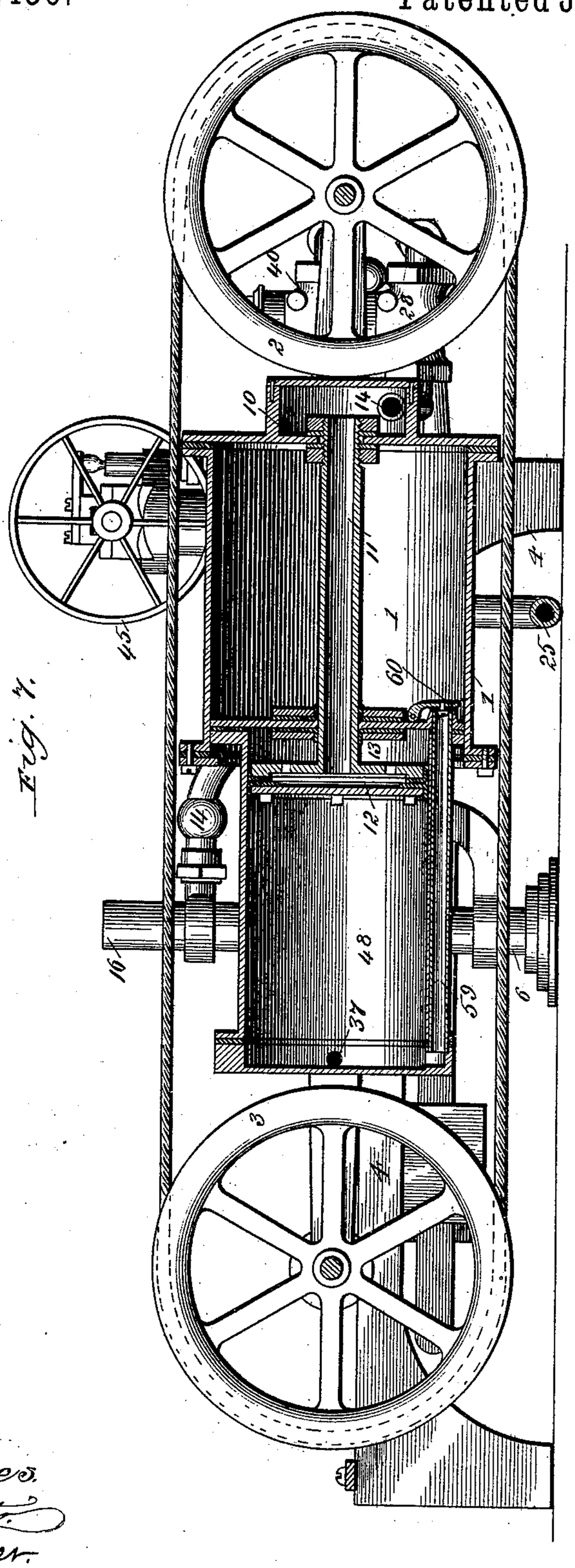

Fig. 1.

Witnesses.
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HYDRAULIC ELEVATOR.

No. 384,436. Patented June 12, 1888.

Fig. 8.

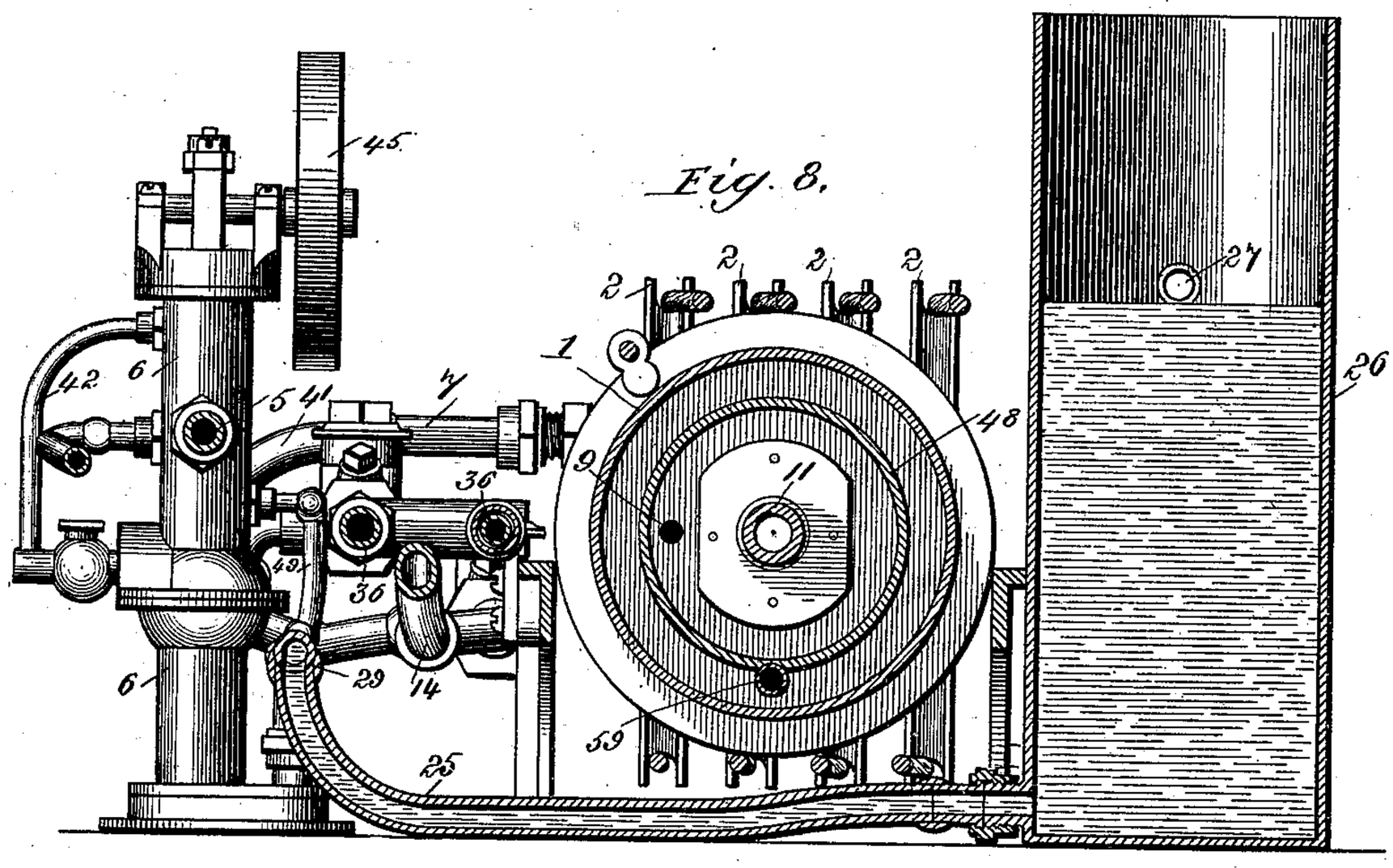


Fig. 9.

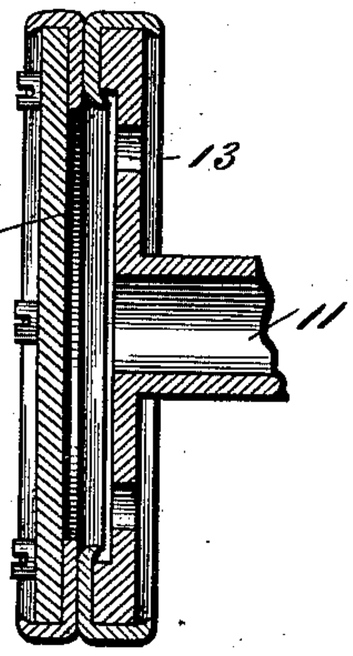
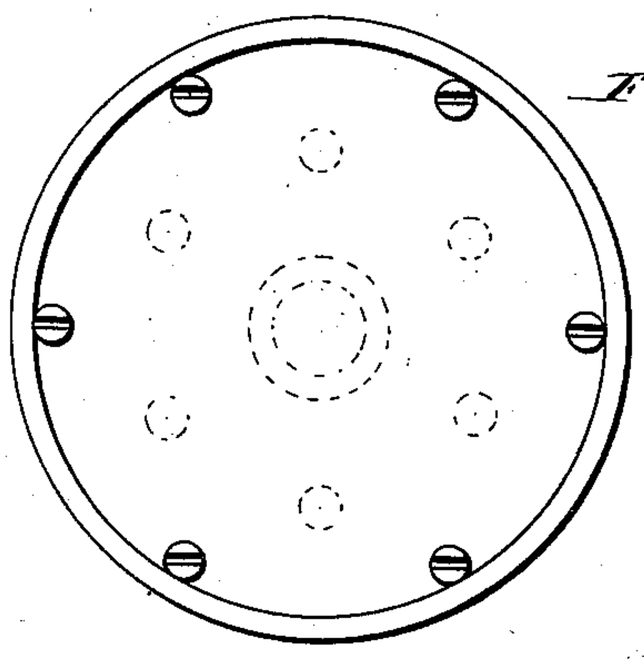


Fig. 10.



Witnesses.
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UNITED STATES PATENT OFFICE.

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HYDRAULIC ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 384,436, dated June 12, 1888.

Application filed December 9, 1887. Serial No. 257,411. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM T. FOX, of Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Hydraulic Elevators, of which the following is a specification.

My invention relates to elevators in which the effective cylinder area and the quantity of water or the non-elastic fluid is variable to suit the load to be raised, and is shown as applied to an elevator constructed in a substantially similar manner to those described in previous United States Patents to me, to wit: No. 355,159, dated December 28, 1886, and No. 369,703, dated September 13, 1887.

My invention has for its object the automatic adjustment of the power applied and water used to the load, so that the elevator-attendant shall, by the shifting of the handling-gear, (to a uniform extent and in a uniform manner,) apply a force which is varied to correspond with demands upon the machine.

My invention consists in the parts and combinations hereinafter described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a side view, partly in section, of an elevator-engine embodying my invention. Fig. 2 is a top view, partly in section, of the same. Fig. 3 is a horizontal section through the cylinders and a part of the pipes, also showing some of the connections in perspective. Fig. 4 is a view from the same side as Fig. 1, some of the pipes being removed and some parts shown in section. Fig. 5 is a cross-section on line *x x*, Fig. 4. Fig. 6 is a section of valve 28, showing the direction in which it opens. Fig. 7 is a vertical section, viewed from the side opposite to the one shown in Fig. 1. Fig. 8 is an end cross section through *v v*, Fig. 1. Figs. 9 and 10 are sections and end views, respectively, of the piston 12.

The main and auxiliary cylinders and the hollow piston have been described as to their essential features in the patents before referred to, but will be briefly described herein.

1, Fig. 1, is the main cylinder, which contains the auxiliary cylinder and the hollow piston, which are shown in subsequent figures.

2 are the fixed pulleys, over which the hoisting-cable passes.

3 are the movable pulleys supported on guides 4.

The arrangement of the cable on the pulleys and its attachment to the elevator do not differ from that in common use.

5 is the water-inlet pipe, which is connected to any source of supply, usually a tank in the top of the building. From the pipe 5 the water passes to the valve 6, and when a heavy load is being lifted, also to the pipe 32 and valve 33, in a manner hereinafter explained. The valve 6 serves to regulate the passage of the water through pipe 7 by means of the piston 8 and the balancing-piston 51. The pipe 7 (see Fig. 2) conducts the water to and from the port 52, which opens into the main cylinder. At present only the method of conducting the water to the cylinder 1 will be considered. Within cylinder 1 is the auxiliary cylinder 48, ts head forming the piston of cylinder 1.

The interior of cylinder 48 is shown in Fig. 3. Within it is the hollow piston 12, communicating by ports 13 with the water-space of piston 48. The piston 12 is connected by the tubular piston-rod to the cavity 10 in the head of cylinder 1. The cavity 10 is distinct from the inlet-port 52 of the main cylinder, which is situated above the section plane of Fig. 3. The cavity 10 communicates with the exhaust-water tank by two routes, one through pipe 14, valve 16, and pipes 15 and 25, and the other through the pipe 31, branching from pipe 14, valve 28, and pipes 29 and 25. The check-valve 28 allows water to flow to the cylinder 48, as indicated by the arrow, but not to return. The pipe 14 leads to the valve marked 16. The structure of this valve will be seen by reference to Fig. 4, in which it is shown partly in section, its companion valve (shown beside it in the preceding figures and in Fig. 5) being removed. Upon a spindle, 17, are located three pistons, 18, 19, and 20. The pipes 14 and 15 open into the side of the valve-casing, and the pipe 15 connects with the exhaust-pipe 25. The pistons 18 and 20 serve to prevent leakage and to balance the valve, the piston 19 being the controlling one. A weighted lever, 21, passes through a slot in the spindle 17, and a piston, 23, is attached to the lower end of said spindle. Water is admitted under the piston 23 by the pipe 24 in a manner here-

inafter explained. When the piston 19 is in the position shown, the communication between the pipes 14 and 15 is cut off, (*vide* Fig. 4;) but by raising the spindle 17, as indicated by the opposition of the lever, as shown in dotted lines in Fig. 4, the piston 19 is raised above the pipe 14 and a flow may take place from one pipe to the other. Water is supplied to the pipe 24 through the check-valve 46, pipe 42, and valve 44.

It is apparent that the check-valve 46 (*vide* Figs. 2 and 4) is attached to the main valve at a point where it will receive water at the same pressure as that existing in the main cylinder when the main valve is opened for starting. This will be seen by reference to the section of the main valve in Fig. 1. By reference to the same figure it will be seen that the small valve 44 is operated at the same time as is the main valve 6. The pistons 56 and 57 of the small valve 44 are so located that when the main valve is opened, as shown in Fig. 1, communication is established between pipes 42 and 24, these pipes being connected to the valve 44 at the rings marked 42 and 24 in Fig. 1. 58, Fig. 1, is an exhaust-port, which is put into communication with pipe 24 when the main valve 6 is raised and closed. Piston 57 of valve 44 rises as valve 6 rises, they having, as before explained, corresponding actions. The function of these connections and valves is to permit water of the same pressure as that in the main cylinder to be admitted to what may be styled the "automatic" valves 16 and 33 whenever the main valve is opened to start the elevator upward. If the pressure is great enough to raise the valve 16 or 33, or both, the check-valve 46 keeps them raised by preventing any return of the water; but when the main valve is closed the water in pipe 24 is exhausted through the port 58 into any convenient place, but, as shown in the drawings, to the tank 26 through pipes 29 and 25, whereupon the automatic valve or valves 16 and 33 close.

It will facilitate the understanding of the whole machine to explain the operation of so much of the machine as has already been described, because the rest of the machine involves an application of the operative principles which govern that part under consideration.

Suppose that a light load is to be taken on the elevator, that the pipes and the cylinder 48 are filled with water to the exclusion of air, that the position of the valves are as shown in Figs. 1, 2, and 3, and that the area of the piston 12 is one-half that of the main cylinder 1. The water will enter by pipe 7, Figs. 1 and 2, and will cause the cylinder 48 to advance, carrying with it the movable sheaves 3 3 and raising the elevator. The water contained between the moving cylinder 48 and the stationary piston 12 (*vide* Fig. 3) is forced through the check-valve 9 into the main cylinder 1, because its exit through the hollow pistod-rod 11 and pipe 14 is prevented by the check-valve 28 and the automatic weighted valve 16, the last being in the position shown in Fig. 4, because the pressure is not great enough to raise said valve 16. The pressure on the main cylinder is thus one-half neutralized and only half of its capacity is filled from the water-supply, the other half being filled from the auxiliary cylinder 48 through valve 9, Fig. 3. When piston 8 of valve 6 is in the position shown in the drawings, Fig. 1, the flow is from the supply-pipe 5 through the valve 6 and the pipe 7 and the port 52 into the main cylinder; but the said piston 8 having been raised to the limit of its upward stroke, the flow is reversed, and is from port 52 through pipe 7 out at the bottom of valve 6, and thence (*vide* Fig. 8) upward to and through pipes 29 and 25 to said tank 26. Now, the cylinder 48 begins to travel from the piston-head 12, a portion of the exhaust-water which is being discharged through the bottom of valve 6 being (in the arrangement shown) drawn back through pipe 29 and check-valve 28 to refill the auxiliary cylinder 48. It is, however, apparent that, instead of diverting a portion of the exhaust-water coming from the bottom of valve 6 to the check-valve 28, the latter may be connected directly to the tank 26; but for convenience in the arrangement shown I have connected check-valve 28 with the other portion of pipe 29, which leads through pipe 25 to the tank 26. Suppose now that a heavier load is to be lifted, and suppose, also, that the available water-pressure is forty pounds per square inch. On admitting water through the main valve the pressure approaches forty pounds without starting the load. The same pressure is accumulating under the automatic valve 16, which has been weighted to rise at, say, thirty-six pounds. When that point is reached, therefore, the valve 16 rises, the pipe 14 is opened through valve 16 to pipe 15, and the water before imprisoned within the cylinder 48 is now free to escape into the exhaust-pipe 25 through the pipes 14 and 15. (*Vide* Figs. 3 and 4.) The whole area of the main cylinder is thus available for raising the load. In the arrangement shown the descent is regulated wholly by the escape of the water in the main cylinder through the pipe 7 and valve 6, and with this the automatic and check valves have nothing to do, their action only being effective on the ascent.

To provide a third degree of power (or a second addition) is the object of the second automatic valve, 33, and its connections, which will now be described. The valve 33 itself is in structure like valve 16, as may be seen in Fig. 5, and therefore it needs no further description. Its upper port is connected to the water-supply pipe 5 by the pipe 32, and its lower port (*vide* Fig. 3) to the closed front end of cylinder 48 through the pipe 36 and sliding tube 37. Branching from pipe 36 is a pipe, 39, leading to a check-valve, 40, which opens inwardly toward the cylinder 48, and is connected to the exhaust through pipes 41 and 29.

A passage, 59, Figs. 3 and 7, leads from the front of cylinder 48 to the interior of cylinder 1 and has a check-valve, 60, opening into the cylinder 1.

The operation of the devices last described is as follows: When the area of the main cylinder is sufficient to operate the elevator, as in the case of a light or of a moderately-heavy load, communication with the water-supply pipe through pipes 32 and 36 and valve 33 (*vide* Fig. 3) is cut off, for the pressure of pipe 24 is not sufficient to raise valve 33 so as to connect the supply-pipes 5 and 32 with pipe 36, and water from the exhaust-tank 26 is drawn into the front of cylinder 48 through the check-valve 40 and its connections just above described. When the elevator is descending, the water so drawn in escapes by the passage 59, Figs. 3 and 7, into the main cylinder 1, and thence back to the exhaust; but if a load too heavy to be lifted by the main cylinder be put upon the elevator, then the accumulating pressure, after having raised valve 16, as before described, will also raise valve 33, said valve 33 being weighted, so as to be raised by a higher pressure than is valve 16. The rising of valve 33 allows the water from the supply-pipe 5 to pass through pipes 32 and 36 to the front of the cylinder 48, thereby assisting in raising the load. On the descent the exhaust water escapes, as in the previous instance, through the passage 59 and valve 60 from the cylinder 48.

It will be seen from the foregoing description that the auxiliary cylinder is used first as a resistance to the main cylinder 1; second, as a merely passive agent, and, third, as an assistant to the main cylinder. It is further apparent that different degrees of power may be obtained by the employment on the one hand of the first and second uses of the auxiliary cylinder, or, on the other hand, of the second and third—that is to say, by the employment of either of the automatic valves 16 or 33, the action of each being independent of the other. It will likewise be seen that the tank 26 for containing exhaust-water is necessary only in connection with the use of the front end of the auxiliary cylinder 48 as an aid to the main cylinder when it is used for the purpose of keeping said front end always filled with water. The front end of cylinder 48 is filled when the elevator is rising, and consequently no water is passing to the exhaust, and for this reason the supply must be drawn from a tank; but the back end of the cylinder 48 is filled while water is escaping from the main cylinder, and its supply may be obtained by diverting some of the exhaust water that would otherwise escape.

As explained in the previous patents before referred to, it is not essential to keep the front end of cylinder 48 always filled with water, as the machine would be operative without so doing; but it is desirable so to do, as it is thereby always ready for action without waiting to fill empty pipes and passage.

The action of the check-valves 9 and 40 is entirely under the control of the automatic valves 16 and 33, respectively—that is, whether the former shall open or not upon the ascent of the elevator depends on the position of their respective control-valves, and said valves might be connected mechanically without departing from my invention, though such a connection is not necessary to its operation.

Dotted lines in Fig. 2 show the pipe 32 connected to the valve 6 in the same manner as pipe 7, so that the water is shut off from pipe 32 whenever the elevator is stopped or descending. When so connected, the position of valve 33 when valve 6 is opened to allow the cage to descend is immaterial, for no water can enter it. When pipe 32 is connected as shown in full lines, it is necessary to keep valve 33 shut upon the descent of the cage, as water could otherwise pass through it, and through the front of cylinder 48 and passage 59, and be wasted through the exhaust. In other words, the use of the auxiliary valve 44 to exhaust the water from pipe 24 on the descent is necessary when pipe 32 is connected as shown in the full lines, but is not necessary when the connection is made as shown in dotted lines; but it is advisable in any case to use both the check-valve 46 and auxiliary valve 44 to insure entire positiveness in the action of the automatic valves 16 and 33.

I claim—

1. The combination of a main cylinder and an auxiliary cylinder having a piston therein which expels the water from said auxiliary cylinder as the elevator rises, with pipes connecting the auxiliary cylinder to the exhaust, and an automatic balanced valve, 16, comprising piston 19, so located upon the spindle 17 that it may close the passage between said connecting-pipes 14 and 15, or may be moved by said spindle to open said passage, and balancing-pistons 18 and 20 above and below piston 19, said valve being operated by pressure from the main cylinder through the pipe 24, whereby the said valve is opened when a predetermined pressure in the main cylinder is exceeded.

2. In a hydraulic elevator having a main and an auxiliary cylinder, the combination of a set of pipes connecting one end of the auxiliary cylinder to the water-supply, an automatic valve operated by pressure from the main cylinder and controlling the admission of water from said water-supply, a branch pipe communicating with the exhaust-tank, having an inwardly-opening check-valve and connected to the first-named set of pipes at points between the auxiliary cylinder and the automatic valve, and a passage leading from the aforesaid end of the auxiliary cylinder to the main cylinder, said passage being covered by a check-valve opening toward the main cylinder.

3. In a hydraulic elevator having a main and an interior auxiliary cylinder moving on a fixed piston secured to main cylinder, the

combination of a set of pipes connecting one end of the auxiliary cylinder to the water-supply, an automatic valve operated by pressure from the main cylinder and controlling the admission of water from said water-supply, a branch pipe communicating with the exhaust-tank, having an inwardly-opening check-valve and connected to the first-named set of pipes at points between the auxiliary cylinder and the automatic valve, and a passage leading from the aforesaid end of the auxiliary cylinder to the main cylinder, said passage being covered by a check-valve opening toward the main cylinder.

4. In an elevator having a main and an auxiliary cylinder, the combination, with an automatic valve controlling the water of the auxiliary cylinder, of a pipe admitting water under the pressure of the main cylinder to operate said valve, and a valve connected to the main control-valve, admitting water to said pipe when the valve is opened to raise the elevator, and exhausting it from said pipe when the main valve is closed, as and for the purpose set forth.

5. In an elevator having a main and an auxiliary cylinder, the combination, with an automatic valve controlling the water of the auxiliary cylinder, of a pipe admitting water under the pressure of the main cylinder to operate said valve, and a valve connected to the main control-valve, admitting water to said pipe when the valve is opened to raise the elevator and exhausting it from said pipe when the main valve is closed, and a check-valve located on said pipe between the main cylinder and the valve last before mentioned, substantially as described.

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