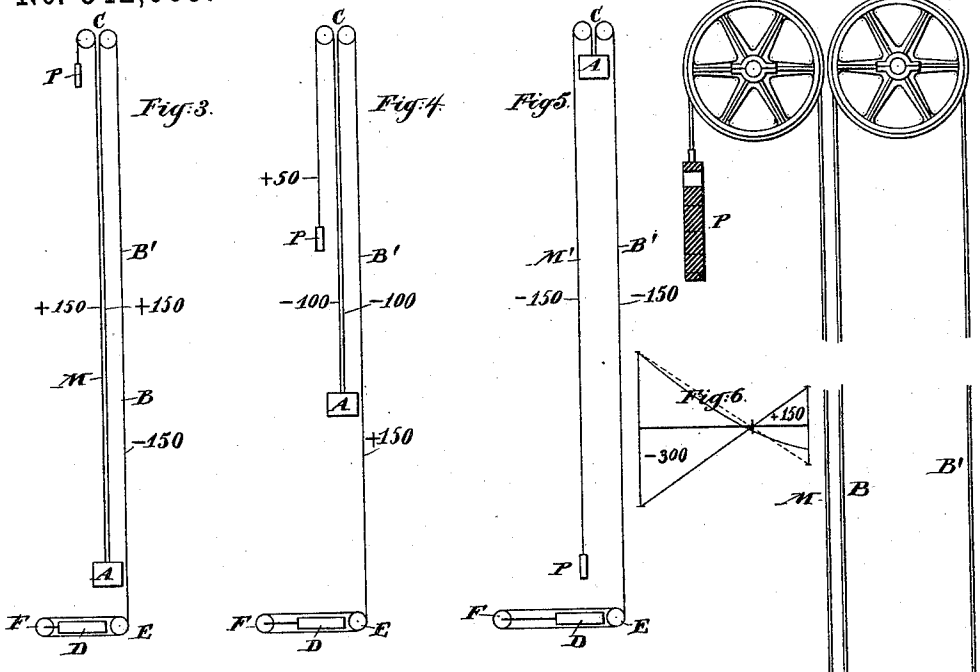
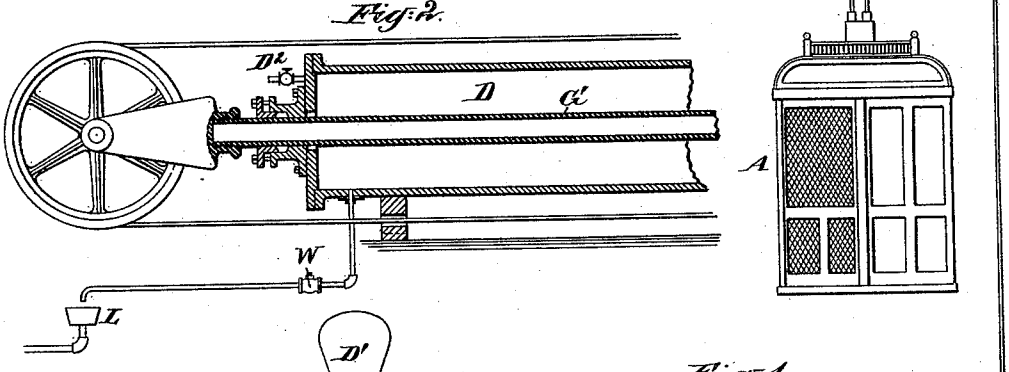
(No Model.) 2 Sheets—Sheet 1.

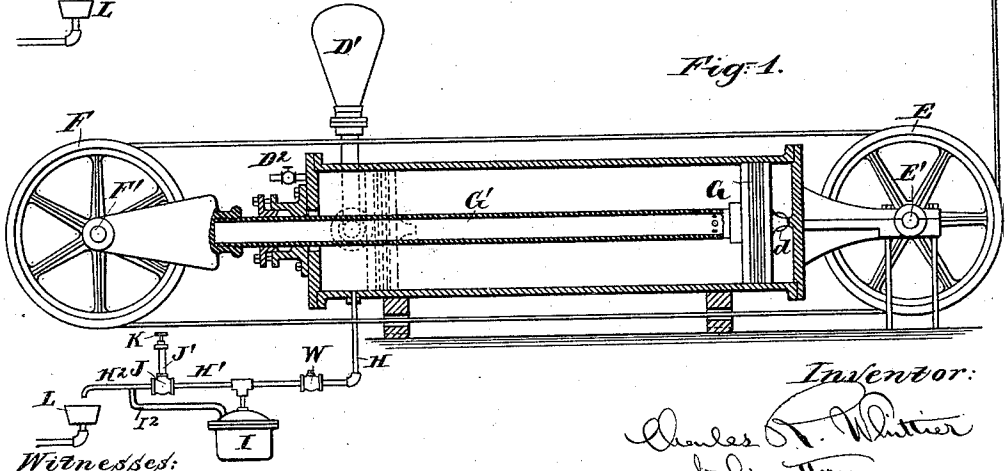
C. R. WHITTIER.

ELEVATOR.

No. 542,665. Patented July 16, 1895.







Witnesses:
Charles R. Searle.
M. F. Boyle

Inventor:
Charles R. Whittier
by his attorney
Thomas Spencer Stetson

(No Model.) 2 Sheets—Sheet 2.

C. R. WHITTIER.

ELEVATOR.

No. 542,665. Patented July 16, 1895.

Fig. 7

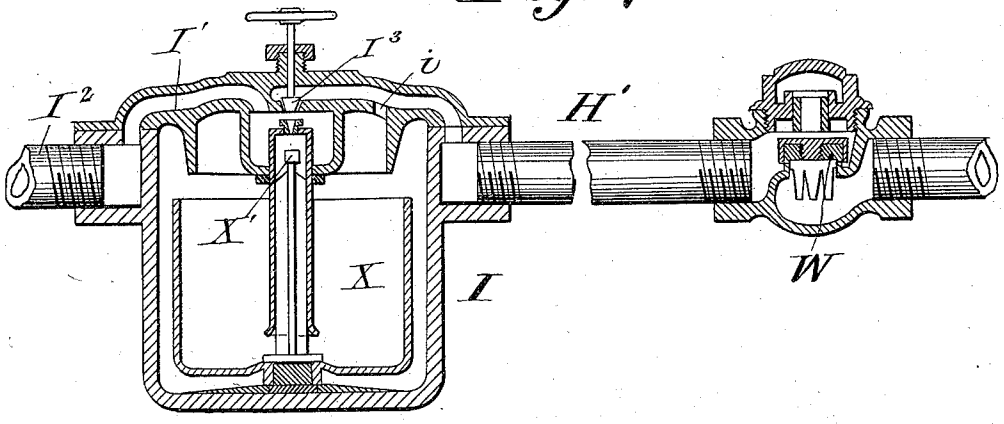
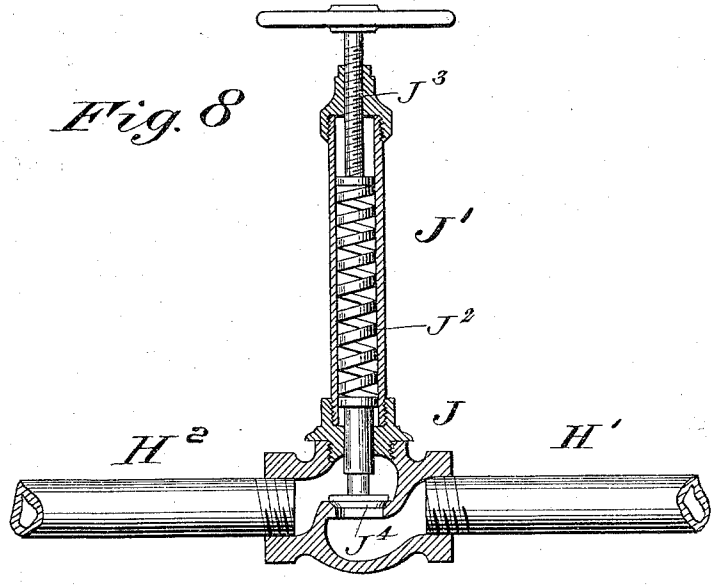


Fig. 8



Witnesses:
M. B. Harris
M. F. Boyle

Inventor
Charles R. Whittier
By Thomas Drew Stetson
Attorney.

UNITED STATES PATENT OFFICE.

CHARLES R. WHITTIER, OF NEW YORK, N. Y.

ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 542,665, dated July 16, 1895.

Application filed March 24, 1894. Serial No. 504,931. (No model.)

To all whom it may concern:

Be it known that I, CHARLES R. WHITTIER, a citizen of the United States, residing in the city and county of New York, in the State of New York, have invented a certain new and useful Improvement in Elevators, of which the following is a specification.

The invention relates to the provisions for counterbalancing the ropes by which the elevator is operated. It is of most importance in connection with the elevators used to convey passengers or freight in high buildings. I will describe the invention as so applied, the elevator being operated by hydraulic power.

It is usual to partially counterbalance the gravity of the car by means of a weight suspended by a separate rope. The considerable weight of the ropes in being transferred from one side to the other of the overhead sheaves is a disturbing element which becomes of importance as the height of the building and the consequent length of the ropes are increased. The difficulty has been recognized and efforts have been made to overcome it by attaching heavy chains to the under side of the elevator or counterweight or by opposing the movement of the piston by the elastic property of compressed air. There are objections to both these methods. I have discovered that the counterbalancing of the weight of the ropes may be attained with great perfection by means of air imprisoned in the cylinder in just sufficient quantities to attain a neutral condition when the piston has traversed about one-third of its path in the direction to elevate the car, and shall be in a condition of compressed air or a plenum during the period while the car is at the mid-height and near the top of its course, and subject to a pressure below that of the external atmosphere, a partial vacuum, when the piston is traversing about a third of its course with the car near the bottom.

The accompanying drawings form a part of this specification and represent what I consider the best means of carrying out the invention as applied to an elevator of the hydraulic-pushing type. The height of the building may be understood to be greater than is here shown.

Figure 1 is a central vertical section partly in elevation. Fig. 2 is a corresponding section of a portion, showing a modification. Figs. 3, 4, and 5 are side elevations showing the entire apparatus in either form on a smaller scale. Fig. 3 shows the car in its lowest, Fig. 4 in its intermediate, and Fig. 5 in its highest, position. Fig. 6 is a diagram indicating the amount of the force which requires to be balanced at different points in the stroke of the hydraulic piston, and also the balancing-force obtained by means of my invention. Figs. 7 and 8 represent details on a larger scale. Each is a central vertical section.

Similar letters of reference indicate corresponding parts in all the figures where they appear.

A is the passenger-car; B, that portion of the hoist-rope which extends from the car up to the pulley C, and B′ is the portion of the hoist-rope which extends downward from said pulley to the operating mechanism, which is at a low point in the building. This latter extent of the rope being always uniform is a constant weight and balances a corresponding portion of the weight of the car. The portion B on the other side of the pulley C is the variable element which requires to be balanced.

D is the hydraulic cylinder. It is of ordinary dimensions and acts in the usual manner, except that the end which has heretofore been practically open is closed and is provided with a stuffing-box through which the piston-rod moves.

E is a series of grooved pulleys running on a fixed pin E′, and F is a corresponding series of grooved pulleys running on a movable pin F′, which is carried by the piston-rod G′, fixed to the piston G. The piston is as usual in this class of apparatus operated to hoist the car by being forced outward or to the left by water admitted through the aperture *d* from a source not shown, and is released and allowed to be returned by the unbalanced portion of the weight of the car and its contents by allowing the water to escape through the same aperture, all of which, and the controlling-valve and means for operating such valve by the attendant in the car, may be of any ordinary or suitable character.

M is a counterbalance-rope attached to the car A and extending up therefrom over a

suitable pulley C, and M′ the portion of such rope which is on the other side of such pulley and carries a counterbalance-weight P. This counterbalance-weight performs its usual function, and the rope M M′ serves in all respects in the usual manner, except as the variable weight of the two parts M M of the counterbalance-rope is affected by the compression and dilation of the air in the operating-cylinder, as will presently appear.

D′ is an air-chamber communicating with the interior of the cylinder D at the point represented, and which may be of larger or smaller dimensions to increase or diminish the volume of air which is imprisoned in the cylinder, and is alternately compressed and attenuated as the piston G is forced by the water in the ordinary manner toward the left and returned toward the right end of the cylinder D. I connect to the bottom of the cylinder near the left extremity a discharge-pipe H, which leads to an air-trap I, which latter it will be understood may be of any ordinary or suitable character adapted to discharge water and retain air. Any leakage of the water past the piston G is delivered through this pipe H into the trap I and discharged therefrom to prevent an undue accumulation.

H′ is a continuation of the pipe H, and delivers through a relief or loaded check-valve J, which is operated by a helical spring inclosed in the upright portion J′. Its tension may be adjusted by turning a hand-wheel K, which operates a screw. (Not shown.) Any water in the cylinder is delivered through the trap I irrespective of the tension. Compressed air may be delivered through the relief-valve J, but only when its tension rises to a high point. The continuation H^2 of the pipe delivers such air at the rare intervals when the tension is exceeded. I provide a drip-cup L and draining means for discharging any water which may through any chance be delivered with such air.

W is a check-valve, which performs the ordinary functions of allowing water or air to pass it freely in the direction to be discharged from the cylinder D, but closes promptly and forbids any return of air when a partial vacuum is formed in the cylinder.

The relief-valve J serves to establish and maintain an adjustable limit of the pressure of fluid of any kind which is allowed to escape. The disk J^4 is held down by a spring J^2, which abuts under the screw J^3. Turning this screw increases or diminishes the minimum pressure under which either air or water will be discharged.

The air-trap I operates in the long approved manner, which may be described, briefly, as follows: The body of the trap is always partially filled with water, and the remainder with air, at the high pressure obtaining in the cylinder D. So long as only air comes the large open-topped vessel X inclosed in the trap is empty and floats, holding its attached valve X′ tightly up against its seat, near the top of the interior. Any water coming descends through the orifice *i* and gradually fills the vessel X. When sufficiently loaded with water the vessel X sinks and opens the valve X′. This valve allows the water to escape through the pipe I′, which extends down around the valve-stem of cuneiform section within the vessel X, and to be led away through the pipe I^2. When a sufficient quantity of the water has escaped, the vessel X again rises and closes the valve X′, and the trap remains as before, holding the contents of the trap by the valve X′ until sufficient water is again received to induce another discharge. A valve I^3 is provided to serve as a by-pass to allow the air to blow out when such effect is desired at any time. The check-valve serves to prevent any flow of air or water into the cylinder D from this source. It contains the usual light disk W, equipped with a seating-ring of rubber. It allows the flow of air and of water, when any water is present, outward from the cylinder D, controlled only by the relief-valve J and the trap I, but when under any condition air or water seeks to flow in the opposite direction this check-valve W closes tightly and arrests it.

When the car is in its lowest position, as shown in Fig. 3, the portion B of the hoist-rope extends between the extreme points of travel, and, assuming its weight to be a corresponding weight, it balances the one hundred and fifty pounds of hoist-rope outside of the shaft. The counterbalance-rope M also extends between the extreme points of travel, and, assuming the weight at one hundred and fifty pounds, it prevents the car being counterbalanced to within one hundred and fifty pounds when on this side. As the water admitted under pressure through the aperture *d* forces the piston G outward, and consequently by the movement of the pulleys F to the left takes up more and more of the hoist-rope, the car is elevated.

Fig. 4 shows the condition when the car is at one-third of its height. In this condition of the apparatus one hundred and fifty pounds of the hoist-rope and fifty pounds of the counterbalance-rope are on the outer side of the shaft and one hundred pounds of hoist-rope and one hundred pounds of counterbalance-rope are on the inside of the shaft, so that the ropes balance each other. When the movement has progressed until the piston has arrived at the position shown in dotted lines in Fig. 1, near the left end of the cylinder, the car is at its highest position, that shown in Fig. 5, and the portion of the rope B has been shortened till its weight is nothing, while the portion of the hoist-rope B′, weighing one hundred and fifty pounds, and the variable counterbalance-rope M, weighing one hundred and fifty pounds, being on the outside of the shaft, prevent the car from being counterbalanced when in this position to within three hundred pounds. My invention practically balances this change in the gravity of the rope B B′

by correspondingly changing the tension of the air expanded and compressed in the left end of the cylinder D and in the interior of the hollow piston-rod G′ and connected air-chamber D′. I have shown the piston-rod as hollow and perforated near the piston, so that a space in the interior of the piston-rod serves as an addition to the chamber in which the air is thus compressed at each elevation of the car. The effect of this is to attain the well-known advantages in stiffness and lightness due to the hollow construction of the piston and to utilize the space in the interior as an addition to the space in which the air is compressed during a small portion and expanded during a larger portion of each traverse. It is equivalent to a corresponding increase of the chamber D′. The movement of the piston causes this air to be alternately expanded and compressed, its tension gradually decreasing as the piston G moves to the right and increasing as it moves to the left. D^2 is an air-cock which may be opened and closed at will. It is evident that by admitting more or less air to be thus imprisoned, which may be determined by opening the cock D^2 and allowing the pressure inside to equal that of the atmosphere when the piston is held at one-third stroke or at any other desired point in the stroke, I can make the tension, when the piston is at the extreme right, any required degree less than that of the atmosphere. I thus admit the air with the piston G held near, but not exactly at one-third stroke. I thus attain a partial vacuum in the end of the cylinder, which is utilized in its effect on the piston G, which aids the water to hoist the unbalanced weight of rope when the car is at and near its lowest position, attains a neutral condition with regard to the pressure of the air when the piston has traversed about one-third of its stroke, and consequently raised the car to about one-third of the height of the well, and causes the confined air to exert a pressure somewhat above that of the atmosphere when the piston is at the extreme left and the car is at the top of its traverse, making it possible to add weights to the counterbalance to balance the ropes in this position. In other words, the force exerted by the compressed air helps to overcome the resistance caused by friction and back pressure, thus making it possible to add more counterweights to the elevator and thus to indirectly balance the rope.

The size of parts and best range of pressures to be carried can be most readily obtained by a diagram. Under ordinary conditions an expansion curve can be obtained in which the loss from curvature and direction is but comparatively little. By this means I attain a sufficiently-approximate balancing of the joint-weights of the variable quantity B of the hoist-rope and M of the counterbalance-rope.

The car will usually be left at the bottom of the well each night. If there shall be a slight leakage at one or more points, the periods during which the pressure in the left of the cylinder D is below that of the atmosphere being much in excess of that during which the pressure is above that of the atmosphere, the balance of the leakage is certain to be inward, so that there is no necessity for ever providing for admitting air after the apparatus is once satisfactorily adjusted, but always for allowing the escape if the pressure of the air shall become excessive. This can be adjusted with great nicety by the relief-valve J, the tension of the spring being regulated at will by the hand-wheel K. The facility for adjusting in this manner and allowing the ready discharge of all excess above the desired tension when the piston is at the extreme left may be preferred by many as the means of determining the proper amount of air to be retained in the cylinder. In other words, the quantity of air in the cylinder may always be correctly adjusted by letting in the air through the air-cock D^2 when the car is at or near its lowest position, and the piston G is consequently at or near the extreme right, and then closing the air-cock and allowing the first operation of the elevator to expel the surplus air through the check-valve W and relief-valve J, and thus to attain automatically the desired condition.

Modifications may be made by any good mechanic without departing from the principle or sacrificing the advantages of the invention.

There may be any desired safety apparatus to arrest the descent of the car in case of accident.

Obviously there may be the ordinary provisions of duplicating the hoist-rope to provide additional safeguards against the possibility of accident from the fracture of one.

I can make the counterbalance-rope M M′ somewhat lighter than the hoist rope or ropes B B′. In such case the point at which the tension of the imprisoned air shall be equal to that of the external atmosphere will be correspondingly nearer the right end of the hydraulic cylinder. The cylinder might also have the piston-rod on the other side, being of the type known as a "pulling-machine," or upright instead of horizontal. The air-trap or other parts might be dispensed with in certain modifications, as shown in Fig. 2; or a separate cylinder may be connected and the variations in pressure effected by another piston; or, in case the friction and back-pressure on piston are slight, the variations in pressure may be obtained mainly below the atmospheric pressure.

I claim as my invention—

1. In an elevator the cylinder A, having its end closed, the air-space being isolated between that end and the piston G, in combination with such piston, and with a hoist-rope B, B′, and provisions for operating such piston, and with the pulleys C and E, and the counterbalance weight P and the rope M, M′, and

pulley therefor, arranged as shown, so that the plenum of air during the period while the car is near the top will tend to counterbalance the friction of the machine, and that there shall be a neutral period when the piston has performed a fraction of its traverse, and that the partial vacuum during the period while the car is performing the lower portion of its traverse will tend to balance the weight of the ropes, all substantially as herein specified.

2. In an elevator the cylinder A having its ends closed so as to isolate the air between one end and the piston G, in combination with such piston and with provisions for operating the hoist rope B, B′ thereby, and with such rope and the pulleys C and E, and a suitable counterbalance weight and a rope and pulley therefor and with a loaded check valve J and means as a spiral spring and adjusting screw and hand wheel K for varying the load on the said valve, arranged to allow fluid to be driven out and forbid its entrance, and thus to automatically make and maintain a correct adjustment of the quantity of air inclosed, as herein specified.

3. In an elevator, a cylinder having its end closed, in combination with a check-valve adapted to allow fluid to be driven out and forbid its entrance, and a suitable hoist rope and a counterbalance weight and a rope and pulley therefor, and with a trap I arranged substantially as shown, so as to allow water to be expelled while the air is retained and the quantity automatically adjusted, substantially as herein specified.

4. In an elevator, a cylinder having its ends closed, in combination with a check-valve J′, and a load as a spring, arranged to allow the air to be driven out when the pressure attains a certain point, and forbid its entrance, and with a trap I arranged substantially as shown, so as to allow water to be expelled while the air is retained, and a suitable hoist rope and a counterbalance weight and a rope and pulley therefor, substantially as herein specified.

In testimony that I claim the invention above set forth I affix my signature in presence of two witnesses.

CHARLES R. WHITTIER.

Witnesses:
CHARLES R. SEARLE,
M. F. BOYLE.