W. C. STRANG.

CONTROLLING APPARATUS FOR ELEVATORS.

APPLICATION FILED DEC. 4, 1912.

1,190,969.

Patented July 11, 1916.

4 SHEETS—SHEET 1.

Fig. 1.

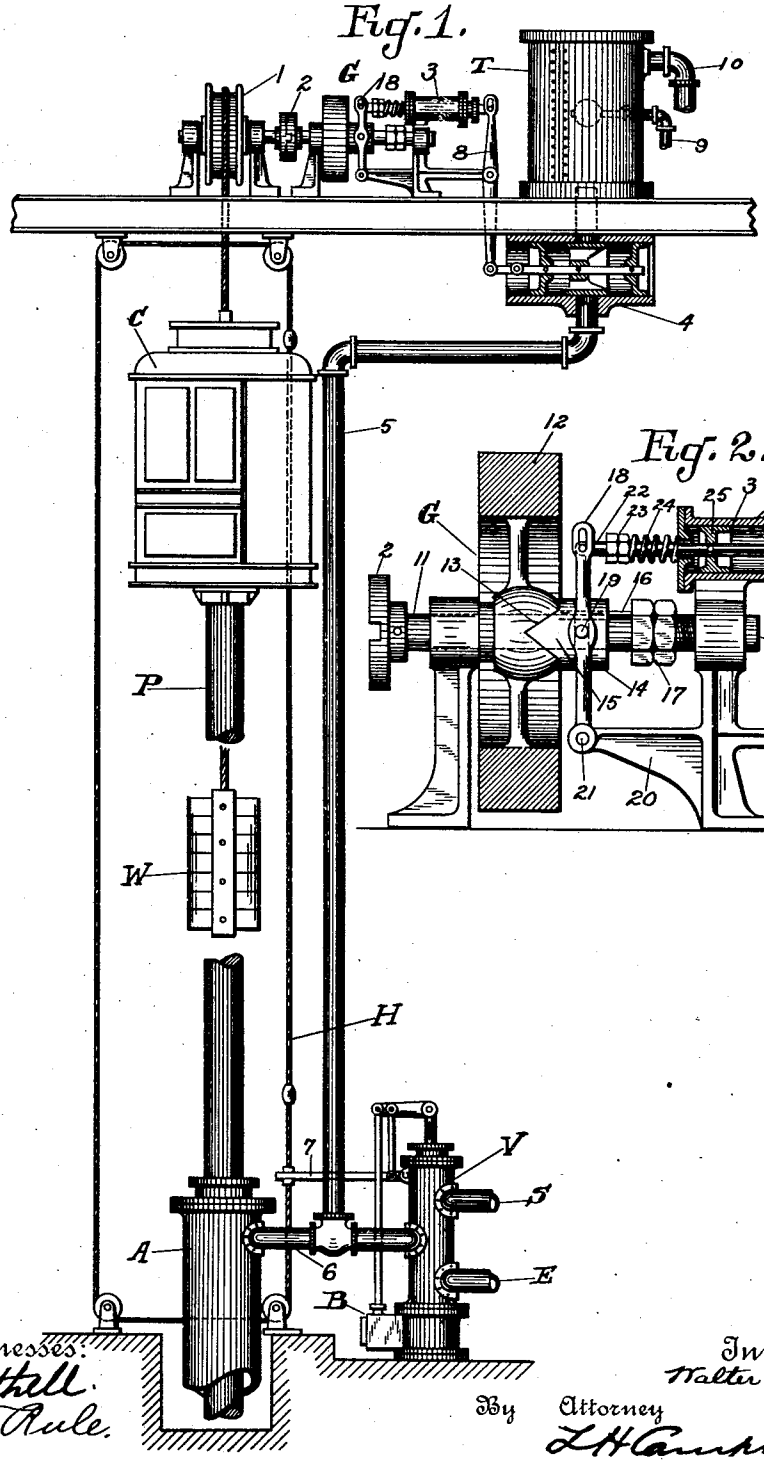


Fig. 2.

Witnesses:

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4 SHEETS—SHEET 2.

Fig. 3

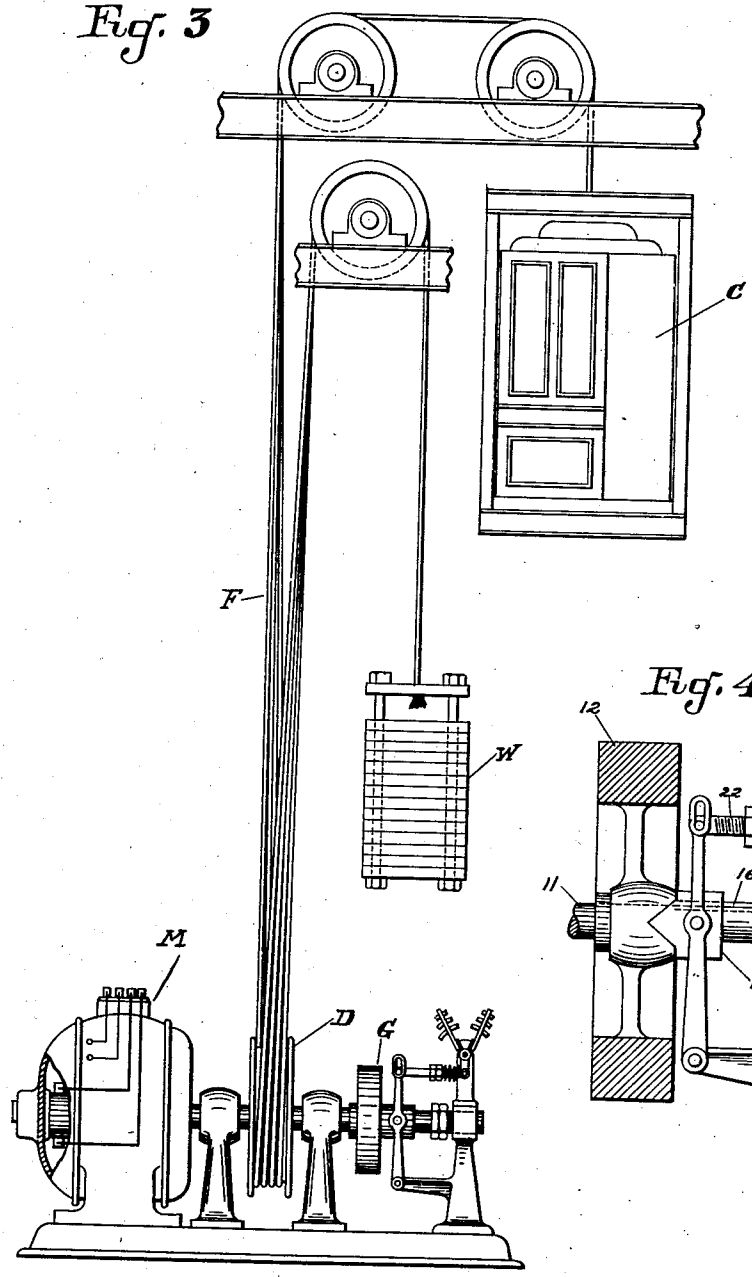


Fig. 4

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4 SHEETS—SHEET 3.

Fig. 5

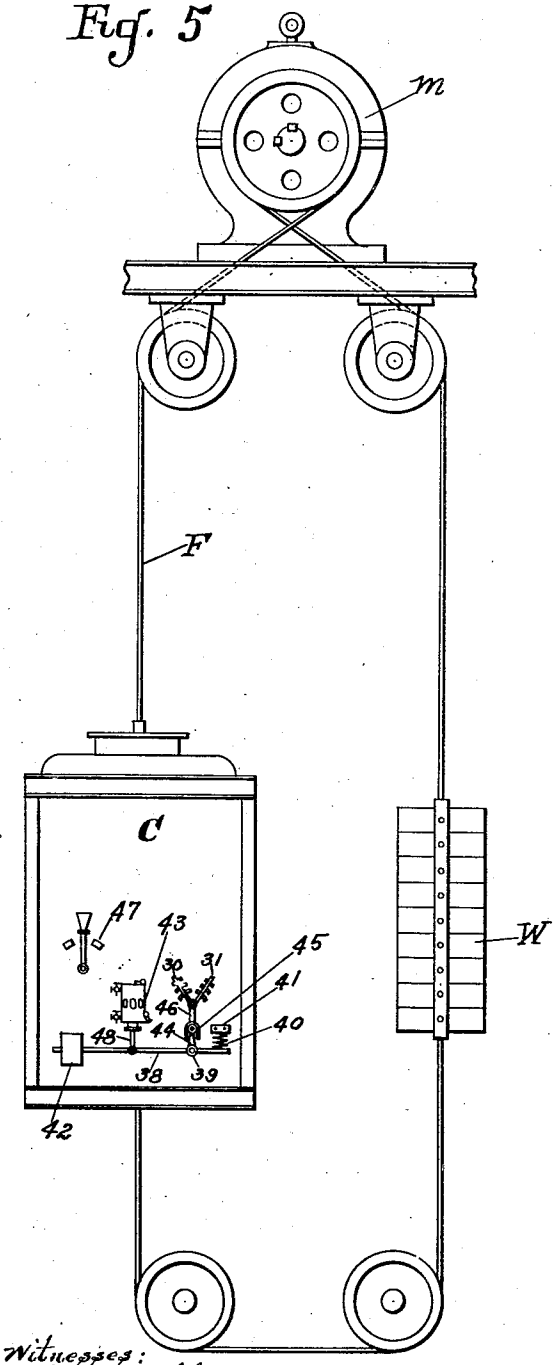
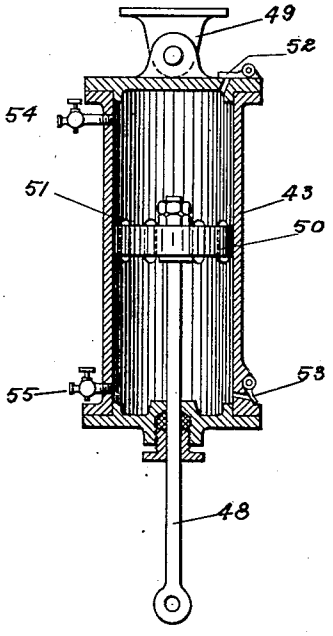


Fig. 6



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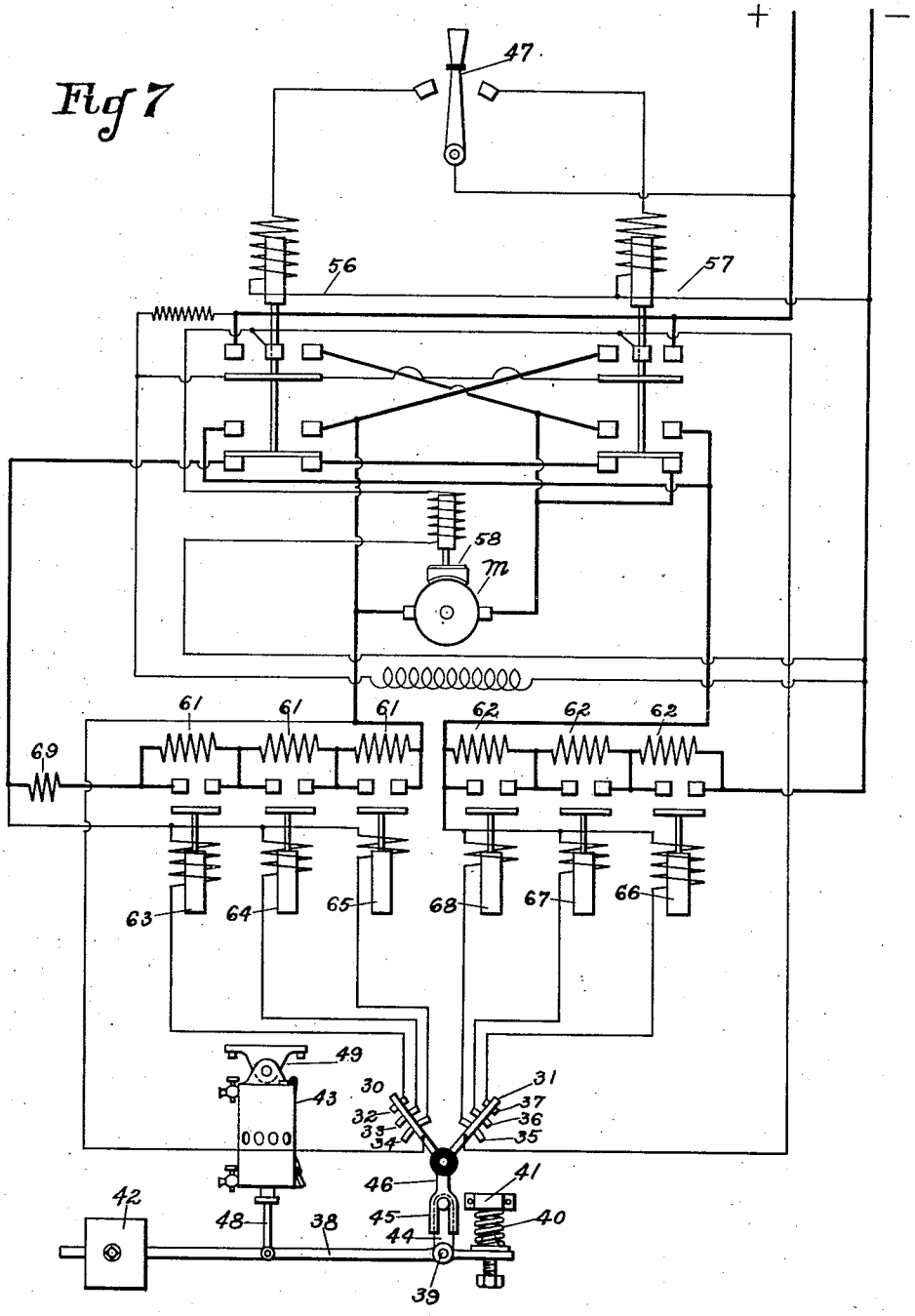
CONTROLLING APPARATUS FOR ELEVATORS.

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1,190,969. Patented July 11, 1916.

4 SHEETS—SHEET 4.

Fig 7



Witnesses:
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UNITED STATES PATENT OFFICE.

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CONTROLLING APPARATUS FOR ELEVATORS.

1,190,969. Specification of Letters Patent. Patented July 11, 1916.

Application filed December 4, 1912. Serial No. 734,828.

To all whom it may concern:

Be it known that I, WALTER C. STRANG, a citizen of the United States, residing in Yonkers, in the county of Westchester and State of New York, have invented a new and useful Improvement in Controlling Apparatus for Elevators, of which the following is a specification.

My invention relates to a system of automatic control for elevators, and has for an object the provision of simple, practical and efficient means for controlling the operation of power driven hoisting apparatus.

Another object of the invention is the provision of an automatic governing device for controlling the speed of an elevator car.

Another object is the provision of a device for controlling the acceleration and deceleration of an elevator car under all conditions.

A further object of the invention is the provision of an inertia controlling device for preventing the too sudden starting, stopping and change in speed of an elevator car under all conditions of load and speed.

Other objects will appear hereinafter, the novel combinations of elements being pointed out in the appended claims.

In the operation of a modern elevator system, one of the most difficult obstacles to overcome is the proper starting and stopping of an elevator car, as well as to effect a proper variation in speed from fast to slow, or from slow to fast while the car is traveling in either direction. It is readily seen that it is out of the question to leave the entire control of an elevator to the operator in the car, since as a rule the operator is indifferent or careless, and it would be positively unsafe to leave the running of the car to his care, unless certain safeguards were not first provided to limit his control. In other words the operation of the modern elevator system is made automatic as far as it is possible to do so, so as to take away from the operator all control of the car except the power to start, stop and reverse the same. As the height of buildings is becoming greater every day and the speed of elevators is being increased to meet the new conditions, the proper control of these high speed elevators presents a problem of no small importance, for, while it is a comparatively easy matter to control a slow moving elevator car, it is much more difficult satisfactorily to control a high speed elevator. It is well known that the human body may be accelerated from rest to any desired speed providing the rate of acceleration does not exceed a predetermined amount, otherwise, great discomfort is produced and if carried to extremes a positive danger is introduced. The same holds true where a person is traveling at one speed and that speed is abruptly changed to a higher or lower speed. The control of an elevator is effected in various ways depending upon the type of elevator, that is, whether it is a hydraulic, steam, electric or other power driven elevator. Take for example the well known plunger type of hydraulic elevator which is controlled by its main and pilot valves. In a high speed elevator of this type, if the valve be closed too quickly with a descending car, the latter is brought suddenly to rest while the inertia of the unbalanced load produces an enormous pressure within the plunger cylinder, which is in itself a source of great danger not to speak of the effect on the passengers in the car. If the valve be suddenly closed with an ascending car, the momentum of the unbalanced load causes the car to continue in an upward direction, until the same is brought to rest by gravity, the plunger separating from the water in the cylinder. As soon as the car comes to rest it immediately falls back again and the plunger strikes the incompressible water a blow and is at once stopped in its movement with a violent shock. Various valves and other mechanism have been devised from time to time to overcome these undesirable features, but only to meet with indifferent success, and such devices are as a rule expensive and complicated, and in general are not to be relied upon.

In the electric elevator the control is effected by regulating the current in the hoisting motor; both in starting and stopping, and this is usually effected by automatically controlled switches which are generally arranged to regulate the amount of current passing in the motor armature and field so as to effect a gradual start and stop. If

these switches be adjusted so as to effect the proper acceleration or deceleration of the elevator car with a predetermined load, any variation in load will tend to change the rate of acceleration or deceleration so that the car may acquire or lose speed too rapidly or too slowly. In one case the rate of acceleration may be excessive so as to effect a violent shock to the elevator apparatus or discomfort to the passengers, while in the other case much valuable time may be lost.

The foregoing conditions exist more or less in substantially all types of elevators and it is the chief object of my invention to overcome all of the above as well as other undesirable features.

In the drawings accompanying this specification, Figure 1 represents a hydraulic elevator system containing an embodiment of my invention; Fig. 2 is an elevational view in part section of an inertia governor arranged to effect the desired control of the elevator; Fig. 3 is an electric traction elevator system containing an embodiment of my invention; Fig. 4 is a detail view in part section of the governor device shown in Fig. 3; Fig. 5 is a diagrammatic representation of a traction elevator containing an embodiment of my invention in a modified form; Fig. 6 is a detail sectional view of the double acting dashpot device shown in Fig. 5; Fig. 7 is a wiring diagram of the electrical circuits associated with the elevator systems shown in Figs. 3 and 5.

Similar reference characters denote similar parts in all the figures.

Referring to Figs. 1 and 2, I show a typical plunger hydraulic elevator comprising an elevator car C partially counterbalanced by a weight W and carried upon the upper end of a plunger P, which is adapted to reciprocate in the plunger cylinder A. A main valve V is connected by the to-and-from pipe 6 to the cylinder A and effects the upward and downward movement of the elevator car by admitting water to or exhausting water from the cylinder A through the supply and exhaust pipes S and E respectively. The main valve V is controlled by the pilot valve B, which in turn is operated from the elevator car by any one of several well known methods such as the handrope H and connected lever 7.

Thus far the description will apply to any standard plunger elevator. In carrying out my invention, a governor G is connected through a coupling 2 to the overhead sheave 1 which always rotates at the same speed as that of the car. The governor G operates a lever 8 which is connected to a valve 4 located between a tank T and a pipe 5. The latter connects with the to-and-from pipe 6 of the elevator. The tank T is open at the top and is always filled or partially filled with water and maintained in that condition by a supply pipe 9 and float-ball-valve connected thereto; an overflow pipe 10 being provided near the top of the tank. The valve 4 is preferably a balanced valve as shown and the same controls the fluid connection between the tank T and plunger cylinder A. As seen in Fig. 2, the governor G comprises a shaft 11 which is carried by suitable brackets near either end and which supports a fly wheel 12 free to turn thereon. The latter contains a V-shaped notch 13 in one hub adapted to receive a corresponding V-shaped projection 15 in a sleeve 14 which is positively driven by the shaft 11 through a feather 16, but has a bodily movement thereon. A yoked lever 18 is pivoted at 21 to a bracket 20 and straddles the sleeve 14, and is operatively connected thereto by means of a pair of oppositely disposed pins such as 19 which enter a circumferential groove in the said sleeve. A pair of nuts 17 are threaded upon the shaft 11 adjacent the sleeve 14 and limit the bodily movement of the latter thereon. The upper end of the yoked lever 18 is connected by a slot and pin connection to a rod 22 carrying upon it a valve 25 adapted to move in a cylinder 26 tightly closed at its right hand end. The piston 25 and cylinder 26 form a dashpot device for dampening the movement of the lever 18; the piston having a freedom of movement in a right hand direction by reason of the check valve 27 but being restricted in its movement in a left hand direction to an extent which may be controlled or regulated by the pet-cock 28. A spring 24 is carried upon the rod 22 and bears against the head of the dashpot and a pair of adjusting nuts 23 and the purpose of this spring is to maintain the sleeve 14 in contact with the hub of the fly wheel 12.

The governor G may be termed an inertia governor and its operation is as follows: As the shaft 11 is rotated, the sleeve 14 is rotated with it and owing to the action of the inclined planes comprising the sleeve wedge 15 and V-slot 13 in the fly wheel hub, the fly wheel is also rotated. If, now, the speed of the shaft 11 be abruptly reduced, the fly wheel, owing to its momentum, will tend to resist this reduction of speed and hence there will be a relative rotary movement between the fly wheel and sleeve 14, which latter, as before pointed out, must rotate with the shaft and at the same speed thereof. It is at once apparent that any relative change in speed between the sleeve and fly wheel will cause the inclined faces of the sleeve wedge to ride up out of the notch in the fly wheel hub, thereby moving the sleeve bodily in a right hand direction along the shaft 11 and thus operating the dashpot rod 22 and valve 25. This move-

ment of the sleeve is opposed by the spring 24 but not by the dashpot owing to the relief valve 27. As the momentum of the fly wheel is overcome and its speed falls to that of the shaft 11, the spring 24 is enabled again to seat the sleeve wedge into the fly wheel notch, thereby moving the rod 22 and dashpot valve 25 to the left, the rod being controlled in this movement by reason of the vacuum set up in the dashpot cylinder under control of the pet cock 28. If the speed of the shaft be increased beyond a certain predetermined rate the inertia of the fly wheel will cause it to lag behind the shaft and sleeve and the rod 22 will, as before, be moved in the same direction and controlled in an opposite direction by the dashpot. The nuts 17 on the shaft 11 prevent the sleeve from moving too far away from the fly wheel, the nuts 23 on the rod 22 control the sensitiveness of the governor, while the pet cock 28 controls the movement of the rod 22.

Referring again to Fig. 1, the operation of a hydraulic elevator system containing an embodiment of my invention is as follows: Assuming the car to be traveling downward and the operator suddenly centers the pilot valve by means of the hand rope H to stop the car. The main valve at once responds and tends abruptly to cut off the outflow of water from the plunger cylinder. Under these circumstances the car will tend suddenly to come to rest being abruptly halted in its downward travel by reason of the imprisoned and incompressible fluid under the plunger. At this time, however, the tendency to effect a rapid change of speed is immediately felt by the governor, the momentum of the fly wheel acting to open the valve 4 and establish a communication between the tank T and the plunger cylinder A through the pipe or riser 5. The water in the plunger cylinder may now back up into the tank T, thereby relieving the pressure under the plunger and check the tendency of a too rapid stop of the car. In the meanwhile the fly wheel of the governor will lose its momentum and the valve 4 gradually close again, its speed of closing being controlled by the dashpot. As the valve 4 is gradually closed the water flowing from the plunger cylinder into the tank T will be gradually cut off and the elevator car will smoothly and gently come to rest.

In a similar manner if the car operator attempts to start upwardly again too suddenly the rate of speed change acting through the governor will move the valve 4 so as to open a communication between the to-and-from pipe 6 and the tank T and a portion of the supply will by-pass into the tank and thus prevent a too sudden start and acceleration of the car due to a too rapid entry of water under pressure into the plunger cylinder.

The governor may be so adjusted by the means furnished for that purpose so that the same will not act when the rate of starting and stopping or varying the speed while running is within proper limits, but it will act under a predetermined speed change under all conditions.

Referring to Fig. 3, I there show a traction drive electric elevator in which an electric motor M is adapted to drive a sheave D in frictional engagement with a plurality of cables F connected at opposite ends to an elevator car C and counterbalance weight W. The governor G may be driven directly from the motor shaft as shown or by any other part of the elevator apparatus, which operates synchronously with the elevator car. The governor G shown in Fig. 4 is substantially the same as that shown in Fig. 2, only in the present instance the governor rod 22 is connected to a lever 29 which carries upon one end, but insulated therefrom, a pair of contact arms 30 and 31 adapted to move over a series of stationary contacts of different lengths such as 32, 33, 34 and 35, 36, 37, respectively, which may be connected to corresponding conductors or wires associated with the controlling system of the elevator and which will be pointed out later in connection with Fig. 7. This governor may be provided with a dashpot similar to that shown in Fig. 2, and it is preferably so equipped.

In Fig. 5 is shown an electric traction elevator in which the governor or speed controlling device is arranged in a different form than that already discussed and is carried directly upon the elevator car. In this instance the governor (see Fig. 7) comprises a long lever 38 pivoted at an intermediate point 39 to the car C and having an adjustable weight 42 near one end and a compression spring 40 near the other end which bears against a fixed stop 41 and tends to counteract the weight 42. A lever 44 is secured to the lever 38 and has a pin thereon which lies in a U-shaped member 46 carrying a pair of contact arms 30 and 31. A double-acting dashpot 43 is hung from the car by a bracket 49 and is operatively connected by the piston rod 48 to a suitable point on the lever. This dashpot is shown in detail in Fig. 6, and comprises a piston which normally occupies a position midway between the closed ends of the dashpot cylinder. Both ends of the dashpot cylinder are closed air tight and are provided with check valves 52 and 53 opening outwardly and pet cocks 54 and 55. At the center of the dashpot are a series of elongated holes or slots 51 which are wider than the thickness of the piston 50.

The operation of the governor shown in

Figs. 3 and 4 is similar to that already described in connection with Figs. 1 and 2, only in Figs. 3 and 4, the governor moves the contact arms 30 and 31 over their respective stationary contacts in a left hand direction and back to center position as shown.

The operation of the governor device of Fig. 5, while embodying substantially the same principle as that of the inertia governors already described, operates in a somewhat different manner. The lever 38 is, under normal conditions, equilibrated by the opposing actions of the weight 42 and the spring 40. If the car is at rest or traveling at a constant speed this lever will remain in equilibrium no matter what the speed may be. If, however, the car undergoes a change of speed, say from a high speed in a downward direction to a slower speed, the momentum of the weight 42 will tend to rock the lever about its pivot in an anti-clockwise direction and thereby move the contact arms 30 and 31 in a clockwise direction over the stationary contacts associated therewith. If the car be suddenly started upwardly from a position of rest, the weight 42 will tend to hang back, due to its inertia, with the result just pointed out, while if the car be suddenly started downward the weight will tend to lose in effective weight and the spring 40 will be enabled to rock the lever 38 in a clockwise direction, again effecting a movement of the contact arms, only at this time in the opposite direction. The dash pot permits the initial movement of the lever without any retarding action owing to the arrangement of the check valves 52 and 53, but it will retard the return of the lever to equilibrated position for both directions of movement an amount depending upon the extent of opening of the pet cocks 54 and 55. While the contact-carrying lever 46 of Figs. 5 and 7 is capable of movement in both directions from a central position, and the contact carrying lever 29 of Figs. 3 and 4 only moves in one direction past central position, the control of the electrical circuits associated with these contacts 32, 33, 34 and 35, 36, 37, is similarly effected.

In Fig. 7, I show a system of electrical circuits well adapted to an electric elevator embodying my invention, and which may be used with either of the types of inertia governors as shown in Figs. 3 or 5. The starting, stopping and reversing of the elevator motor M is effected from the car switch 47 which is operatively connected to the reversing switches 56 and 57 which operate to establish the proper motor armature, field and brake circuits in a well known way from the source of current supply designated by + and −. A sectional resistance 62, 62, 62 is used in starting and is controlled by a series of accelerating magnets 66, 67 and 68, arranged to operate in successive order gradually to short circuit the sectional resistance 62 by the varying counter electro-motive force of the motor armature. A sectional resistance 61, 61, 61, performs the same functions in stopping the motor, being connected across the armature terminals when both reversing switches are in stopping position, the short-circuiting of the stopping resistance being effected by the stopping magnets 63, 64 and 65, which are also connected to the motor armature terminals in stopping and operate gradually to short-circuit the sections of stopping resistance according to the varying counter-electro-motive force of the motor in stopping, thereby effecting a variable dynamic brake action which is assisted by the usual friction brake 58. A resistance 69 alone is never cut out of the stopping circuit and by its presence it prevents damage to the motor by any excessive dynamic brake current.

It will be observed that one terminal of each accelerating and stopping magnet is connected through the governor contacts 37, 36, 35 and 32, 33, 34, respectively, and hence, by controlling the circuits to these various magnets by means of the inertia governor, the control of the elevator may be effected by the governor throughout its every movement. For example, let us assume that the elevator car is lightly loaded and the operator in the car desires to go up. Should the motor tend to accelerate too rapidly and the accelerating magnets attempt to short circuit the starting resistance without allowing sufficient time for the car gradually to acquire speed, the rate of change of car speed will be such that the governor will move the contact arm 31 off of more or less of the contacts 37, 36 and 35 in successive order, depending upon the rate of speed change, thereby open circuiting more or less of the accelerating magnets 66, 67 or 68 and thus introducing all, or a portion of, the starting resistance back into the armature circuit and checking the tendency of the elevator car to attain full speed at an excessive rate of acceleration. If the car be traveling at full speed and it is desired to stop the same, the dynamic brake circuit comprising the sectional resistances 61, 61, 61, is closed across the armature brushes by the lowermost contacts of the reversing switches and the stopping magnets 63, 64 and 65 are energized at the same time successively to short circuit the stopping resistance and thus slow down and stop the motor and car. Should, however, the rate of stopping or deceleration be excessive, the governor will move the contact arm 30 so as to open circuit one or more of the stopping magnets, thereby reinserting more or less of the stopping resistance in the armature circuit and in this manner con-

trolling the braking or stopping effect in proportion to the rate of speed reduction of the car and motor. The dashpot controls the return of the governor to equilibrated position and hence controls in a measure the action of the governor and prevents a too sudden or violent movement of the same while at the same time without interfering with its proper functions.

The governor device will respond instantly to excessive speed changes of the car or motor under all conditions met in practice, and affords a simple and effective means for absolutely preventing too quick a start or stop or change of speed for both directions of travel, thereby guarding against any undue or excessive strain throughout all parts of the hoisting apparatus and preventing any discomfort to the passengers caused by excessive speed changes.

The particular elevator apparatus shown in the accompanying drawings is merely typical and was chosen for the purpose of illustrating the invention and its operation as clearly as possible, and I desire not to be limited to the specific arrangement and construction of parts herein set forth, since it is obvious that my invention is applicable to any and all types of power driven elevators or hoisting apparatus of all descriptions and furthermore the same may be used to advantage with any apparatus in which it is desired to control the rate of speed changes of a power driven movable member of which an elevator car is but one example.

I believe it is broadly new automatically to control an elevator car by means whose action is governed by the rate of speed changes to which the elevator may be subjected.

What I claim, and desire to secure by Letters Patent of the United States is:—

1. In an electric elevator, the combination of a hoisting motor, means for varying the current in the said motor in starting and stopping, and additional means dependent for its operation upon the rate of speed variation of the motor for controlling the current in said motor both in starting and stopping.

2. In an elevator, the combination of a car, an electric motor operatively connected thereto, means for controlling the motor, and additional means operative upon excessive speed variation in the said car for reducing the current flow to the motor.

3. In an elevator, the combination of a car, an electric motor operatively connected thereto, a starting and dynamic stopping resistance for the motor, means for controlling the said resistances, and means dependent upon the rate of speed change in the said car for controlling the said resistance controlling means.

4. In an elevator, the combination with a vertically movable load carrying device, an electric motor for operating the device, means for controlling the speed of the motor, an inertia controlled means for controlling the rate of speed variation of the motor both in starting and stopping.

5. In an elevator, the combination with a vertically movable load carrying device, an electric motor for operating the device, means for controlling the speed of the motor, and additional motor controlling means independent of the counter-electromotive force of the motor for controlling the speed of the motor both in starting and stopping.

6. In an elevator, the combination with a vertically movable load carrying device, an electric motor for operating the device, a resistance in a circuit of the motor, means for cutting out said resistance in starting the motor, and inertia controlled means for reinserting said resistance upon excessive acceleration of the motor.

7. In an elevator, the combination with an electric hoisting motor, a resistance for controlling the acceleration of the motor, a resistance for controlling the deceleration of the motor, and means dependent for its operation upon the rate of speed change of the motor for varying said resistances.

8. In an elevator, the combination with an electric hoisting motor, a resistance for controlling the acceleration of the motor, a resistance for controlling the deceleration of the motor, automatic means for controlling said resistances, and means controlled by the rate of speed variation of the motor for modifying the action of said automatic controlling means.

9. In an elevator, the combination with an electric hoisting motor, a starting resistance in a circuit of the motor, an electroresponsive device controlling the resistance, a stopping resistance in a circuit of the motor, an electroresponsive device controlling the stopping resistance, and means dependent upon the rate of change in speed of the motor for controlling said electro-responsive devices.

10. In an elevator, the combination with an electric hoisting motor, a starting resistance in a circuit of the motor, an electroresponsive device controlling the resistance, a stopping resistance in a circuit of the motor, an electroresponsive device controlling the stopping resistance, and inertia controlled means for controlling said electroresponsive devices.

11. In an elevator, the combination with an electric hoisting motor, a starting resistance in a circuit of the motor, an electroresponsive device controlling the resistance, a stopping resistance in a circuit of the motor, an electroresponsive device controlling the stopping resistance, and an equili-

brated lever responsive to variations in speed of the load carrying device for controlling said electroresponsive devices.

12. In an elevator, the combination with an electric hoisting motor, automatic means for effecting the starting and stopping of the motor in accordance with the load on the motor, and additional automatic means for modifying the operation of said starting and stopping means in accordance with the rate of speed variation of the motor.

13. In an electric elevator, the combination with an electric hoisting motor, a starting resistance in series with the motor armature, a stopping resistance in parallel with the motor armature, a series of switches for controlling said starting and stopping resistance, means for operating said switches to effect the starting and stopping of the motor, and additional means controlled by the rate of change in speed of the car for operating said switches.

14. A vertically movable elevator car, an electric motor operatively connected therewith, a resistance in the motor circuit for controlling its speed, and means dependent upon the rate of speed change of the motor for controlling said resistance.

15. In an elevator, the combination with an electric motor, a resistance in a circuit of the motor, means for cutting out said resistance in starting the motor, and inertia controlled means for reinserting said resistance into the motor circuit in the event of an excessive motor acceleration.

16. In an elevator, the combination with an electric motor, a resistance in a circuit of the motor, means for cutting out said resistance in starting the motor, and means dependent for its operation upon the rate of acceleration of the motor for reinserting the starting resistance into the motor circuit.

17. In an elevator, the combination with an electric motor, a starting resistance therefor, means for removing said resistance from the motor circuit, and automatic means dependent upon the rate of acceleration of the motor for reinserting said resistance in accordance with the rate of acceleration.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

WALTER C. STRANG.

Witnesses:
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JAMES G. BETHELL.