No. 655,012. Patented July 31, 1900.

G. H. REYNOLDS.

ELEVATOR.

(Application filed Mar. 27, 1895.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.

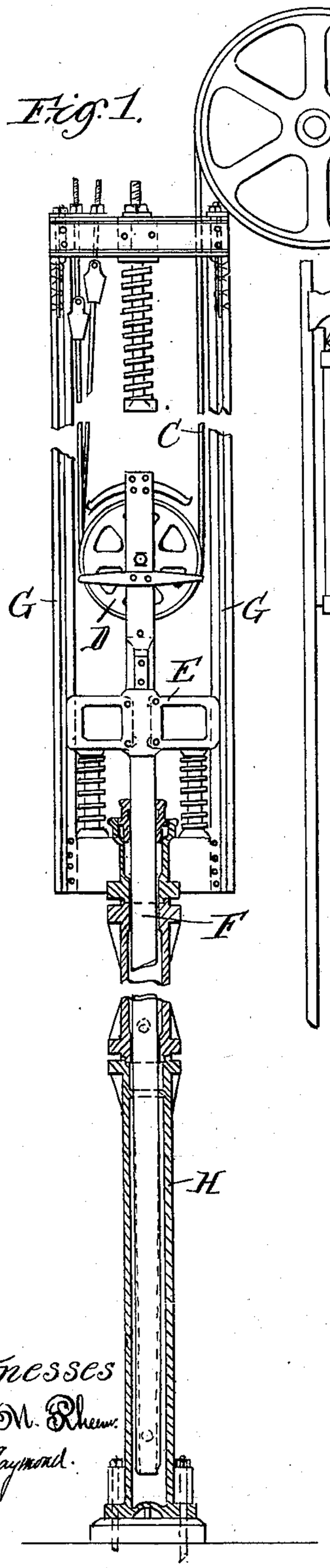

Fig. 2.

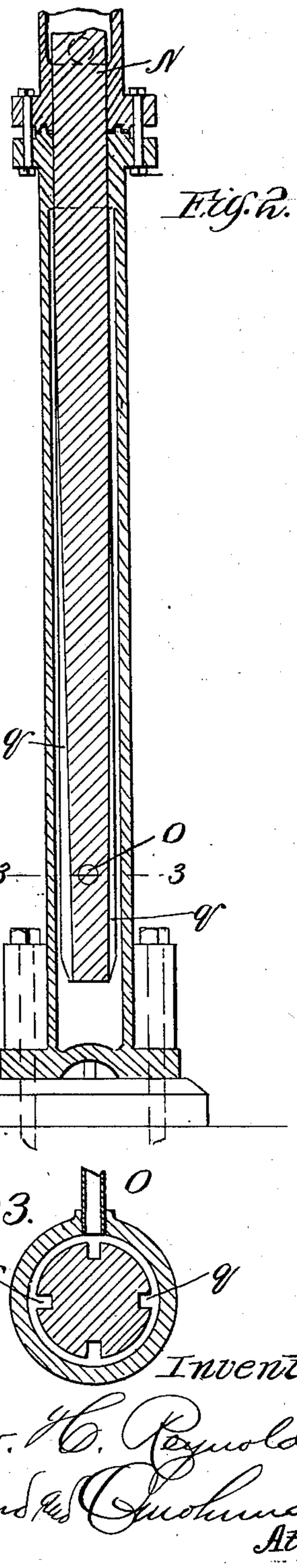

Fig. 3.

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(No Model.) 4 Sheets—Sheet 2.

Fig. 4.

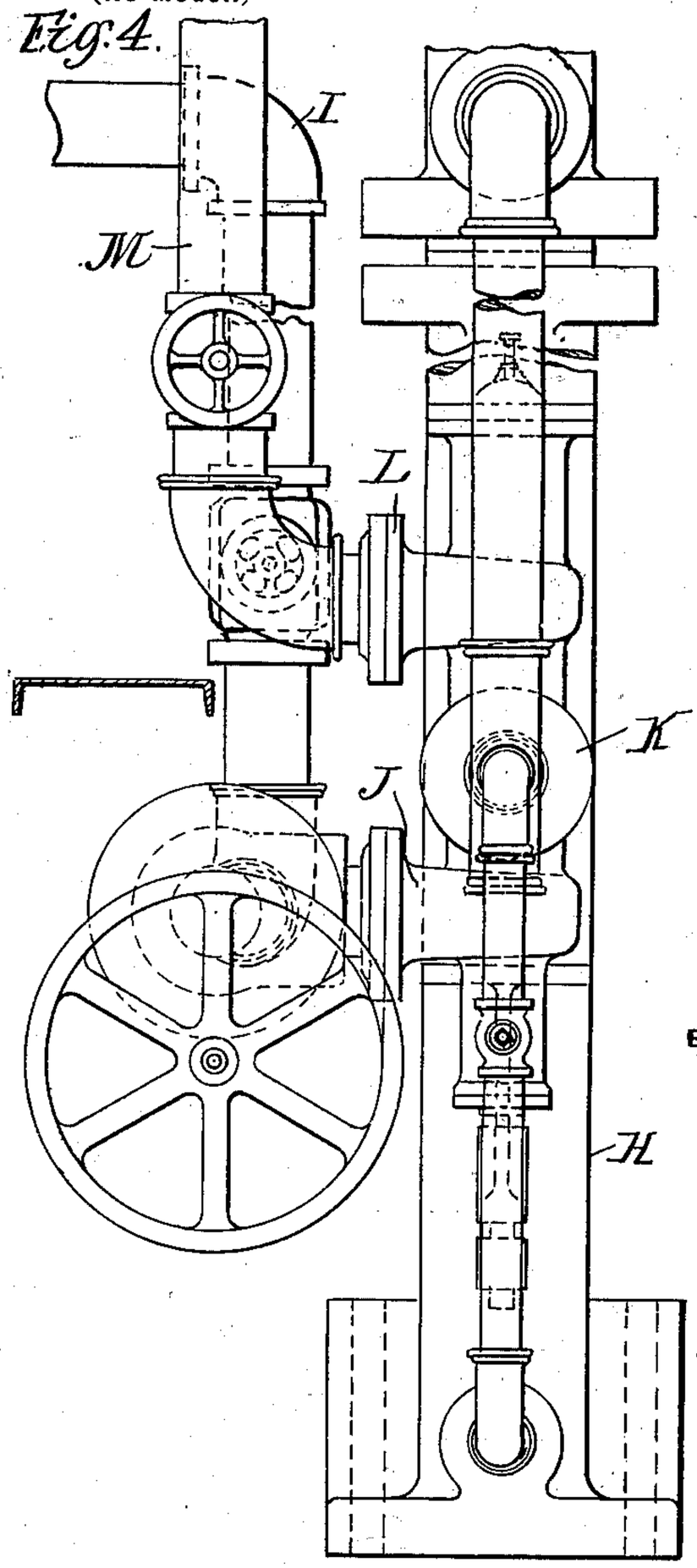
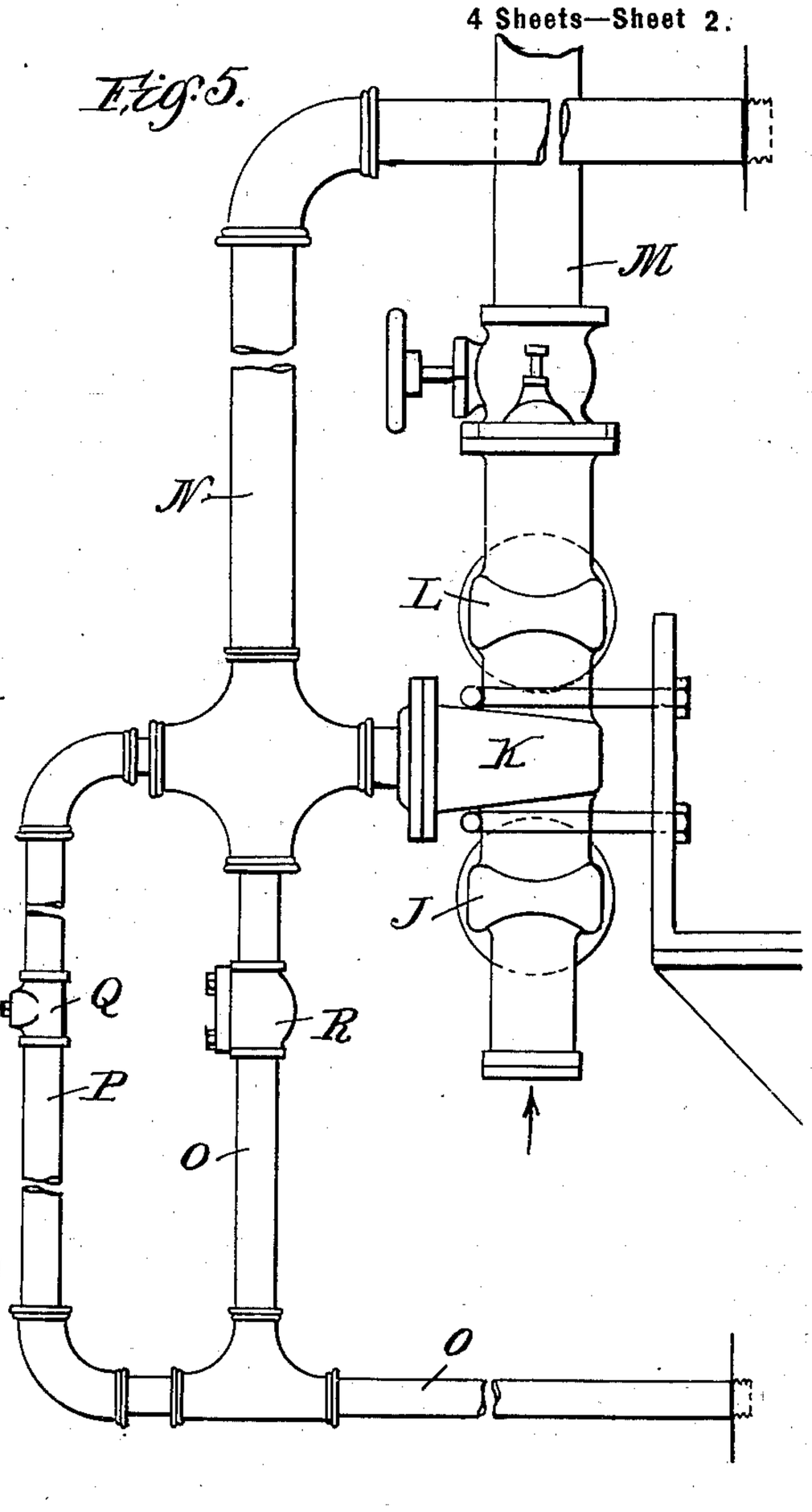


Fig. 5.



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(No Model.) 4 Sheets—Sheet 3.

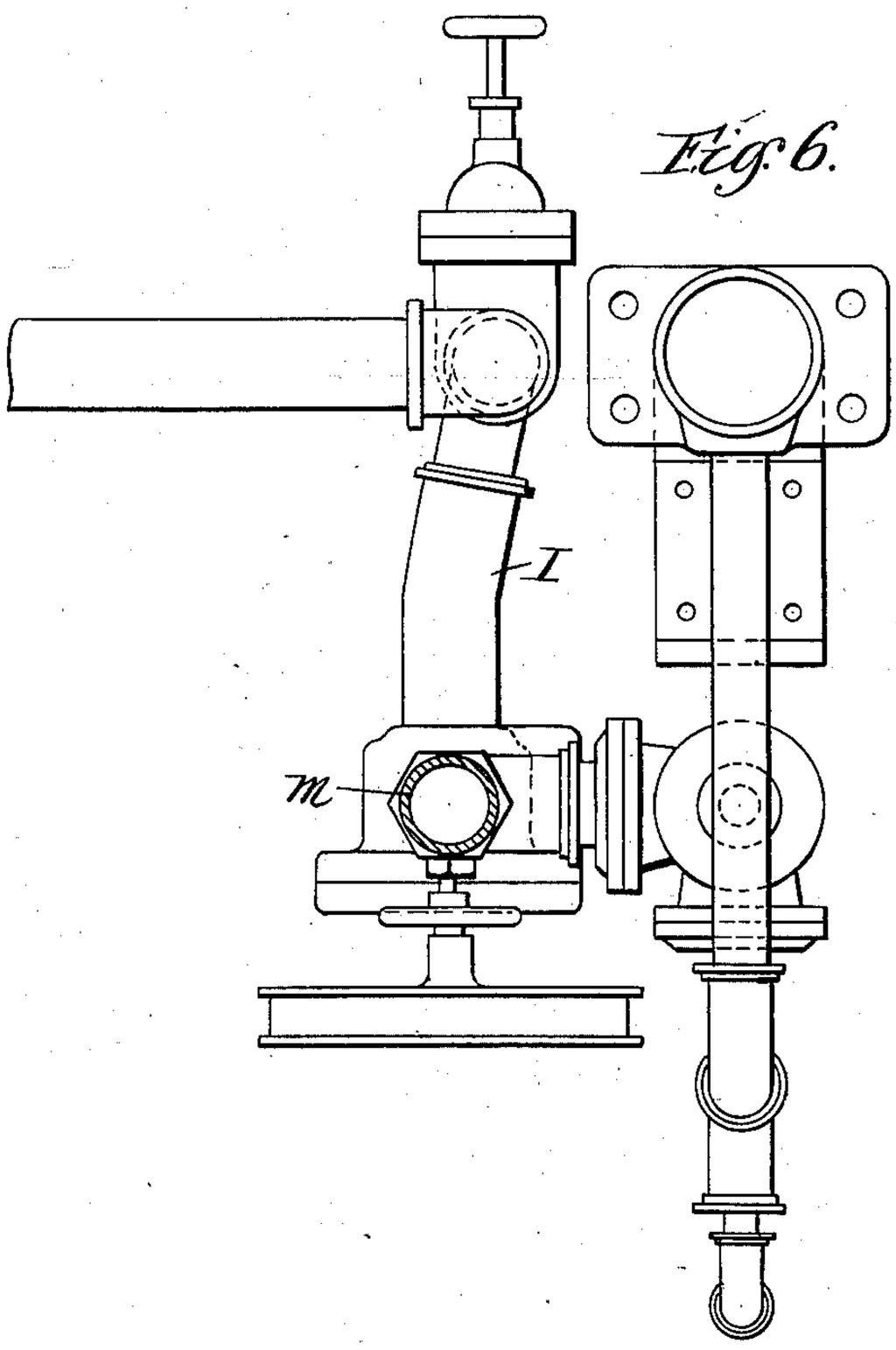

Fig. 6.

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ELEVATOR.

(Application filed Mar. 27, 1895.)

(No Model.) 4 Sheets—Sheet 4.

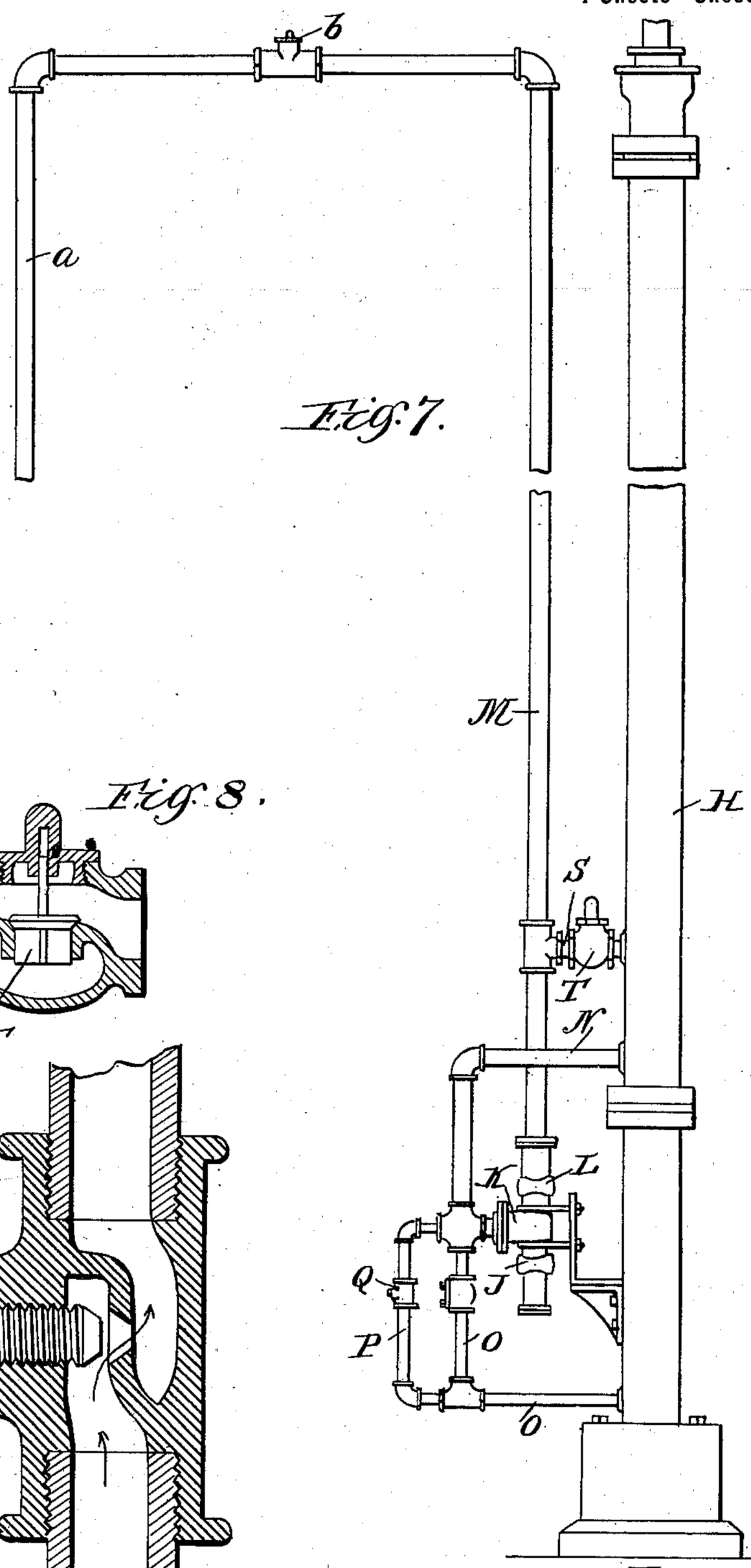

Fig. 7.

Fig. 8.

Fig. 9.

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UNITED STATES PATENT OFFICE.

GEORGE H. REYNOLDS, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE CRANE ELEVATOR COMPANY, OF SAME PLACE.

ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 655,012, dated July 31, 1900.

Application filed March 27, 1895. Serial No. 543,881. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. REYNOLDS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Elevators, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

This invention relates more particularly to hydrogravity-elevators in which the car is raised by the gravity of a falling ram and lowered by hydraulic pressure directed against, so as to lift, the ram. Elevators of this class are necessarily of the vertical type, and in vertical and horizontal types of elevators heretofore it is common to provide a variable counterbalance in the shape of a chain attached to the car at one end and resting at its other end in the elevator-shaft to compensate for the running of the lifting-cables to one side or the other of the main sheaves.

This invention has for one of its objects to dispense with the variable weight in the shape of a chain and compensate for the running of the lifting-cables to one side or the other of the main sheaves by a hydrostatic column.

Another object is to utilize the hydraulic column, which lifts the ram, as a part of the hydrostatic column, whereby a constant hydraulic pressure or "head" is maintained in operating the elevator under all practical conditions.

A further object is to automatically arrest the descent of the ram or plunger as it approaches the limit of its stroke, while at the same time providing for the prompt action of the apparatus when the ram or plunger is started on its ascent.

A still further object is to avoid the "jumping" or vertical vibration of the ram or plunger when the lifting-pressure is suddenly cut off, thereby avoiding the exceedingly-disagreeable and dangerous jumping of the elevator-car resulting therefrom.

These and such other objects as will hereinafter appear are attained by the devices illustrated in the accompanying drawings, in which—

Figure 1 is a sectional elevation of an elevator apparatus embodying my invention; Fig. 2, a detail vertical section through a portion of the ram and its cylinder; Fig. 3, a horizontal section on the line 3 3 of Fig. 2. Fig. 4 is a front elevation of the controlling-valves and their connections; Fig. 5, a side elevation of the controlling-valves and their connections; Fig. 6, a plan view of the same. Fig. 7 is a detail view of the devices for applying hydraulic pressure to the ram, and Fig. 8 a detail section of the check-valve between the ram and cylinder and the standpipe. Fig. 9 is a detail section.

Similar letters of reference indicate the same parts in the several figures of the drawings.

Referring by letter to the accompanying drawings, A indicates the elevator-car, B the main sheaves, C the lifting-cables, and D the multiplying-sheave, all of which may be of the usual or any desired construction. The multiplying-sheave is carried upon a cross-head E, mounted upon the upper end of a ram or plunger F and working in a suitable guide-frame G, secured at one side of the elevator-shaft. In practice the ram and the guide-frame would be each equal in length to about half the height of the building in which the elevator apparatus is to be used, the guide-frame being a fixture extending to the upper half of the building, while below it, to the bottom of the shaft, extends a cylinder H, in which the ram or plunger works. The ram should be of a weight sufficient to lift the car and its accessory parts with its maximum load, and the ram is lifted by hydraulic pressure directed against the lower end thereof, so as to lower the car, the discharge of the water from the cylinder after the ram is lifted serving to control the fall of the ram, and consequently the lifting of the car.

It is well understood in this art that as the car ascends and descends the weight of the lifting-cables C is constantly shifting from one side to the other of the main sheave B, and heretofore this shifting of the weight of the cables has been compensated for by the provision of a variable weight in the shape of a chain hanging from the car, which is picked up from the bottom of the shaft or from the support at the side of the shaft as the car ascends and accumulates on the bot-

tom of the shaft or other support as the car descends, the chain being of sufficient weight to practically counterbalance the weight of the lifting-cables at any point in the shaft. I propose to dispense with these variable weights or counterbalances for the lifting-cables by providing a hydrostatic column which, in conjunction with the cables themselves, will serve to perfectly compensate for the shifting of the weight of the cables to one side or the other of the main sheave, as will now be described. The control-valves for admitting the supply of water to the cylinder and discharging the same therefrom may be of any desired construction, and are now so well understood in this art that it is not deemed necessary to herein illustrate or describe them in detail. Suffice it to say that I (see Figs. 4 and 5) is the main supply-pipe; J, the inlet-valve; K, the change-valve; L, the outlet-valve, and M the discharge-pipe from the outlet-valve, which I utilize as a stand-pipe, as will be better understood by reference to Figs. 5 and 7. The supply of water to the ram-cylinder H enters at the supply-valve J and passing the change-valve K enters the branch pipes N and O, which connect with the cylinder at different points along its height, the pipe O connecting with the cylinder near the lower end thereof and the pipe N at a point somewhat above the lower end of the cylinder. As will be explained further on, the lower end of the plunger, when the latter is in its lowermost position, extends below and cuts off the connection N, so that the first supply of water to the cylinder is through the connection O; but after the ram has raised a short distance the supply is from both connections.

In the pipe O is located a check-valve R, also of ordinary construction, which opens to admit the flow of the water into the cylinder from the change-valve, but closes as against a return of the water. Hence when the change-valve K is operated to connect the discharge-pipe M with the cylinder the discharge of the water from the cylinder is mainly through the pipe N and partly through the by-pass P, which is smaller than the pipe N and is throttled by the cock-valve Q, which is adjustable to vary the amount of water that may be discharged through this pipe, according to the requirements of each case.

The discharge-pipe M is carried up to a height about equal to that of the cylinder, so as to provide a stand-pipe in which there is always contained a hydrostatic column substantially equal to the height of the cylinder. Now assuming the water is being forced into the cylinder to lift the ram, during this operation the stand-pipe will be cut off by the change-valve, and as the ram rises out of the cylinder the car is traveling down, and consequently the weight of the lifting-cables is shifting to the car side of the main sheave. Hence as the ram rises out of the water in the cylinder, in which it is completely immersed at each downstroke thereof, the ram theoretically acquires weight recovered from the buoyant effect of the water in the cylinder; but this apparent increase in weight of the ram is counterbalanced and offset by the running of the lifting-cables to the car side of the main sheave. Therefore the same power that is required to start the ram will be sufficient to move it to the full limit of its stroke. On the descent of the ram the hydrostatic column in the stand-pipe is connected with the hydrostatic column in the cylinder by the change-valve, and as the two columns are of substantially-equal height there will be an exact balance between the two columns, and thus the cylinder is at all times kept full of water. This would be equally true were the water discharged from the cylinder into some other source of constant pressure, such as a pressure-tank, wherein sufficient pressure would be normally maintained to support the hydrostatic column in the cylinder. As the ram descends it theoretically loses in weight by immersion, due to the buoyancy of the water in the cylinder; but this loss of weight is counterbalanced by the weight of the lifting-cables running to the ram side of the main sheave. It will thus be seen that the weight of the ram and its accessory parts remain practically the same throughout its downward as well as upward travel. However, to attain this desirable result it is necessary that the displacement of the ram, regardless of its shape or weight, should be so proportioned to the weight of the lifting-cables that the weight of the water displaced by each foot thereof shall substantially equal or counterbalance the weight of so much of the cables as run from one side to the other of the main sheave during each foot of travel of the ram. In other words, the displacement of the ram should be so proportioned to the weight of the lifting-cables that the changing displacement of the ram will substantially counterbalance the changing weight of the lifting-cables. It is also necessary that a hydrostatic column, through which the ram falls, must be maintained at all times by keeping the cylinder full of water under all circumstances. My stand-pipe, a pressure-tank, or other means may be employed to this end, the stand-pipe or pressure-tank possessing especial advantages over any other means known to me by providing a hydrostatic column or constant source of pressure through or into which the cylinder discharges, with the accompanying advantages thereof hereinbefore mentioned as incident to such constructions.

The importance of the stand-pipe or other means for maintaining a constant pressure or head upon the plunger or ram in all of its positions will be appreciated when it is borne in mind that in practice a car may be much more heavily loaded after leaving the lower floors of a building than at the start

and may sometimes be overloaded. This is especially true of freight-elevators, where bulk has little to do with weight and where the operators are more careless. Hence if the load put on at, say, the third or fourth floor of a high building were greater than the ram could lift if the discharge of the water took place at the bottom of the building direct from the outlet-valve a part or even the whole of the water in the cylinder might be let out by an operator in his efforts to start the car. Under such conditions if the load were lessened to any considerable extent beyond a balance for the ram the car would be instantly and rapidly run up to the top of the shaft, the sole reliance for safety under such conditions being the safety devices, which might or might not work under such conditions. On the other hand, if the operator after discharging a part or the whole of the contents of the cylinder were to reverse, so as to send the car down, the water, under high pressure, would rush into the empty cylinder and strike the end of the ram with such force and suddenness as to send the car to the bottom of the shaft before any control could be gained over the apparatus by the operator. With the use of the stand-pipe or any pressure-retaining device or apparatus there would at all times be a head or pressure against the ram whenever the discharge or outlet valve was open; but no discharge of the water from the cylinder would take place unless the ram descended and displaced the water. The stand-pipe also serves another useful purpose in that it is a permanent source of supply for water to the cylinder, which may be utilized to avoid or prevent the jumping of the ram and car due to sudden stoppage, cutting off the lifting-pressure from the ram.

It is obvious that if the ram is being lifted very rapidly and the pressure is suddenly cut off the momentum will carry the ram up a slight distance beyond the head of the column in the cylinder, and then the ram will immediately fall back to the head of the column, giving a violent jerk upward to the car, causing tremendous strain to be suddenly thrown upon the lifting-cables and upon their supporting and connecting parts, which strain is several times repeated in sudden jerks until the car and ram come to a rest in their proper relative positions. This I know to be true from practical experience. To avoid this jumping, I provide a connecting-passage S between the stand-pipe and the cylinder, preferably at a point just above the connection of the upper supply-pipe N to the cylinder, and in this passage locate a check-valve T, which opens to permit the flow of water from the stand-pipe into the cylinder, but closes against the return of the water. Hence when the pressure is suddenly cut off during the upward travel of the ram and the latter continues its upward movement there is a tendency to a vacuum below the ram, and this vacuum is immediately and automatically filled by the water, which will pass into the cylinder from the stand-pipe through the passage S, and thereby sustain the ram in any position to which it may move. Of course the water which thus enters the cylinder is only so much as the suction created by the ram will draw in, and as it cannot again escape from the cylinder it serves to keep the same full and level with the bottom of the ram at all times, so that the ram cannot fall back again after jumping, but will be sustained in the position to which it moves.

To prevent a siphoning action on the part of the discharge-leg *a* of the discharge-pipe N, which might empty the latter pipe once it was started in operation, I provide a relief-valve *b*, which is simply an inwardly-opening check-valve that permits air to enter the pipe whenever the supply to the discharge-leg *a* ceases. This relief-valve would also serve to admit air to the discharge-pipe, so as to permit the free passage of the water through the passage S in the event of an unusual demand thereon tending to create a vacuum in the upper part of the pipe N.

The cylinder H, in which the ram works, is of necessity of considerable length, sometimes from one hundred to one hundred and thirty feet, more or less, and in practice it is necessary to have the pipe sectional in character. It is difficult in a pipe of this length to get a smooth and straight bore for the ram or plunger, which is in the nature of a piston, and by reason of the great length of the ram it would bind easily in a cylinder providing a continuous bore therefor. I have therefore provided my sectional cylinder with a series of bearings or bulk-heads at or near the meeting ends of the sections through which the plunger works without having any bearing upon the sections at intermediate points. By such a construction, in which a series of bulk-heads is employed, it is comparatively easy to center all of the sections of the cylinder and furnish a free bearing for the ram without objectionable looseness of fit and also without danger of binding.

In carrying out my invention, as illustrated in the drawings, I propose to have only a reasonably-close fit of the ram in working through the lowermost bearing or bulkhead in the cylinder for reasons elsewhere explained, the rest of the bearings or bulkheads in the cylinder being sufficiently larger than the ram to permit the free flow of water between them and the ram and yet serving the purpose of guides for the ram in its work in the cylinder.

As before explained, the supply and discharge of water from the cylinder takes place through the two pipes N and O, and in practice the upper connection N is made with the cylinder just above the lowermost bulkhead. The lower end of the ram is either formed tapering for a distance less than that between

the lowermost bulkhead and the lower end of the cylinder or is provided with tapering grooves *q* in the sides thereof, so that as the ram descends the escape of water through the connection N is gradually cut off until finally its sole escape is through the connection O by way of the by-pass P. The check-valve R in the pipe connection O prevents the escape of the water through the pipe O and compels it to pass through the pipe P, and the cock-valve Q of the said pipe P enables the throttling of this pipe, so as to adjust to a nicety the discharge of the water from the lower end of the cylinder, so as to arrest the descent of the ram gradually and without shock. Obviously the cock-valve Q may be dispensed with and the pipe P made of such diameter as to constitute a permanently-contracted by-pass in the first instance without departing from the spirit of my invention.

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

1. In an elevator, the combination of a car, a ram operatively connected with, so as to elevate, said car, a closed cylinder in which said ram freely works, means for introducing a hydraulic lifting-column in said cylinder at the lower end thereof, for raising the ram, and means for connecting the hydraulic lifting-column with a hydrostatic column, substantially as described.

2. In an elevator, the combination of a car, a ram operatively connected with said car, a cylinder in which said ram freely works, supply and discharge ports at the lower end of said cylinder, a valve mechanism for controlling hydraulic pressure in said cylinder and an independent source of constant hydraulic pressure adapted to be connected with the discharge-port of the cylinder, substantially as described.

3. In an elevator, the combination of a car, a ram operatively connected therewith, a cylinder in which said ram freely works, supply and discharge ports at the lower end of said cylinder, a valve mechanism for controlling hydraulic pressure in said cylinder and a stand-pipe adapted to be connected by said valve mechanism with the discharge-port of said cylinder, substantially as described.

4. In an elevator, the combination with a car, a ram operatively connected therewith, and a cylinder in which said ram works, of a valve mechanism for admitting and relieving hydraulic pressure in the cylinder, connections from said valve mechanism to two different points along the cylinder, a check-valve in the lowermost connection, and a contracted by-pass around said check-valve, substantially as described.

5. In an elevator, the combination with a car, a ram operatively connected therewith, and a cylinder in which said ram works, of a valve mechanism for admitting and relieving hydraulic pressure in the cylinder, connections from said valve mechanism to two different points along the cylinder, a check-valve in the lowermost connection, a by-pass around said check-valve, and a cock-valve in said by-pass, substantially as described.

6. In an elevator, the combination with a car, a ram operatively connected therewith, and a cylinder in which the ram freely works, of a valve mechanism for admitting and relieving hydraulic pressure in said cylinder, a source of constant pressure into which said cylinder discharges, a passage connecting said source of constant pressure with the cylinder near the lower end thereof, and a check-valve located in said passage, substantially as described.

7. In an elevator, the combination with a car, a ram operatively connected therewith, and a cylinder in which said ram freely works, of a valve mechanism for admitting and relieving hydraulic pressure in said cylinder, a stand-pipe connecting with said valve mechanism and through which the cylinder discharges, a passage connecting said stand-pipe with the cylinder, and a check-valve in said passage, substantially as described.

8. In an elevator, the combination of a car, a ram, cable connections therebetween, a closed cylinder in which said ram works, a series of guide-bearings for said ram at intervals in the cylinder through which said ram freely works, a succession of supply and discharge openings in the cylinder upon opposite sides of the guide-bearings and means for raising said ram by hydraulic pressure to lower the car and for controlling the fall of the ram by hydraulic pressure to raise the car, substantially as described.

9. In an elevator, the combination with a car, a ram operatively connected therewith and having a reduced end, and a cylinder in which said ram works, composed of a series of sections having bulkheads at the ends thereof, of supply and discharge connections for the cylinder above and below the lowermost bulkhead, coöperating with the reduced end of the ram, substantially as described.

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