(No Model.)

4 Sheets—Sheet 1.

# G. H. REYNOLDS.

## HYDRAULIC ELEVATOR.

No. 328,614. Patented Oct. 20, 1885.

Fig. 1.

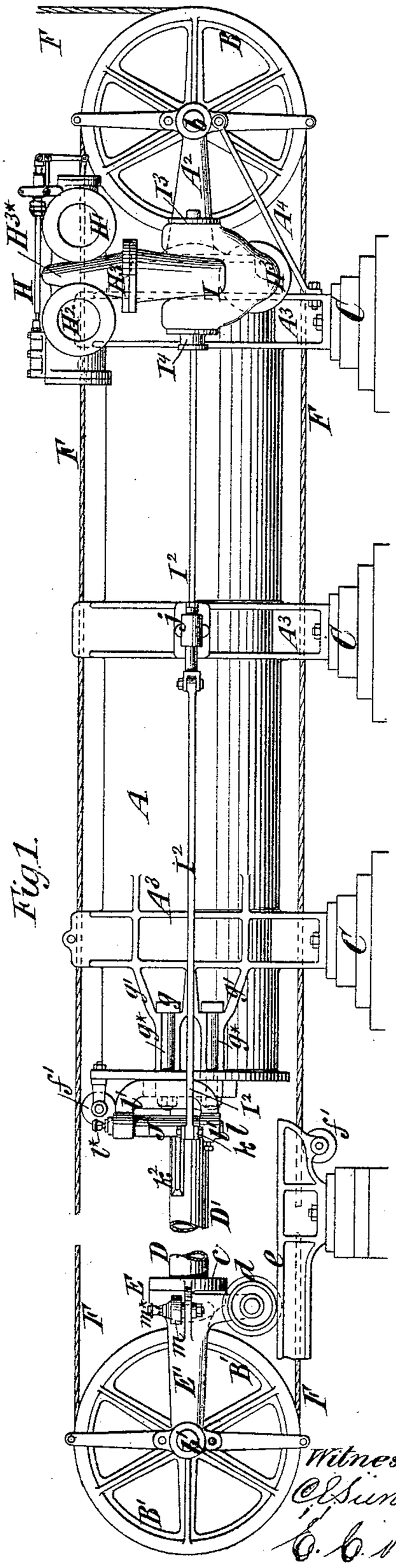
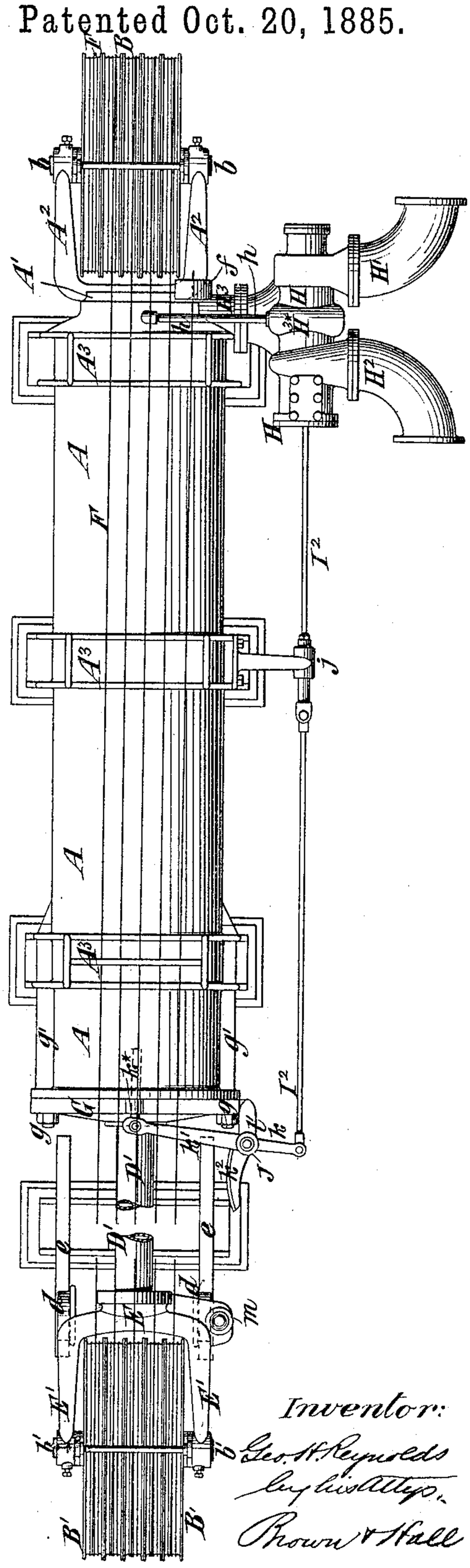



Fig. 2.




Witnesses:
C. L. Sundgren
E. C. Perkins.

Inventor:
Geo. H. Reynolds
by Brown & Hall
Attys.

(No Model.) 4 Sheets—Sheet 2.

# G. H. REYNOLDS.

## HYDRAULIC ELEVATOR.

No. 328,614. Patented Oct. 20, 1885.

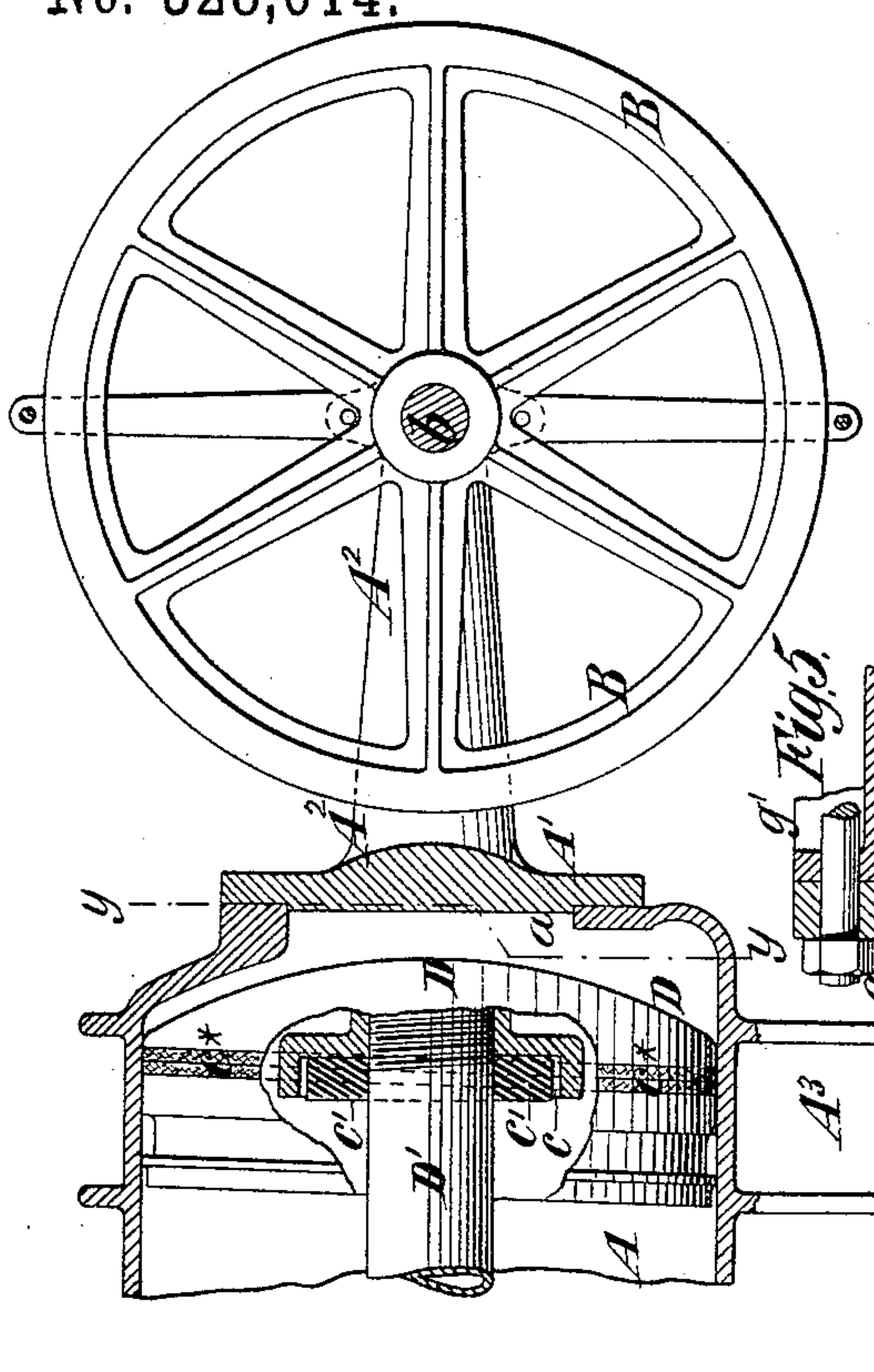


Fig. 5.



Fig. 3.



Fig. 4.



Witnesses:
C. L. Sundgren
E. C. Perkins.

Inventor:
Geo. H. Reynolds
by his Attys.
Brown & Hall

(No Model.) 4 Sheets—Sheet 3.

# G. H. REYNOLDS.

## HYDRAULIC ELEVATOR.

No. 328,614. Patented Oct. 20, 1885.

Fig. 9.

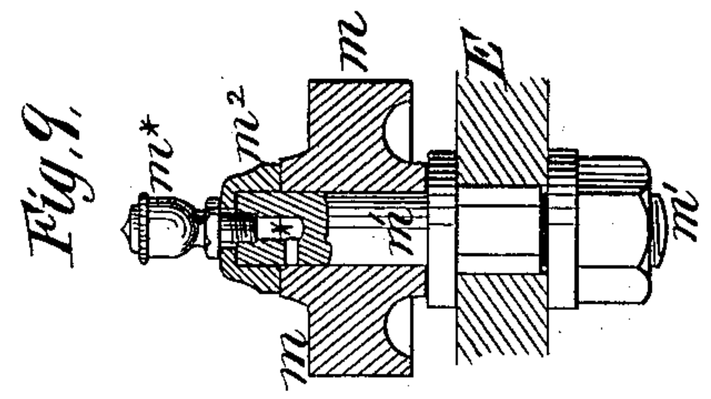



Fig 10.

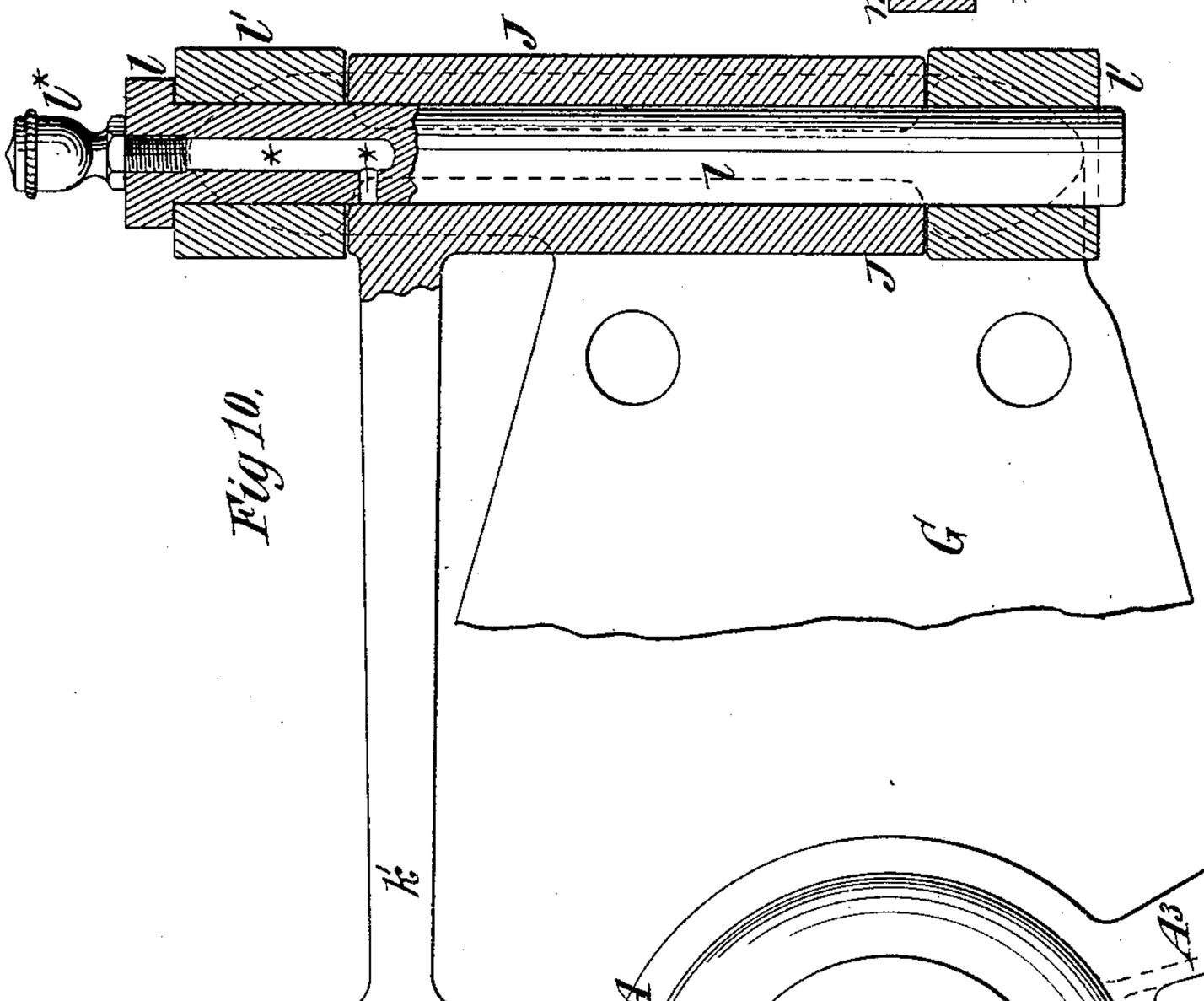
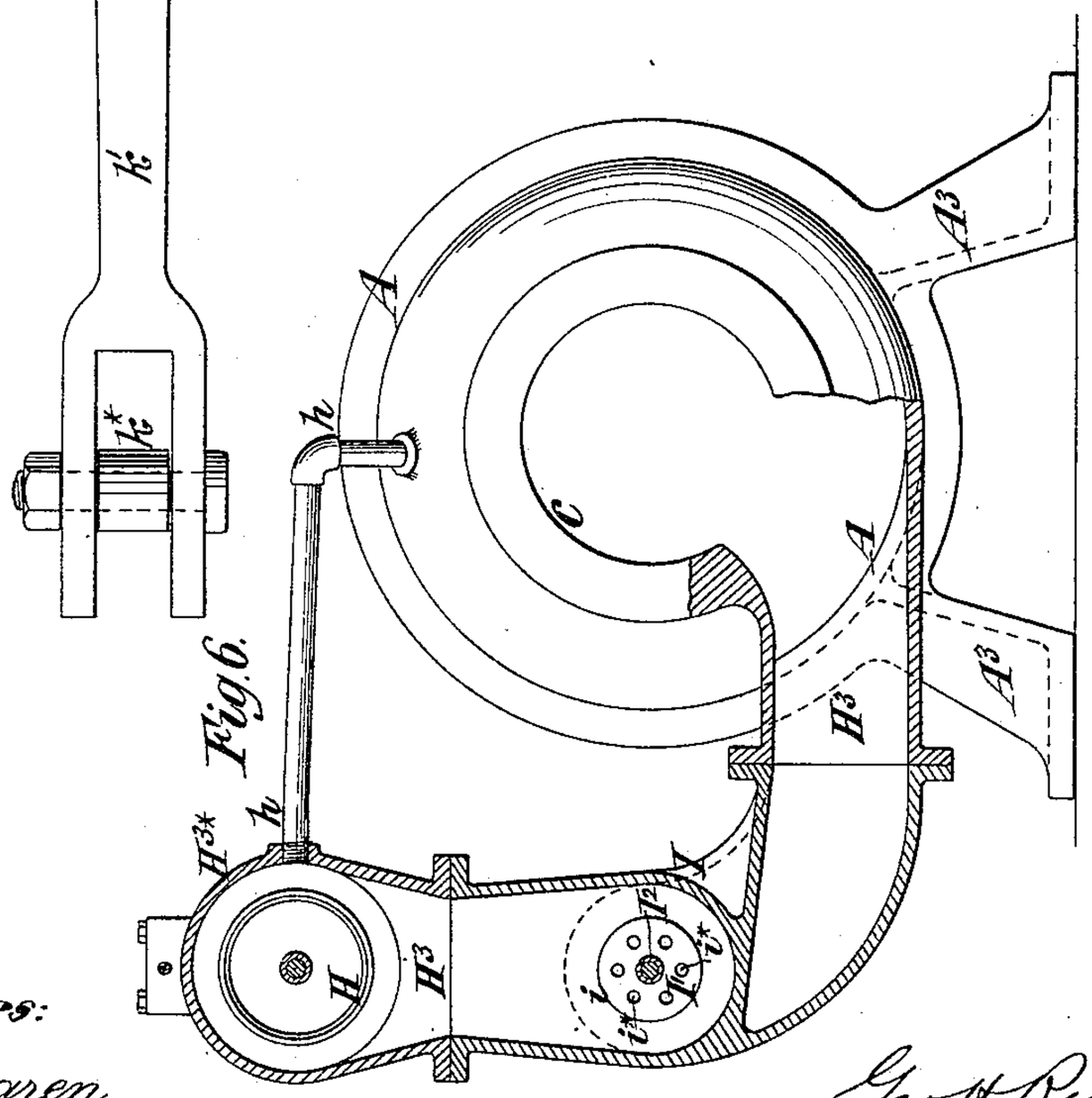



Fig 6.




Witnesses:
C. Sundgren
E. C. Perkins

Inventor:
Geo. H. Reynolds
by his attys.
Brown & Hall

(No Model.) 4 Sheets—Sheet 4.

# G. H. REYNOLDS.

## HYDRAULIC ELEVATOR.

No. 328,614. Patented Oct. 20, 1885.

Fig. 8.

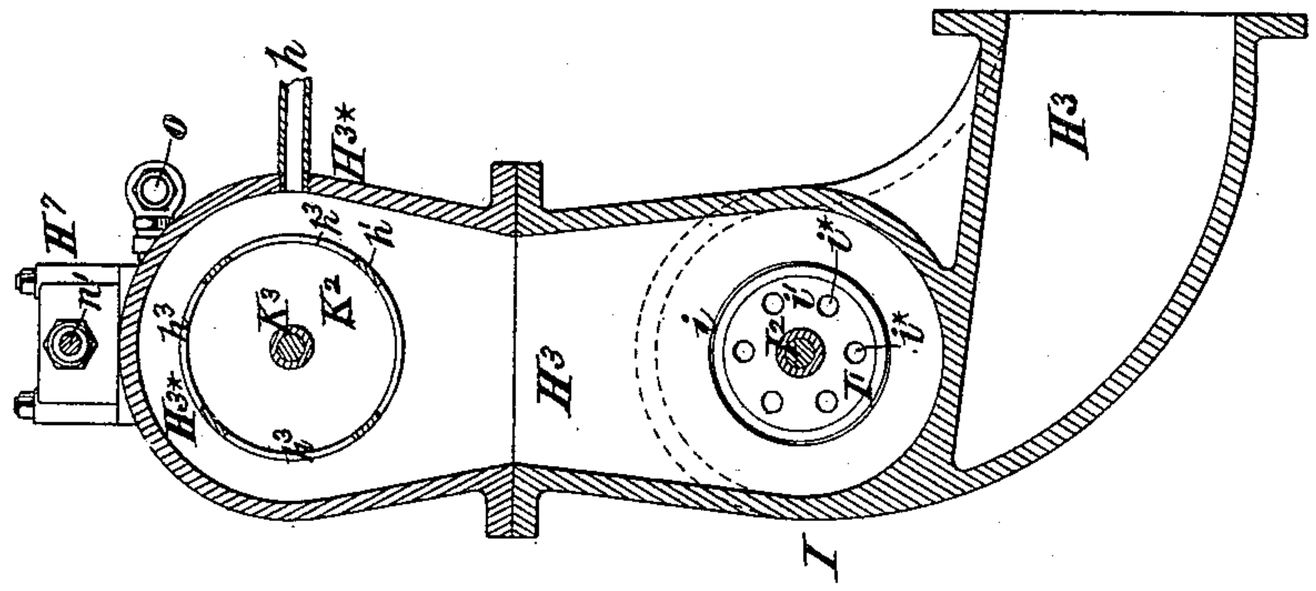
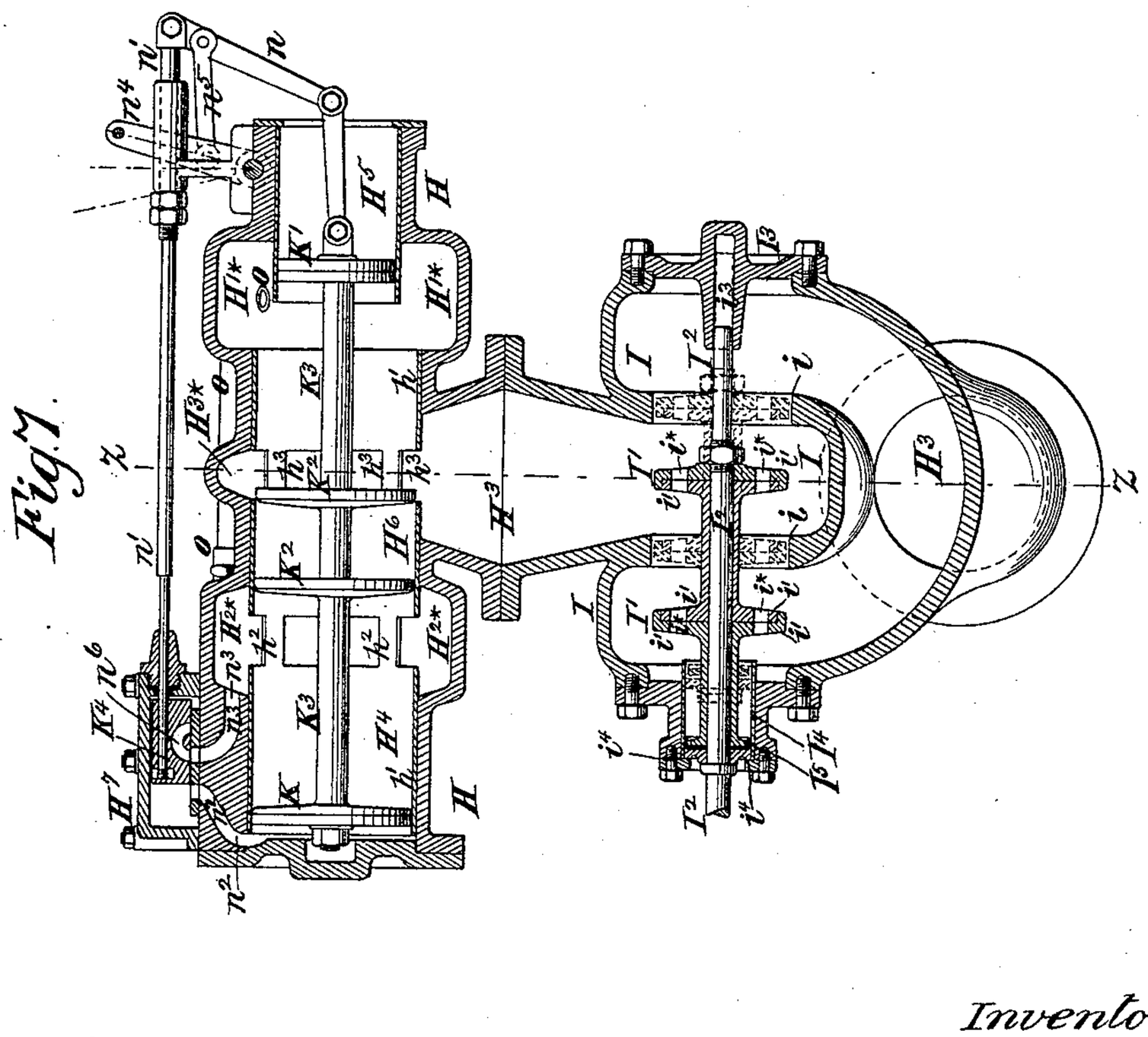



Fig. 7.




Witnesses:
C. L. Sundgren
Emil Herter.

Inventor:
Geo. H. Reynolds
by his attys
Howard Hall

# UNITED STATES PATENT OFFICE.

GEORGE H. REYNOLDS, OF NEW YORK, N. Y., ASSIGNOR OF ONE-HALF TO CRANE BROTHERS MANUFACTURING COMPANY, OF CHICAGO, ILLINOIS.

## HYDRAULIC ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 328,614, dated October 20, 1885.

Application filed December 10, 1884. Serial No. 150,028. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE H. REYNOLDS, of the city and county of New York, in the State of New York, have invented a new and useful Improvement in Hydraulic Elevators, of which the following is a specification.

For operating elevators by hydraulic power there are commonly employed a cylinder, and a piston movable therein by water-pressure, and having connected with it a sheave or sheaves, over or around which the hoisting-cables are passed, the cables being drawn down by the movement of the piston to produce the rising movement of the car or cab, and the piston being returned by the weight of the car or cab when the controlling-valve is opened to permit the discharge of water from the cylinder.

The invention relates more particularly to hydraulic apparatus, of the kind above described, in which the cylinder is of comparatively large size and only a fraction of the length required to lift the car, the cylinder being arranged horizontally and the movement of the piston being multiplied by means of two sets of sheaves or pulleys—one set being arranged side by side in fixed bearings at the back end of the cylinder, and the other set being mounted in and carried by the moving cross-head, with which the piston is connected. The hoisting-cables are attached at the end to a fixed abutment, which may be formed on the cylinder, and are thence carried back and forth between and over the two sets of sheaves or pulleys, and thence upward over the sheave or pulley at the top of the wellway or shaft, and down to the car, and when the piston moves one foot the car will be moved a number of feet corresponding to the number of courses or lengths of cable which extend between the two sets of sheaves.

Although, as above stated, the invention relates more particularly to apparatus of the kind last-above described, certain features of the invention are applicable to hydraulic-elevator apparatus whether the cylinder and piston be arranged horizontally or vertically, and whether the movement of the piston be multiplied many times in the car or only doubled, as is common in many elevators now in use.

A clear understanding of my invention will be facilitated by a brief description of an apparatus which combines all the features of the invention, and which will be hereinafter described in detail.

The cylinder is arranged horizontally, and is open at the front end. The piston, which is fitted to the cylinder, has a piston-rod, which may consist of a piece of pipe or tube, and to which is attached a cross-head provided with rollers which travel upon guides or rails parallel with the cylinder. One set of sheaves occupy a fixed position at the back end of the cylinder, and this end is partly cast integral with the cylinder, leaving an aperture large enough to receive a boring-bar, and which is subsequently closed by a removable head. This removable head is centered in the partly-closed end of the cylinder, and has formed integral with it brackets which support the fixed axle or shaft on which one set of sheaves turn. The movable set of sheaves are free to turn independently of each other on an axle or shaft fixed in the movable cross-head.

In connection with the cylinder and piston, constructed as described, I may use any suitable valve for controlling the flow of water to the cylinder and the discharge of water from the cylinder; but I prefer to use a valve such as is shown and described in my Letters Patent dated March 31, 1885, and numbered 314,720. In that valve is a casing or casting which comprises a valve-cylinder and two controlling-cylinders on opposite sides thereof, and the main valve, which consists of two piston-heads, has attached to and moving with it two controlling-pistons fitted to said controlling-cylinders. This casing is constructed with a central belt, which communicates with the valve-cylinder by a working-port, which is by the movement of the main valve placed in communication with the supply or discharge spaces of the valve, or covered entirely to hold the piston stationary. The main valve is operated by water-pressure acting on the controlling-pistons, and the operation of the said pistons and main valve is controlled by an

auxiliary or pilot valve, which is shifted by the operator in the car.

Difficulty is often experienced by reason of air accumulating in the cylinder of a hydraulic elevator, and to prevent this I connect the top of the horizontal cylinder with the valve-casing by a pipe which extends upward from the top of the cylinder, and offers a free avenue of escape through the valve for any air which may be in the cylinder. If this pipe be connected with the working-belt of the valve above described, then the flow through it is controlled by the main valve, and all air and then water can escape through said pipe only when water is being discharged through the main valve. Any waste of water through said air-pipe while the piston is being moved by water-pressure is thereby prevented.

The pipe which serves for the supply and discharge of water to and from the cylinder, and which is controlled by the valve, I connect with the extreme bottom of the cylinder, and hence any foreign matter in the cylinder will always be carried out with the rush of water through the valve, and will not be allowed to accumulate therein.

The valve above described may be connected directly with the cylinder; but I prefer to interpose between them a safety or shut-off valve, which will be automatically operated as the piston comes to the ends of its movement, to nearly shut off the supply of water to or the escape of water from the cylinder, and so bring the piston and car almost to a standstill. This safety or shut-off valve in what is now considered its most approved form consists of a casing interposed between the change or reversing valve and the cylinder, and fitted with balanced disks or heads, which are connected, and by axial movement open or close the passage through the casing. This valve has connected with its stem a small unbalanced piston by which the valve is always kept open until closed by an outside force, and by which it is always opened, as the agent which closed the valve recedes from the part on which it has acted to close the valve. In connection with the valve which is thus automatically closed, I provide a regulated leakage, which may be in the valve itself or around it, and which provides for the passage of enough water to or from the cylinder to complete the movement of the piston very slowly and bring it gradually to a stop against buffers, which I shall soon describe. I prefer to make each piston-head or disk of the safety or shut off valve of two plates, which may be adjusted circumferentially relatively to each other, and thereby set to more or less close circular series of holes with which they are provided.

The stem of the safety or shut-off valve above described I connect by a rod with a lever arranged at the front end of the cylinder. As before stated, this valve is always held open by the pressure on its unbalanced piston unless otherwise acted on; but when the piston nears the outer end of its direct movement it strikes a push-rod, and so closes the safety or shut-off valve, leaving the leakage through said valve to gradually bring the piston to the end of its movement. When the piston nears the end of its return movement, a roller on the cross-head bears against the cam-face on the safety-lever, and so shuts the safety-valve, as before described. When the change or reversing valve has been shifted, and the piston commences its reverse movement, the water leaking through the safety or shut-off valve effects the starting of the piston very slowly until the said valve is opened gradually as the agent which has closed it (the piston or roller) recedes, and thereafter the piston moves at full speed. It will therefore be seen that the piston is always started at the commencement of its stroke with the same speed which it had in stopping.

A further object of my invention is to provide a buffer which is strong enough to stop the piston at each end of its movement, even if the safety or shut-off valve and connections shall fail to act, and the piston shall strike the buffer at full speed. To this end I attach to the front and open end of the cylinder a strong and rigid cross-bar, and I provide the piston and cross-head with blocks of india-rubber, which strike against the said cross-bar at each end of the piston's movement. To prevent any possibility of the buffer-bar or cross-bar tearing loose from the cylinder in case the piston strikes it, I re-enforce the end portion of the cylinder by ribs and integral braces, which give the bolts that secure the buffer-bar a very strong hold on the cylinder. If desired, the buffer-bar or cross-bar might be provided with rubber blocks, and the piston and cross-head formed with projecting necks or hubs to strike upon the buffer-blocks.

The machine will be described in detail with reference to the accompanying drawings, and its several features afterward pointed out in the claims.

In the drawings, Figure 1 is a side elevation of a machine of the kind above described, the piston being partly run out. Fig. 2 is a plan thereof. Fig. 3 is a vertical longitudinal section of the machine on a large scale, the middle portion of the cylinder being removed to reduce the length of the figure. Fig. 4 is a transverse section and end view on the plane of the dotted line *x x*, Fig. 3. Fig. 5 is a horizontal section of the front end portion of the cylinder and the buffer-bar. Fig. 6 is a transverse section on the plane of the dotted line *y y*, Fig. 3. Fig. 7 is a longitudinal section of the reversing or change valve and the safety or shut-off valve on a larger scale. Fig. 8 is a sectional view on the plane of the dotted line *z z*, Fig. 7, and Figs. 9 and 10 are sectional detail views, hereinafter described.

Similar letters of reference designate corresponding parts in all the figures.

A designates the cylinder, which is of cast metal, and arranged horizontally. At one end, which is here the left-hand and front end, the

cylinder is open, and at the other or back end it is closed by a removable head, A′. As here shown, the head A′ is much smaller than the cylinder, the latter being cast with an aperture, *a*, only large enough to admit a boring-bar, and the head has a projection which enters this aperture *a*, and thereby centers the head relatively to the cylinder.

The head A′ is here shown as having integral arms or brackets $A^2$, in which is fixed a shaft or axle, *b*, and on said shaft or axle are a number of sheaves, B, which are capable of rotating freely and independently of each other. This construction provides for the holding of the sheaves B in proper central relation to the cylinder, and enables the cylinder-head to support them without any other support.

The cylinder A is constructed with integral circumferential ribs or flanges $A^3$, whereby it is re-enforced and prevented from becoming oval in shape owing to great weight, and these re-enforcing brackets or portions also form feet or standards whereby the cylinder is supported on a suitable foundation, C.

To the cylinder is fitted a piston, D, which may be of any suitable construction. The piston here shown and which I now prefer to use, is similar in most respects to that shown and described in my application for United States Letters Patent filed September 20, 1884, and the serial number of which is 143,523, and no detail description thereof is necessary. The piston is provided with suitable packing, *c**, which I prefer to arrange in a plane slightly oblique to the axis of the cylinder. The packing *c** is nearer the rear end of the cylinder at the top than at the bottom of the piston, as shown in Fig. 3, and as the pressure of water always acts at right angles to the plane of the packing, it will be evident that the water will have a tendency to lift the piston and to balance the weight, thereby relieving the bottom of the cylinder of undue wear.

D′ designates the piston-rod, which may consist of a pipe or tube screwed into the piston D, and around the rod in the front side of the piston is a circular cavity, *c*, in which is fitted a buffer-block, *c′*, of rubber or other yielding substitute therefor, the purpose of which will be hereinafter described. It will be observed that the cavity *c*, wherein this block is placed is larger in diameter than the block, and this is necessary to allow the block to expand laterally when pressure comes upon its face. If the block fitted snugly in the cavity, when the block is not under pressure the force exerted by the lateral expansion of the block under pressure might be sufficient to split the piston.

The front end of the rod D′ is fixed in a cross-head, E, which comprises arms or brackets E′, in which is fixed a shaft or axle, *b′*, and upon said shaft or axle are free to turn independently of each other a number of sheaves, B′, all of which are carried by the cross-head. The cross-head E is mounted upon or provided with wheels or rollers *d*, which run upon tracks or ways *e*, parallel with the axis of the cylinder and with each other. Both the tracks or ways may be and preferably are cast integral with cross-bars which connect them, and hence their parallelism will be maintained.

F designates the cables, only one of which is shown, but the sheaves B B′ are represented in Fig. 2 as grooved for four cables. The cables are attached rigidly at their one end to a projection or abutment, *f*, on the cylinder, and are thence passed to and fro between and around the two sets of sheaves B B′, and upward over the usual overhead sheave, (not here shown,) from which they pass down to the car. The cables may be supported in their upper and lower travel between the sheaves B B′ by small sheaves *f′*. (Shown in Fig. 1, but which are omitted from Fig. 2 in order not to hide the parts below.) The cross-head E is also provided with a cavity, *c*, in which is also placed a rubber block, *c′*, as best shown in Fig. 3.

As before stated, the front end of the cylinder is not closed but has attached to it a cross-bar or buffer-bar, G, which is shown in Figs. 3, 4, and 5. This is here shown as cast metal and is attached to the cylinder by bolts *g* at each end of the cross-bar. As best shown in Fig. 1, these bolts *g* are not merely inserted through a flange on the cylinder, but the cylinder is re-enforced at the ends by ribs or flanges *g′*, which extend clear back to the first re-enforcing-band and form seats *g**, in which long bolts may be laid and on which the heads of the bolts may bear. The buffer-bar G has on each side a circular boss or neck, $c^2$, of a size to bear upon the rubber buffer-block *c′* in the piston or cross head, and so arrest the piston in its movement in either direction. These parts should be made of sufficient strength to withstand the strain even if the piston comes at full speed to the end of its stroke, and for this reason the buffer-bar is made very deep and heavy, and the portion thereof which forms the boss or neck $c^2$ on the inner side of the bar is spread laterally, so as to join the bar proper near the securing-bolts *g*, and so throw the strain upon these bolts and not on the middle portion of the bar. If desired, the parts of the buffer might be reversed and an india-rubber block or other spring arranged in each side of the buffer-bar for the impact of bosses or projections on the piston and cross head.

The main change or reversing valve is shown in elevation and plan in Figs. 1 and 2, and on a larger scale and in longitudinal and transverse section in Figs. 7 and 8. As this valve is similar to that shown in my aforesaid Letters Patent No. 314,720, but little description thereof is necessary.

H designates the external casing of the valve, wherein are constructed larger and smaller controlling-cylinders, $H^4$ $H^5$, and an interposed valve-cylinder, $H^6$. The water-inlet H′ is between the cylinders $H^5$ $H^6$, and

the water-outlet $H^2$ is between the cylinders $H^4$ $H^6$. The lining $h'$ of the cylinders has a circumferential series of openings, $h^2$, communicating with a belt, $H^{2*}$, from which leads the outlet $H^2$, and the valve-cylinder $H^6$ also has openings $h^3$, which communicate with the working-belt $H^{3*}$, from which the working-passage $H^3$ leads to the main cylinder A.

To the cylinder $H^4$ and $H^5$ are fitted larger and smaller controlling-pistons, K K', and to the valve-cylinder $H^6$ is fitted a valve, $K^2$, consisting of two disks or piston-heads. The pistons and valve are connected by a rod, $K^3$, to move simultanously, and through a lever, $n$, and valve-stem $n'$ this rod is connected with and operates an auxiliary valve, $K^4$, arranged within a chest, $H^7$, from which ports $n^2$ $n^3$ lead to the outer end of the larger controlling-cylinder $H^4$ and to the exhaust or discharge-belt $H^{2*}$.

Not only is the auxiliary valve $K^4$ moved automatically by the controlling-pistons and main valve during the movement of the latter, but it may be automatically shifted by hand by means of a lever or arm, $n^4$, which is connected by a rod, $n^5$, with the lever $n$, and with which are connected appliances accessible from the elevator-car and not here shown.

The valve-chest $H^7$ is supplied with water under pressure by a pipe, $o$, leading from the supply-belt $H'^*$. In Fig. 7 the valve $K^2$ and pistons K K' are shifted to place the supply-belt $H'^*$ in communication with the working-belt $H^{3*}$ through the openings $h^3$, and thence water may pass to the working-cylinder A. Fig. 7 also represents the auxiliary valve $K^4$ as having just been shifted by hand to uncover the port $n^2$ and admit water under pressure from the chest $H^7$ to the outer end of the controlling-cylinder $H^4$. The pressure of water on the larger controlling-piston, K, toward the right will then balance the pressure of water on the main valve $K^2$ toward the left, and the main valve and controlling-pistons will be moved toward the right by the unbalanced pressure on the smaller controlling-piston, K'. This movement will continue until the auxiliary valve has been moved automatically to cover the port $n^2$, at which time the main valve will have moved sufficiently to place the working-belt $H^{3*}$ in communication with the exhaust-belt $H^{2*}$ through the openings $h^3$ and $h^2$.

If it be desired to shift the main valve again to the left and to the position shown in Fig. 7, the auxiliary valve $K^4$ is moved by hand so as to place the ports $n^2$ $n^3$ in communication through the passage $n^6$ in the auxiliary valve. The left-hand end of the larger controlling-cylinder, $H^4$, will thus be placed in communication with the exhaust-belt $H^{2*}$, and the left side of the controlling-piston K relieved of pressure. The pressure on the valve $K^2$ toward the left will then overbalance the pressure on the smaller controlling-piston, K', toward the right, and the main valve and controlling-pistons will be moved by such excess of pressure toward the left-hand and brought to the position shown in Fig. 7.

Considerable difficulty is caused in hydraulic cylinders of elevators by reason of the accumulation of air therein, and to prevent this I connect the top of the cylinder A by a pipe, $h$, with the working-belt $H^{3*}$ of the valve-casing, from which the passage $H^3$ leads. This pipe $h$ will therefore be controlled by the main valve in the casing H, and no water can escape therefrom when the valve is set to admit water under pressure to the cylinder. When the valve is set to allow the discharge of water from the cylinder, the water will force the air out through the pipe $h$ at each stroke, and consequently no air can accumulate in the cylinder.

The passage $H^3$ communicates with the extreme bottom of the cylinder A, as seen in Fig. 6, and consequently any foreign matter in the cylinder will be carried out with the rush of water, and will not accumulate therein.

The passage $H^3$ may be uninterrupted from the reversing or change valve in the casing H to the cylinder; but I prefer to arrange in the said passage a safety or shut-off valve, which will be operated automatically as the piston approaches very near the end of its movement. The valve which I now prefer to use is shown best in Figs. 7 and 8, to which I now particularly refer.

I designates the casing, which is connected by nozzles or branches with the other portions of the passage $H^3$. In the casing I are circular apertures or openings $i$ $i$, which are controlled by two heads or disk-valves I' I', which are on a common stem, $I^2$. Each disk-valve or head I' is composed of two plates, $i'$, which have in them circular series of openings or holes $i^*$, which range with each other in their position—that is, each series is in a circle of the same diameter. The plates $i'$ of the heads or disk-valves I' may be adjusted circumferentially relatively to each other, so as to entirely close or more or less enlarge the opening allowed through the openings or holes $i^*$, and they may be held in any position to which they are adjusted by tightening up a nut, $i^2$, on the stem $I^2$.

On one side of the shell I is a bonnet, $I^3$, in which is a guide, $i^3$, for the stem $I^2$, and on the other side thereof is a small cylinder, $I^4$, to which is fitted a suitably-packed piston, $I^5$, also fixed on the rod $I^2$. The outer end of this cylinder is open, and as the piston $I^5$ is unbalanced, the pressure of water on its inner side, unless the valve is acted upon by an outside agent, will always keep the valve I' in the position shown in full lines in Fig. 7, when the opening through the shell I will be comparatively unobstructed. In the outer end of the cylinder $I^4$ is a shoulder, $i^4$, which forms a stop to limit the movement of the piston $I^5$, and the pressure of water tends to keep the piston against said shoulder, as shown in Fig. 7.

The valve-stem $I^2$ is fitted to a suitable guide, $j$, and is extended to near the front end of the

cylinder A, where it is connected to an arm, *k*, on a rock-shaft, J. This rock-shaft is here shown as hollow, and is fitted to turn on a fixed pin, *l*, which is held in brackets or arms *l'*, which are here shown as cast upon one end of the buffer-bar G. The construction of the rock-shaft J and its supports are best shown in Fig. 10. The shaft, as before said, is hollow, and in order to lubricate it a hole, *, is drilled down into the pin *l* and an oil-cup, *l**, is applied to its upper end. A hole is drilled into the side of the pin, and thus the oil-passage * is made to communicate with the bore of the rock-shaft J, and the ample lubrication of the latter is provided for. The rock-shaft J also is provided with an arm, *k'*, and with a cam-like arm, $k^2$, which, with the arm *k*, are preferably all cast integral with the shaft. The arm *k'* has connected with it a push-rod, *k**, which projects into the cylinder and is struck by the piston D in its forward movement. The cam-like arm $k^2$ is to be acted upon by a roller, *m*, on the cross-head E as it approaches the end of its inward movement, and the arm *k* is connected with the continuation of the valve-stem $I^2$, as before described. It will therefore be observed that no matter whether the rock-shaft J is operated by the piston D striking the push-rod *k** near the end of its forward movement, or by the roller *m* striking and moving along the cam-arm $k^2$ near the end of the rearward movement of the cross-head and piston, the action on the saftety or shut-off valve will be the same—namely, to overcome the pressure on the unbalanced piston $I^5$ and bring the heads or disks I' to the position shown by dotted lines in Fig. 7. This will of course close the valve, save for the graduated leakage through the openings *i**, which leakage will be sufficient to move the piston very slowly and bring it to a state of rest by reason of it or the cross-head striking against the buffer-bar G. There the piston will remain until the main change or reversing valve is shifted, and the leakage through the graduated openings *i** will then be sufficient to start the piston D very slowly in the same direction and with the same speed at which it was brought to rest. As the piston D recedes from the rod *k**, or the roller *m* recedes from the cam-arm $k^2$, the pressure of water on the unbalanced piston $I^5$ causes it to follow and thereby to open the safety or shut-off valve full and move the piston at full speed. I do not necessarily make the valve heads or disks I' perforated or with holes *i**, as the regulated leakage might be provided for by a separate pipe extending around the casing I or joining the portions of the passage $H^3$ which are above and below said casing, and the result would be substantially the same, the said pipe being provided with a valve or cock.

The construction of the support for the roller *m* is best shown in Fig. 9. It is fitted to a stud, *m'*, which is to be fixed in the cross-head E, and the roller is surmounted by a head or washer, $m^2$, which holds it in place. An oil-passage, *, is formed downward from the upper end of the stud *m'*, and to the exterior thereof and to the top of the stud is applied an oil-cup, *m**, by which means oil is supplied to lubricate the bore of the roller *m*.

The cables F, after passing back and forth around the sheaves B B', are carried upward, as shown in Fig. 1, and they therefore have a tendency to lift the sheaves B. This is prevented by the secure attachment of the head A' to the cylinder; but to afford still greater security I provide braces $A^4$, which extend from the outer ends of the arms or brackets $A^2$ downward to one of the feet or re-enforcing brackets $A^3$.

By the term "hydraulic" as herein used, I mean to include any elevator operated by the pressure of liquid, be it water, oil, or any other substance.

By the term "horizontal" as used in this specification, I mean to include all cylinders which are arranged upon their side in an inclined or approximately horizontal or truly horizontal position.

I am aware that it is not new to employ buffers for arresting the movement of a reciprocating piston, and hence do not claim this, broadly, as of my invention.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination, with the cylinder A, constructed with circumferential re-enforcing ribs or flanges $A^3$ which also constitute feet or standards for supporting the cylinder, of the piston, piston-rod, and cross-head, a set of sheaves, B', connected with the cross-head, and a second set of sheaves, B, supported at the rear end of the cylinder, substantially as herein described.

2. The combination, with a hydraulic cylinder and piston and a change or reversing valve for controlling the flow of water to and from the cylinder, of an air-escape pipe leading from the top of the cylinder to the valve-casing and controlled by said change or reversing valve, substantially as and for the purpose herein described.

3. The combination, with the horizontal cylinder A and its piston, of the change or reversing valve arranged as high as the top of the cylinder, and the air-escape pipe *h*, leading at an upward inclination from the top of the cylinder to the valve-casing and controlled by the valve, substantially as and for the purpose herein described.

4. The combination, with the horizontal cylinder A, its piston, piston-rod, and cross-head, of two sets of sheaves, B B', the change or reversing valve whereby the flow of water to and from the cylinder is controlled, and the water-passage $H^3$, leading from said valve to the bottom of the cylinder at the rear end thereof, whereby the discharge of any foreign matter from the cylinder will be facilitated, substantially as and for the purpose herein described.

5. The combination, with the cylinder and

piston of a hydraulic elevator and the change or reversing valve for controlling the direction of movement of the piston, of a safety or shut-off valve arranged between the change or reversing valve, and the cylinder and appliances through which said safety or shut-off valve is closed automatically as the piston approaches the end of its movement, substantially as herein described.

6. The combination, with the cylinder and piston of a hydraulic elevator and a passage for liquid to and from the cylinder, of a shut-off or safety valve arranged in said liquid-passage, an unbalanced piston for holding said valve normally open, and appliances through which said valve is moved automatically against the pressure of water on said piston to close the valve as the main piston approaches the end of its movement, substantially as herein described.

7. The combination, with the cylinder and piston of a hydraulic elevator and a change or reversing valve for controlling the direction of movement of the piston, of a safety or shut-off valve arranged between the change or reversing valve and the cylinder, and through which water flows to and from the cylinder, and which is constructed to permit a regulated leakage when closed, and appliances whereby the closing of said valve is automatically effected as the piston approaches the end of its movement, substantially as herein described.

8. The combination, with the piston and cylinder of a hydraulic elevator and a change or reversing valve for controlling the direction of movement of the piston, of a valve-casing, I, arranged between the change or reversing valve and the cylinder, and through which the water flows to and from the cylinder, balanced valve disks or heads I′, for controlling the flow through the casing, each valve disk or head being provided with leakage-openings and means for regulating them, and appliances whereby said valve disks or heads will be moved automatically to close as the piston approaches the end of its movement, substantially as herein described.

9. The combination, with the cylinder and piston of a hydraulic elevator and the change or reversing valve for controlling the direction of movement of the piston, of the passage $H^3$, leading from the change or reversing valve to the cylinder, the valve-casing I, in said passage, the valve disks or heads I′, each composed of plates having corresponding series of openings, I*, and adjustable circumferentially to more or less close said openings, the valve-rod $I^2$, and single nut $i^2$, for securing the several plates of the two heads I′ when regulated, and appliances for automatically moving the rod to close the valve as the piston approaches the end of its movement, substantially as herein described.

10. The combination, with the cylinder and piston of a hydraulic elevator, of a change or reversing valve, a safety or shut-off valve between the change-valve and the cylinder, an unbalanced piston for holding said safety or shut-off valve normally open, and appliances whereby said unbalanced piston and attached valve will be moved automatically to close the valve as the main piston approaches the end of its movement, substantially as herein described.

11. The combination, with the cylinder and piston of a hydraulic elevator, of a change or reversing valve, a safety or shut-off valve between the change-valve and cylinder and constructed to permit a regulated leakage when closed, an unbalanced piston for holding said safety or shut-off valve normally open, and appliances whereby said safety-valve will be closed automatically as the main piston approaches the end of its movement, substantially as herein described.

12. The combination, with the cylinder and piston of a hydraulic elevator and the change or reversing valve for controlling the direction of movement of the piston, of the valve-casing I, the disks or heads I′, having regulated openings $i$*, for leakage, the stem $I^2$, the cylinder $I^4$, having the shoulder $i^4$, for limiting the opening movement of the valve, and appliances whereby the valve will be closed automatically as the main piston approaches the end of its movement, substantially as herein described.

13. The combination, with the cylinder, piston, piston-rod, and cross head of a hydraulic elevator, of a safety or shut-off valve, through which water flows to and from the cylinder, a rock-shaft, J, having an arm, $k$, with which the stem of said valve is connected, and also having arms $k'$ $k^2$, and the push-rods $k$*, connected with the arm $k'$, all substantially as herein described.

14. The combination, with the cylinder and its re-enforcing ribs and seats $g$* $g'$, of the buffer-bar G and bolts $g$, whereby it is secured to the cylinder, the piston D, and cross-head E, and buffer-cushions $c'$, interposed between the piston and cross-head and the buffer-bar, substantially as herein described.

GEO. H. REYNOLDS.

Witnesses:
C. HALL,
C. R. CRANE.