

May 12, 1959

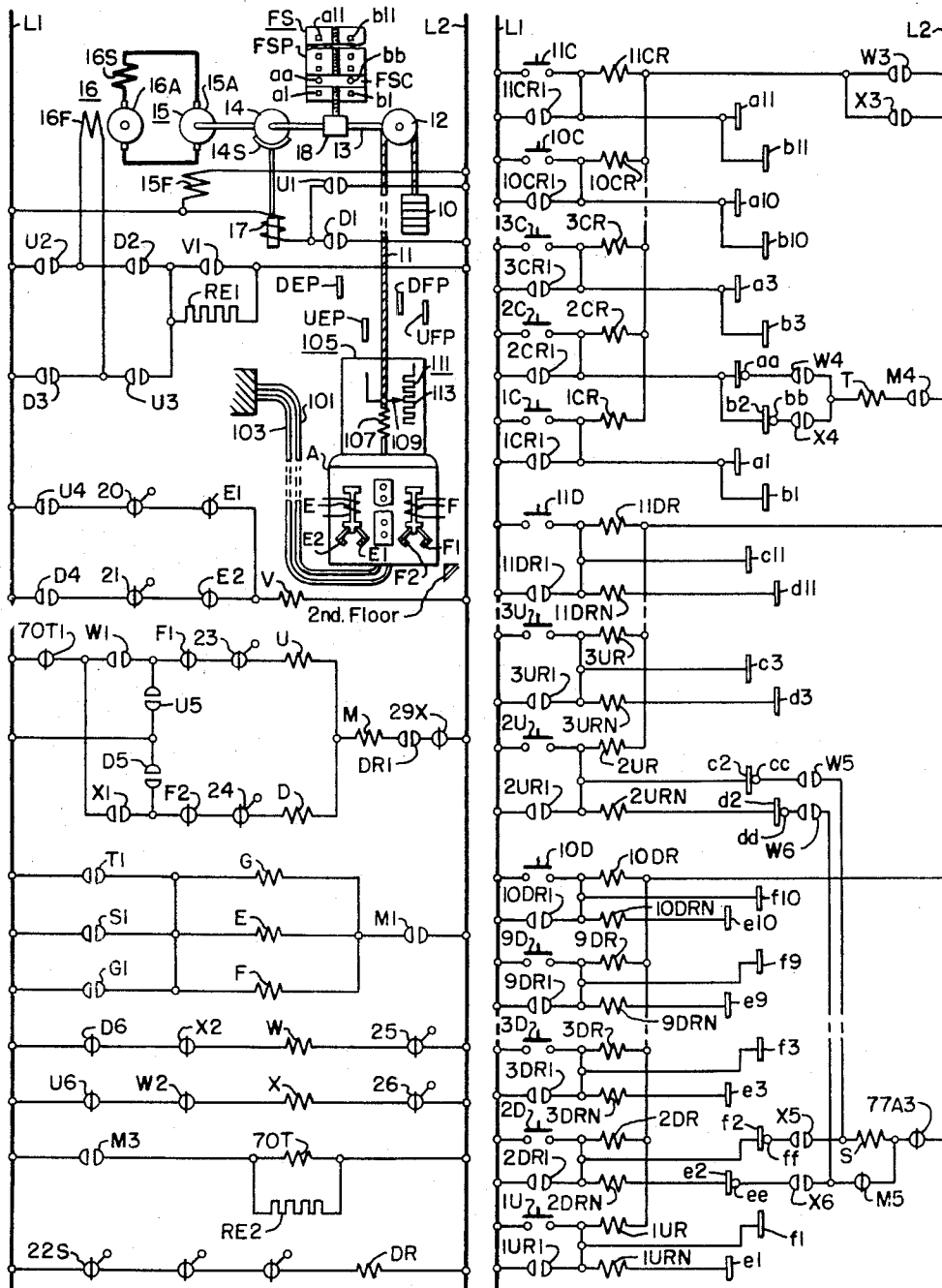
A. O. LUND ET AL

2,886,137

LOAD MEASURING DEVICE FOR ELEVATOR SYSTEMS

Filed March 27, 1958

4 Sheets-Sheet 1



(System of Suozzo et al Patent 2,727,591 With Modifications)

WITNESSES:

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Fig.1.

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4 Sheets-Sheet 2

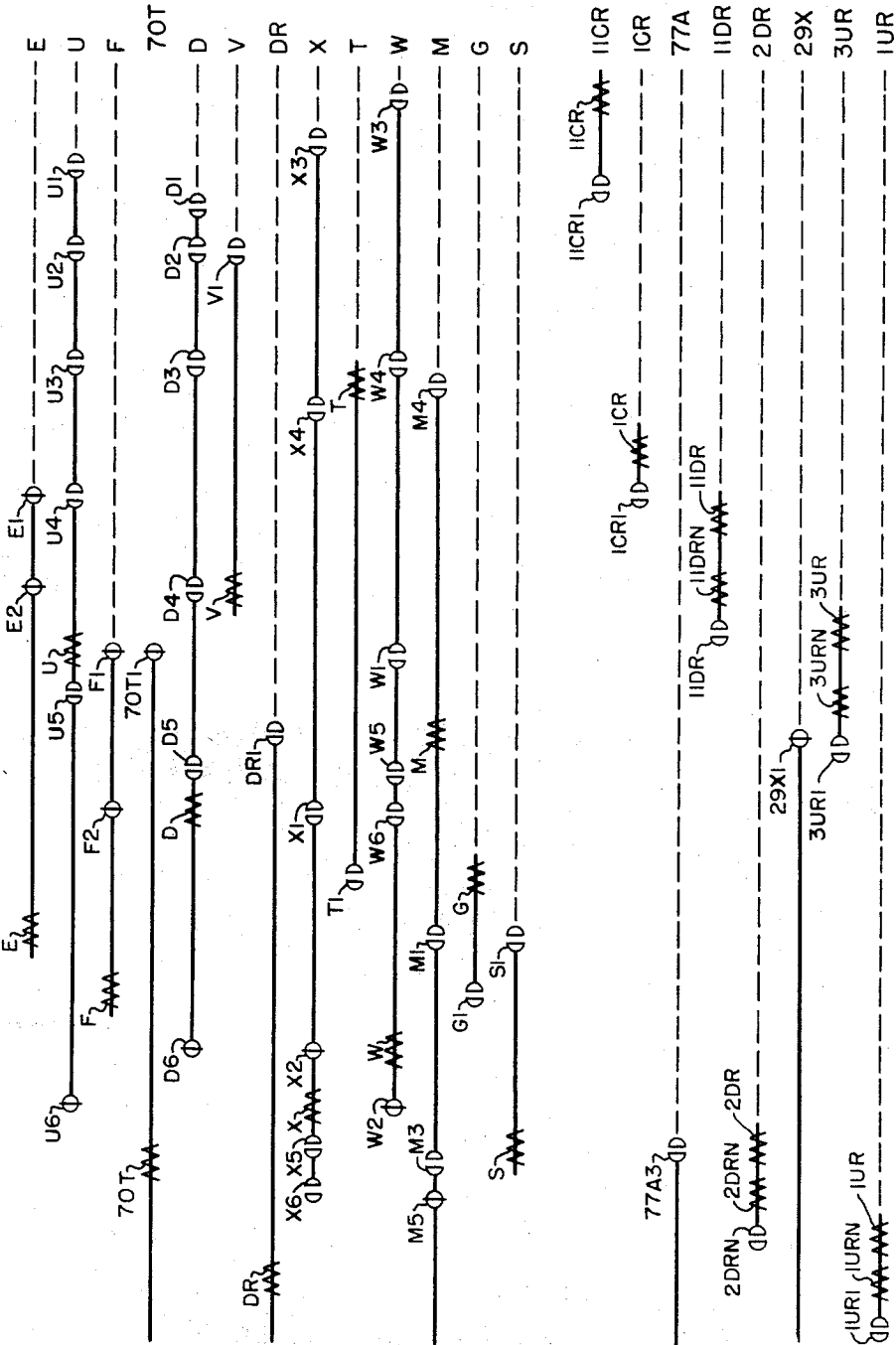
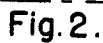


Fig. 1A.

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4 Sheets-Sheet 3



May 12, 1959

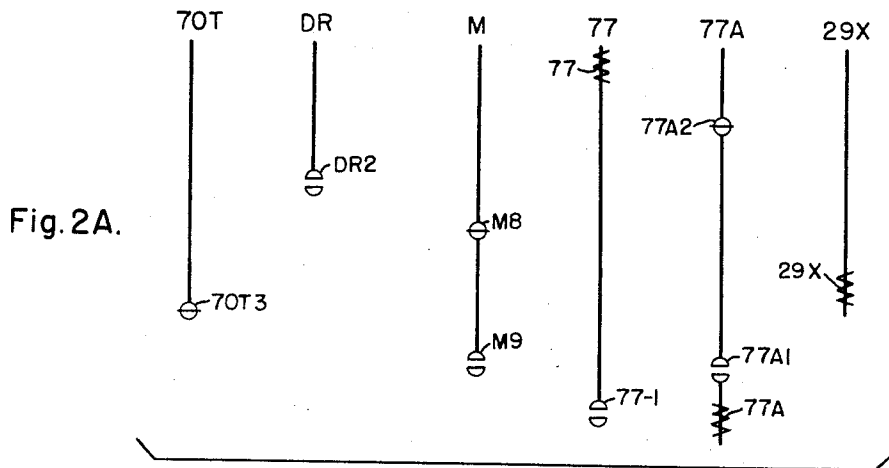
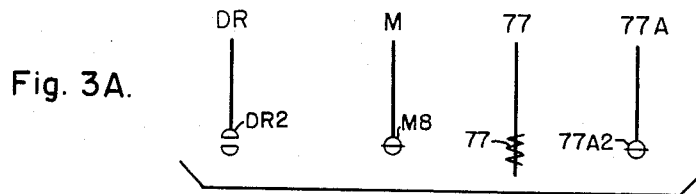
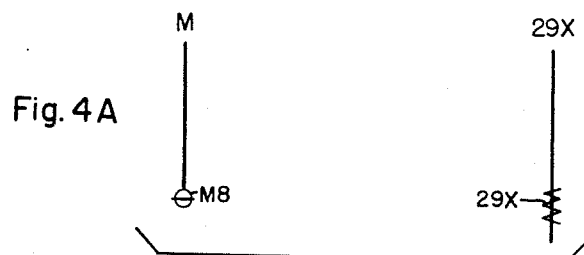
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2,886,137

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4 Sheets-Sheet 4



1

2,886,137

LOAD MEASURING DEVICE FOR
ELEVATOR SYSTEMS

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Application March 27, 1958, Serial No. 724,395

9 Claims. (Cl. 187—29)

This invention relates to elevator systems and it has particular relation to elevator systems employing a load-determining device for controlling operation of an elevator car.

The invention is applicable to elevator systems employing one or more elevator cars serving any desired number of landings or floors of a structure or building. The invention may be applied to an elevator system operated with or without attendants in the elevator cars. The invention is particularly suitable for elevator systems which are arranged for operation without attendants in the cars.

Elevator systems may be furnished with means for modifying the operation of an elevator car when the load carried by the car exceeds a predetermined value. For this purpose, a load-determining device may be utilized to ascertain the total load supported by the elevator car's hoisting rope, the device having an output which may be employed in various ways. For example, when a predetermined load supported by the hoisting rope is exceeded, the output of the load-determining device may be employed for operating switching means for preventing the elevator car from leaving a floor or for bypassing floors for which corridor calls have been registered by intending car passengers.

An elevator car is generally provided with a traveling cable for supplying electrical energy to the car. In addition to the traveling cable, the elevator car is often provided with a compensating rope or cable. It is particularly desirable to employ a compensating rope for an elevator car having a rise of a relatively large number of floors. It will be observed, however, that in such instance the total load supported by the hoisting rope comprises not only the weight of the elevator car, which is constant, and the weight of the load to be transported by the car, but also a "dead load" represented by those portions of the total weights of the traveling cable and the compensating rope supported by the elevator car. It follows, therefore, that the total load supported by the hoisting rope, assuming a constant car load, varies, depending upon the vertical position of the elevator car as it moves between its limits of travel. Thus, the total hoisting rope load is least when the elevator car arrives at the bottommost landing and greatest when the car arrives at the topmost landing (assuming the same car load at both positions). Operation of the load-determining device described above is thus dependent upon both the elevator car load and the vertical position of the elevator car with respect to the structure which it serves.

In accordance with the invention, an elevator car having a traveling cable and a compensating rope is provided with a load-weighing device responsive to the total load supported by the car's hoisting rope. Compensating means is provided for compensating for the variable component of such total load. In a preferred embodiment of the invention, the compensating means is responsive to the vertical position of the elevator car.

2

The load-weighing device has an output which is combined with the output of the compensating means for initiating a modification in the operation of the elevator car upon the occurrence of a predetermined load in the car, regardless of the vertical position of the car with respect to the structure which it serves.

It is, therefore, an object of the invention to provide an improved load-determining device for elevator cars.

It is a further object of the invention to provide an elevator car having a hoisting rope with means for compensating for variable hoisting rope load.

It is another object of the invention to provide an elevator car which has a traveling cable and a compensating rope with a load-determining device operable to modify operation of the elevator car upon the occurrence of a predetermined load in the car, regardless of the vertical position of the car with respect to the structure which it serves.

Other objects of the invention will be apparent from the following discussion taken in conjunction with the accompanying drawing, in which:

Fig. 1 is a schematic view with circuits shown in straight-line form of portions of an elevator system embodying the invention.

Fig. 2 is a schematic view with electrical circuits shown in straight-line form of an additional portion of the elevator system illustrated in Fig. 1.

Fig. 3 is a schematic view with electrical circuits shown in straight-line form illustrating a modification of the portion of the elevator system shown in Fig. 2.

Fig. 4 is a schematic view with electrical circuits shown in straight-line form illustrating a modification of the circuits of Fig. 3.

Figs. 1A, 2A, 3A and 4A are key representations of electromagnetic switches and relays employed in the circuits of Figs. 1, 2, 3 and 4. If Figs. 1A, 2A, 3A and 4A are placed in horizontal alignment with Figs. 1, 2, 3 and 4, respectively, it will be found that the associated coils and contacts of the relays and switches of the horizontally aligned drawings are substantially in horizontal alignment.

Features of the present invention may be employed in single-car or multi-car elevator systems which are designed to serve structures or buildings having various numbers of floors. In a multi-car system, the system may include any desired number of elevator cars. However, in order to simplify the presentation as much as possible, the invention will be described with reference to the system shown in the Suozzo et al. Patent 2,727,591 which issued December 20, 1955. Insofar as is possible, the conventions employed in the Suozzo et al. patent will be adhered to in the present discussion. Components of the Suozzo et al. system which are herein illustrated, will be identified by the same reference characters employed in the Suozzo et al. patent.

Fig. 1 includes components of Figs. 1 and 2 of the Suozzo et al. patent associated with the elevator car A. The left-hand column of Fig. 1 is similar to the left-hand column of Fig. 1 of the Suozzo et al. patent with the following exceptions: switches 31 and 36S, manual start relay 80 and its contacts 80-1, and relay contacts J1, J2, M2, TR1 and TR2 have been removed; relay contacts 29X1, a traveling cable 101, a compensating rope 103 and a load-weighing device 105 have been added. The right-hand column of Fig. 1 is similar to the left-hand column of Fig. 2 of the Suozzo et al. patent with the exceptions that relay contacts IS1 have been removed and relay contacts 77A3 have been added. Operation of the above-named additional components is discussed below. Similar components of the three figures

operate in identical manner. For this reason, a detailed discussion of the components is believed unnecessary at this time. For convenience, however, the following components appearing in Fig. 1 are listed:

A—car
10—counterweight
11—hoisting rope
12—sheave
M—running relay
DR—door safety relay
FS—floor selector
70T—non-interference relay
22S—door safety switch
S—floor call stopping relay
W—up-direction relay
X—down-direction relay

Fig. 1 shows the elevator car A which is connected to a counterweight 10 through one or more flexible hoisting ropes or cables 11 passing over a traction sheave 12. For purpose of illustration, only one hoisting rope is shown. In addition, the elevator car A has been provided with a flexible traveling cable 101 and a flexible compensating rope or cable 103. The elevator car A serves eleven floors.

One end of the traveling cable and one end of the compensating rope are secured to the bottom of the elevator car, the other end of each being secured to the structure which the elevator car serves approximately halfway between the limits of vertical travel of the car. Since the use and application of traveling cables and of compensating ropes for elevator cars is well known in the art, it appears unnecessary to describe them further.

The elevator car A is also provided with a load-weighing device 105 in order to ascertain the total load supported by the hoisting rope 11. In a preferred embodiment of the invention the load-weighing device 105 comprises a helical spring 107 connected in series with the hoisting rope 11, as is shown in Fig. 1, or interposed between the rope 11 and the car A. Suitably secured to the hoisting rope 11 is an arm 109 of a rheostat 111. A resistance element 113 of the rheostat 111 is secured to the elevator car. Since deflection of the spring 107 is proportional to the load supported by the hoisting rope 11 and since the resistance element 113 is secured to the car, vertical movement of the elevator car with respect to the rheostat arm 109 upon deflection of the spring 107 will change the position of the arm 109 with respect to the ends of the resistance element 113. Thus, by making suitable connections to the rheostat 111, the load-determining device 105 may have a variable impedance output which may be used for controlling operation of the elevator car A, as hereinafter explained.

As noted above, due to the use of the traveling cable 101 and the compensating rope 103, the hoisting rope load is least when the elevator car arrives at the first floor and greatest when the car arrives at the eleventh floor (assuming the same car load at both positions). Operation of the load-weighing device as thus far described is, therefore, dependent upon both the elevator car load and the vertical position of the car with respect to the structure which it serves. It is desirable, however, in elevator systems wherein a load-weighing device is employed to control operation of an elevator car that such control be independent of the weight of the traveling cable and the compensating rope supported by the hoisting rope; i.e., that it be independent of the vertical position of the elevator car. For example, in passenger elevators it is desirable for the load-weighing device to control operation of the elevator car when the car is transporting a predetermined number or weight of passengers. For this purpose, the circuit shown in Fig. 2 may be used.

In Fig. 2 the rheostat 111 is used in conjunction with a saturable reactor or magnetic amplifier 115 of a type

well known in the art. The magnetic amplifier 115 has control or input windings 117 and 117', bias or reference windings 119 and 119' and load or output windings 121 and 121'. Each winding of each pair of windings has substantially the same number of turns. The windings are disposed in inductive relationship on a pair of substantially identical magnetic core members 123 and 123', respectively.

The magnetic amplifier 115 has a control circuit including the following series-connected components: the rheostat 111, a switch 125, and the windings 117 and 117'. The reference circuit of the magnetic amplifier includes the following components: resistors RR1 through RR11, contact segments k1 through k11, a brush kk and the windings 119 and 119'. Electrical energy for the control and the reference circuits is supplied from direct current voltage buses L1 and L2. The load circuit of the magnetic amplifier 115 includes the following series-connected components: a self-saturating rectifier 127, the windings 121 and 121', break contacts M8, make contacts DR2, break contacts 77A2, a coil of a passing control relay 77, which is paralleled by a discharge rectifier 128, and a switch 129 (assuming the switch 129 to be in closed condition, as shown in Fig. 2, the contacts DR2 to be closed, and a switch 131 to be in open condition). The load circuit is supplied with electrical energy from a suitable alternating current source 133.

The theory and the principles of operation of magnetic amplifiers are well known in the art. Briefly, the magnetic amplifier of Fig. 2 has a unidirectional half-wave output. By virtue of the rectifier 127 current flows in the load circuit and voltage is thereby developed across the coil of the passing control relay 77, upon saturation of the core members 123 and 123', during alternate half-cycles of the load circuit current source 133. The average values of such current and voltage depend upon the extent to which the core members are withdrawn from saturation during those alternate or reset half-cycles when no current flows in the load circuit, which is, in turn, determined by the current flowing in the reference and control windings. The magnetomotive force applied to each core member by its associated reference winding tends to withdraw the core member from saturation, while the magnetomotive force applied to each core member by its associated control winding has the opposite effect. Thus, for a given reference circuit current, the average load current, within the linear range of operation, will be proportional to the control circuit current. When there are magnetic flux changes in the core members 123 and 123', voltages are induced in the windings associated with each of the core members. In order to prevent circulating currents from flowing in the load, reference and control circuits because of such induced voltages and thus to improve the efficiency of operation of the magnetic amplifier, each pair of windings in these circuits is wound in series opposing relationship.

When the current flowing in the load circuit of the magnetic amplifier attains a predetermined value, the passing control relay 77 will pick up. Alternatively, when the switch 129 is in open condition and the switch 131 is in closed condition, the coil of an elevator car overload relay 29X, which is paralleled by a discharge rectifier 134, is substituted for the coil of the passing control relay 77 in the load circuit of the magnetic amplifier 115. The discharge rectifiers 128 and 134 in parallel with the coils of the relays 77 and 29X, respectively, provide these relays with slight dropout delays. Since the magnetic amplifier load circuit conducts current only on alternate half-cycles of the current source 133, such delays prevent relay "chatter" and insure positive pickup of that relay in the load circuit of the magnetic amplifier (depending upon the conditions of the switches 129 and 131) when the predetermined load is present in the elevator car.

It should be noted that, while the circuits of Fig. 2 are

shown to include a particular type of magnetic amplifier, other types of magnetic amplifiers, for example, a magnetic amplifier having unidirectional full-wave output, may be employed therein.

As long as either the passing control relay 77 or the elevator car overload relay 29X is not picked up, the operation of the elevator car A in the present case is substantially identical with its operation in the aforesaid Suozzo et al. patent. For this reason, the present discussion of the operation of the system will be directed primarily to the features which modify the operation presented in the Suozzo et al. patent. It will be assumed initially that the switch 129 is in closed condition and that the switch 131 is in open condition, as is shown in Fig. 2.

The elevator system of Fig. 1 is provided with a floor selector FS. In addition to the contact segments and brushes provided for the floor selector FS as described in the Suozzo et al. patent, the floor selector, for purposes of the present invention, is provided with contact segments *k1* through *k11* and a brush *kk* which is adapted to successively engage the contact segments *k1* through *k11* as the elevator car moves from the first to the eleventh floor of the structure (Fig. 2). Because of the similarity of these circuits, the contact segments and their respective associated resistors RR1 through RR11 are illustrated only for the first, second, third and eleventh floors. Thus, as the elevator car moves in an upward direction, resistors RR1 through RR11 are successively connected in series with the magnetic amplifier reference windings 119 and 119'. Each of these resistors has a resistance which is less than the resistance of that resistor immediately preceding it. As the elevator car moves from the first to the eleventh floor, therefore, the current flowing in the reference windings 119 and 119' increases, and progressively increasing bias is thereby applied to the magnetic amplifier. The converse is true, of course, as the elevator car travels in a downward direction. The resistors RR1 through RR11 are selected so that the change in the magnetic amplifier bias as the elevator car moves from floor to floor is a function of the change in the aforementioned "dead load" represented by those portions of the total weights of the traveling cable and of the compensating rope supported by the hoisting rope 11.

It will be recalled that the position of the rheostat arm 109 with respect to the ends of the rheostat resistance element 113 is a function of the total load supported by the hoisting rope 11. Referring to Fig. 2, the rheostat 111 is connected in the control circuit of the magnetic amplifier so that, as the load supported by the hoisting rope 11 increases, the resistance element 113 moves relative to the arm 109 in the direction indicated by an arrow 135. Since the passing control relay 77 will pick up only when the current flowing in the load circuit of the magnetic amplifier attains a predetermined value, it follows that, as the elevator car moves in an upward direction and the magnetic amplifier bias increases at each successively higher floor, greater control current will be required in order to effect pickup of the passing control relay 77. This, in turn, requires a greater movement of the rheostat resistance element 113 in the direction of the arrow 135 in order to effect pickup of the passing control relay 77. The converse is true for downward travel of the elevator car. It will be seen, therefore, that by proper design and selection of circuit components compensation may be provided for the variable component of the hoisting rope load, so that the relay 77 will pick up only when the load carried by the elevator car attains a predetermined value, regardless of the vertical position of the elevator car with respect to the structure. This is so despite the fact that, as heretofore pointed out, deflection of the spring 107 and movement of the rheostat resistance element 113 are dependent upon such position for a given car load.

For passenger elevators, the predetermined car load

mentioned above essentially amounts to a predetermined number of passengers, keeping in mind that this "predetermined number" may vary slightly from load to load, since all passengers will not necessarily weigh the same. Conveniently, the predetermined load may be 80% of the rated load of the elevator car.

Since the various relays of Fig. 1 operate in the same manner set forth in the aforesaid Suozzo et al. patent, a detailed discussion thereof is considered unnecessary. For present purposes, it is sufficient to point out that, as in the Suozzo et al. patent, the elevator car A is provided with a running relay M, a non-interference relay 70T, and a door relay DR, all of which operate in the same manner and for the same purposes as in the aforesaid Suozzo et al. patent. Thus, when the doors of the elevator car A close preparatory to movement of the elevator car to another floor, the door safety relay DR picks up, since safety switches 22S are then closed, thereby closing make contacts DR1. Assuming either contacts W1 or contacts X1 to be closed when the contacts DR1 make, the running relay M picks up. When the relay M picks up, contacts M3 make, and the non-interference relay 70T thereby picks up. As in the aforesaid Suozzo et al. patent, the elevator car A is also provided with a floor-call stopping relay S which is energized when the elevator car A is to stop at a floor in response to a registered floor call. The relay S initiates a stopping operation of the elevator car.

Operation of the control circuits associated with the load-determining device will now be described. Assuming that the elevator car A is stopped at a landing and that the car doors have closed after discharging or receiving a load at the landing, the door safety relay DR will pick up, closing make contacts DR2 in the load circuit of the magnetic amplifier 115. If the predetermined load necessary to effect pickup of the passing control relay 77 is present in the elevator car, the resulting closing of the make contacts 77-1 will place a passing relay 77A across the direct current voltage buses L1 and L2 to effect pickup of the relay 77A. When the relay 77A picks up, make contacts 77A1 close to complete with contacts 70T3 a holding circuit for the relay 77A, and break contacts 77A2 in the load circuit of the magnetic amplifier 115 open. As noted above, pickup of the door relay DR causes the running relay M to pick up as a result of the closing of the make contacts DR1. When the relay M picks up, make contacts M9 close to parallel the break contacts 70T3 in the holding circuit of the relay 77A. Pickup of the relay M is also accompanied by the closing of make contacts M3 to pick up the non-interference relay 70T. When the relay 70T picks up, break contacts 70T3 open, but the holding circuit for the relay 77A is maintained through the then closed contacts M9.

It will be observed that when the running relay M picks up, contacts M8 open to open the load circuit for the magnetic amplifier 115. Opening of the contacts M8 prevents possible false or unwanted operation of the passing control relay 77 which otherwise might occur when the elevator car is not carrying the predetermined load.

Pickup of the passing relay 77A is accompanied by the opening of its break contacts 77A3 in the circuit of the floor-call stopping relay S (Fig. 1). As long as the passing relay 77A remains picked up, therefore, the elevator car A is prevented from stopping at a floor in response to a floor call registered by an intending car passenger.

Inasmuch as the running relay M drops out when the elevator car A stops at a floor and the car doors are opened, the contacts M9 in the holding circuit of the passing relay 77A open, causing the relay 77A to drop out. At the same time, the contacts M8 close to partially reset the load circuit of the magnetic amplifier 115. Before the passing control relay 77 can pick up again upon reclosing of the car doors, the predetermined load must be present in the elevator car.

If, in Fig. 2, the switch 129 is in open condition and

the switch 131 is in closed condition, the coil of the elevator car overload relay 29X is substituted for the coil of the passing control relay 77 in the load circuit of the magnetic amplifier 115. Pickup of the relay 29X in the manner described for the relay 77 is accompanied by the opening of break contacts 29X1 in series with the coil of the running relay M (Fig. 1). Thus, when the load in the elevator car attains the predetermined value, the elevator car will be prevented from leaving a floor until the load in the car is lightened, at which time the elevator car overload relay 29X will drop out.

If instead of one hoisting rope the elevator car A is provided with a plurality of hoisting ropes, each of such hoisting ropes may have a spring 107 and a rheostat 111 associated therewith in the manner heretofore described. In such instance the individual rheostats 111 may be connected in series to reflect the total load supported by all of the hoisting ropes. The movable element of the switch 125 of Fig. 2 may then be conditioned to engage the bottom contact of the switch, as viewed in Fig. 2. All of the rheostats 111 will then be connected in series with the control windings 117 and 117', the circuit of Fig. 2 otherwise functioning in the manner heretofore described. Alternatively, in the case of a plurality of hoisting ropes, the individual rope loads may be totaled to obtain a resultant output representing the total load supported by all of the ropes by employing a load-determining device such as is described in the Rissler et al. Patent 2,604,782 which issued July 29, 1952.

The circuit of Fig. 3 may be substituted for that portion of the circuit of Fig. 2 contained within a broken-line box RE to effect the same results as the latter circuit when the switch 129 is in closed condition and the switch 131 is in open condition.

In Fig. 3, an electronic tube 141, preferably of the cold cathode gas type, replaces the magnetic amplifier 115 of Fig. 2. A tube such as the RCA 1C21 is satisfactory for this application and is illustrated. The tube 141 has a cathode 143, a starter anode 145 and an anode 147. Voltages for the tube electrodes are derived from a suitable alternating voltage source 149 connected to buses L3 and L4. The anode 147 is connected through the passing control relay 77, which is paralleled by a discharge rectifier 151, to the bus L3. The cathode 143 is connected through the break contacts 77A2 and M8 and the make contacts DR2 to the bus L4. When the elevator car door is closed and the door safety relay DR is picked up, the make contacts DR2 are closed to complete the cathode circuit of the tube 141 to the bus L4.

Bias and control voltages for the starter anode 145 are furnished by means of the following circuit: L3, brush *kk*, one of the contact segments *k1* through *k11* tapped resistor 153, resistance element 155 of voltage divider 157, and fixed resistor 159, one end of the fixed resistor 159 being connected to the cathode 143. The starter anode 145 is connected through a fixed isolating resistor 161 to an arm 163 of the voltage divider 157. The voltage divider 157 replaces the rheostat 111 of Fig. 1, the arm 163 and the resistance element 155 being suitably secured to the hoisting rope 11 and to the elevator car A, respectively.

Since the tube 141 cannot conduct current when the bus L4 is positive with respect to the bus L3 the following discussion of circuit operation will be confined to those half-cycles of the alternating voltage source 149 wherein the bus L3 is positive with respect to the bus L4.

The voltage applied to the anode 147 with respect to the cathode 143 is of itself insufficient to cause breakdown of the tube 141; and under normal conditions, i.e., when the elevator car is carrying a load less than the predetermined load referred to above, the positive bias applied to the starter anode 145 is insufficient to initiate breakdown of the tube 141.

It will be observed in Fig. 3 that the brush *kk* successively engages the contact segments *k1* through *k11*

of the floor selector FS to short out various portions of the tapped resistor 153, depending upon the vertical position of the elevator car with respect to the structure which it serves. Thus, the higher the position of the car, the smaller the portion of the tapped resistor 153 shorted out, and consequently the less positive the bias applied to the starter anode 145; and conversely for successively lower positions of the elevator car. The change in positive bias due to the operation of the brush *kk* as the elevator car moves between its limits of travel is an inverse function of the traveling cable and compensating rope "dead load" supported by the hoisting rope. This change counteracts the change in control voltage applied to the starter anode 145 due to movement of the resistance element 155 of the voltage divider 157 with respect to the voltage divider arm 163 as a result of the "dead load" change.

As mentioned heretofore, the voltage applied to the starter anode 145 is normally insufficient to initiate breakdown of the tube 141. Upon occurrence of the predetermined load in the elevator car, however, the resistance element 155 moves relative to the arm 163 in the direction indicated by an arrow 165 by an amount sufficient to increase the positive voltage applied to the starter anode 145 to a value great enough to initiate tube breakdown. Such breakdown results in tube current flow of a magnitude sufficient to cause pickup of the passing control relay 77, the elevator car control circuits thereafter operating in the manner previously described for Fig. 2.

The circuit of Fig. 4 is substantially the same as that of Fig. 3, except that the elevator car overload relay 29X is substituted for the passing control relay 77 in order to effect the same results which obtain upon pickup of the relay 29X in the circuit of Fig. 2 when the switch 129 is in open condition and the switch 131 in closed condition; when the predetermined load is present in the elevator car, the car is prevented from leaving a floor.

The discharge rectifiers 151 and 167 of Figs. 3 and 4, respectively, operate in substantially the same manner and for the same purposes as heretofore described for the discharge rectifiers 128 and 134 of Fig. 2. (It will be recalled that the tube 141 conducts current only on alternate half-cycles of the voltage source 149, i.e., those half-cycles during which the anode 147 is positive with respect to the cathode 143.)

While electrical energy for the circuits of Figs. 3 and 4 is shown to be supplied from the alternating voltage source 149, a suitable direct voltage source may be substituted therefor (L3+, L4-), operation of the circuits otherwise being essentially the same as heretofore described.

Conveniently, a tapped resistor similar to the tapped resistor 153 of Figs. 3 and 4 may be substituted for the resistors RR1 through RR11 in the reference circuit of the magnetic amplifier 115 of Fig. 2. Likewise, resistors similar to the resistors RR1 through RR11 of Fig. 2 may be substituted for the tapped resistor 153 in the bias circuit of the tube 141 of Figs. 3 and 4.

Although the invention has been described with reference to certain specific embodiments thereof, numerous modifications falling within the spirit and scope of the invention are possible.

We claim as our invention:

1. An elevator system comprising a structure having a plurality of vertically-spaced landings, an elevator car for transporting load, means mounting the elevator car for movement in two directions relative to the structure to serve the landings, a hoisting rope for continuously supporting the elevator car, motive means engaging the hoisting rope for moving the elevator car relative to the structure, control means operable for controlling the motive means to move the motive means and thereby the elevator car relative to the structure and for stopping

the elevator car at predetermined landings, load-measuring means for measuring the total load supported by the hoisting rope, said total load including a variable component dependent upon the vertical position of the elevator car with respect to the structure, compensating means for compensating for said variable component, and means responsive to said load-measuring means and said compensating means for modifying operation of said control means upon occurrence of a predetermined load in the elevator car.

2. An elevator system comprising a structure having a plurality of vertically-spaced landings, an elevator car for transporting load, means mounting the elevator car for movement in two directions relative to the structure to serve the landings, a traveling cable secured to the elevator car, a hoisting rope for continuously supporting the elevator car, a compensating rope for the hoisting rope, said traveling cable and said compensating rope being supported by the elevator car, motive means engaging the hoisting rope for moving the elevator car and thereby the traveling cable and the compensating rope relative to the structure, control means operable for controlling the movement of the elevator car by the motive means and for stopping the elevator car at predetermined landings, load-measuring means for measuring the total load supported by the hoisting rope, said compensating rope and said traveling cable exerting variable load on said hoisting rope, said variable load and thereby said total load varying in accordance with the vertical position of the elevator car with respect to the structure, compensating means for compensating for said variable load, and means responsive to said load-measuring means and said compensating means for modifying operation of said control means upon occurrence of a predetermined load in the elevator car.

3. An elevator system comprising a structure having a plurality of vertically-spaced landings, an elevator car for transporting load, means mounting the elevator car for movement in two directions relative to the structure to serve the landings, a hoisting rope for continuously supporting the elevator car, motive means engaging the hoisting rope for moving the elevator car relative to the structure, control means operable for controlling the motive means to move the motive means and thereby the elevator car relative to the structure and for stopping the elevator car at predetermined landings, load-measuring means for measuring the total load supported by the hoisting rope, said total load including an elevator car-position responsive component, position-responsive means responsive to the vertical position of the elevator car with respect to said structure for compensating for said car-position responsive component, and means responsive to said load-measuring means and said position-responsive means for modifying operation of said control means upon occurrence of a predetermined load in the elevator car.

4. An elevator system comprising a structure having a plurality of vertically-spaced landings, an elevator car for transporting load, means mounting the elevator car for movement in two directions relative to the structure to serve the landings, a hoisting rope for continuously supporting the elevator car, motive means engaging the hoisting rope for moving the elevator car relative to the structure, control means operable for controlling the motive means to move the motive means and thereby the elevator car relative to the structure and for stopping the elevator car at predetermined landings, resilient means connected in series with the hoisting rope, said resilient means having displacement proportional to the total load supported by the hoisting rope, said total load and thereby said displacement each including a variable component dependent upon the vertical position of the elevator car with respect to the structure, displacement-responsive means responsive to the total displacement of said resilient means, compensating means for compensating for

said variable displacement component, and means responsive to said displacement-responsive means and said compensating means for modifying operation of said control means upon occurrence of a predetermined load in the elevator car.

5. An elevator system comprising a structure having a plurality of vertically-spaced landings, an elevator car for transporting load, means mounting the elevator car for movement in two directions relative to the structure to serve the landings, a hoisting rope for continuously supporting the elevator car, motive means engaging the hoisting rope for moving the elevator car relative to the structure, control means operable for controlling the motive means to move the motive means and thereby the elevator car relative to the structure and for stopping the elevator car at predetermined landings, resilient means connected in series with the hoisting rope, said resilient means having displacement proportional to the total load supported by the hoisting rope, said total load and thereby said displacement each including a variable component dependent upon the vertical position of the elevator car with respect to the structure, displacement-responsive means responsive to the total displacement of said resilient means, position-responsive means responsive to the vertical position of the elevator car with respect to said structure for compensating for said variable displacement component, and means responsive to said displacement-responsive means and said position-responsive means for modifying operation of said control means upon occurrence of a predetermined load in the elevator car.

6. An elevator system comprising a structure having a plurality of vertically-spaced landings, an elevator car for transporting load, means mounting the elevator car for movement in two directions relative to the structure to serve the landings, a hoisting rope for continuously supporting the elevator car, motive means engaging the hoisting rope for moving the elevator car relative to the structure, control means operable for controlling the motive means to move the motive means and thereby the elevator car relative to the structure and for stopping the elevator car at predetermined landings, and modifying means for modifying operation of said control means upon occurrence of a predetermined load in said elevator car, said modifying means including first and second circuits, means for applying to said first circuit an electrical energizing quantity proportional to the total load supported by said hoisting rope, said total load including a variable component dependent upon the vertical position of the elevator car with respect to the structure, means for applying to the second circuit an electrical energizing quantity for compensating for said variable component, and means responsive to both said electrical energizing quantities for effecting said modification.

7. An elevator system comprising a structure having a plurality of vertically-spaced landings, an elevator car for transporting load, means mounting the elevator car for movement in two directions relative to the structure to serve the landings, a traveling cable secured to the elevator car, a hoisting rope for continuously supporting the elevator car, a compensating rope for the hoisting rope, said compensating rope being secured to the elevator car, motive means engaging the hoisting rope for moving the elevator car and thereby the traveling cable and the compensating rope relative to the structure, control means operable for controlling the movement of the elevator car by the motive means and for stopping the elevator car at predetermined landings, a first circuit, means for applying to said first circuit an electrical energizing quantity proportional to the total load supported by said hoisting rope, said compensating rope and said traveling cable exerting variable load on said hoisting rope, said variable load and thereby said total load varying in accordance with the vertical position of the elevator car with respect to the structure, a second circuit, means for applying to the second circuit an electrical

11

energizing quantity proportional to the displacement of the elevator car from the bottommost of said landings for compensating for said variable load, and means responsive to both said electrical energizing quantities for modifying operation of said control means upon occurrence of a predetermined load in said elevator car.

8. An elevator system comprising a structure having a plurality of vertically-spaced landings, an elevator car for transporting load, means mounting the elevator car for movement in two directions relative to the structure to serve the landings, a hoisting rope for continuously supporting the elevator car, motive means engaging the hoisting rope for moving the elevator car relative to the structure, control means operable for controlling the motive means to move the motive means and thereby the elevator car relative to the structure and for stopping the elevator car at predetermined landings, and modifying means for modifying operation of said control means upon occurrence of a predetermined load in said elevator car, said modifying means comprising a magnetic amplifier, said magnetic amplifier including control circuit means connected for energization by a control electrical quantity proportional to the total load supported by the hoisting rope, said total load and thereby said control electrical quantity each including an elevator car-position responsive component, reference circuit means connected for energization by a compensating electrical quantity for compensating for said car-position responsive component of said control electrical quantity, and load circuit means responsive to said control and compensating electrical quantities for effecting said modification.

9. An elevator system comprising a structure having

12

a plurality of vertically-spaced landings, an elevator car for transporting load; means mounting the elevator car for movement in two directions relative to the structure to serve the landings, a hoisting rope for continuously supporting the elevator car, motive means engaging the hoisting rope for moving the elevator car relative to the structure, control means operable for controlling the motive means to move the motive means and thereby the elevator car relative to the structure and for stopping the elevator car at predetermined landings, and modifying means for modifying operation of said control means upon occurrence of a predetermined load in said elevator car, said modifying means including a cold cathode gas tube having an anode, a control and a cathode, means for applying to the anode with respect to the cathode voltage of a value above sustaining voltage of the tube but insufficient to cause breakdown of the tube, means for applying to the control with respect to the cathode control voltage of a magnitude proportional to the total load supported by the hoisting rope, said total load and thereby said control voltage each including an elevator car-position responsive component, and means for applying to the control with respect to the cathode compensating voltage for compensating for said car-position responsive component of said control voltage, the combination of said control and compensating voltages being insufficient to cause breakdown of the tube except upon occurrence of said predetermined load in said elevator car, and means responsive to said breakdown for initiating said modification.

No references cited.