June 10, 1958 W. A. NIKAZY 2,838,136

TRAFFIC ADJUSTED STANDING TIME CONTROL

Filed Aug. 9, 1956 5 Sheets-Sheet 1

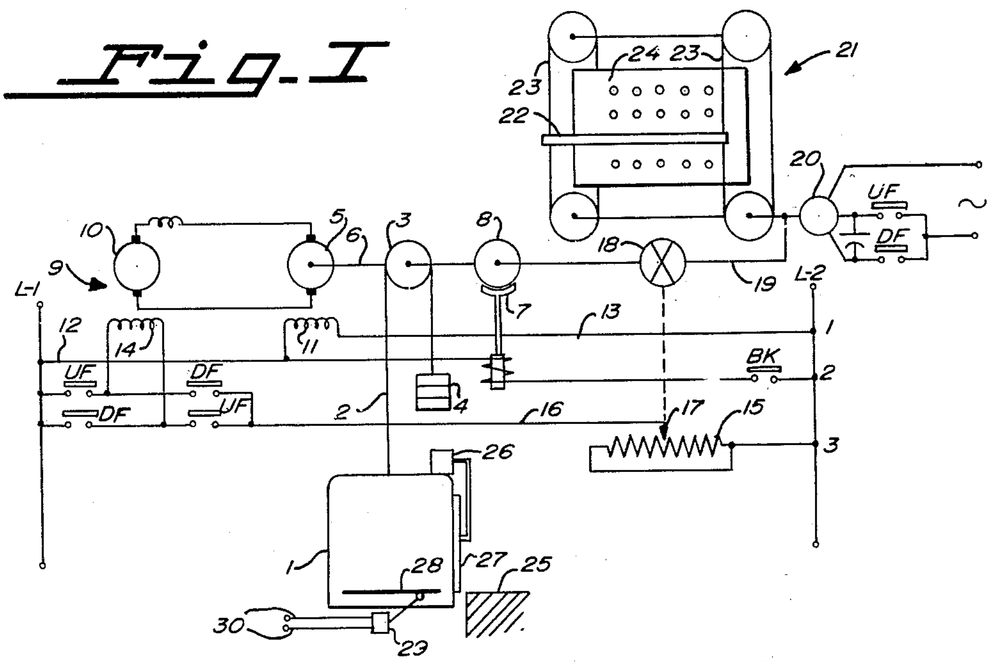

Fig. I

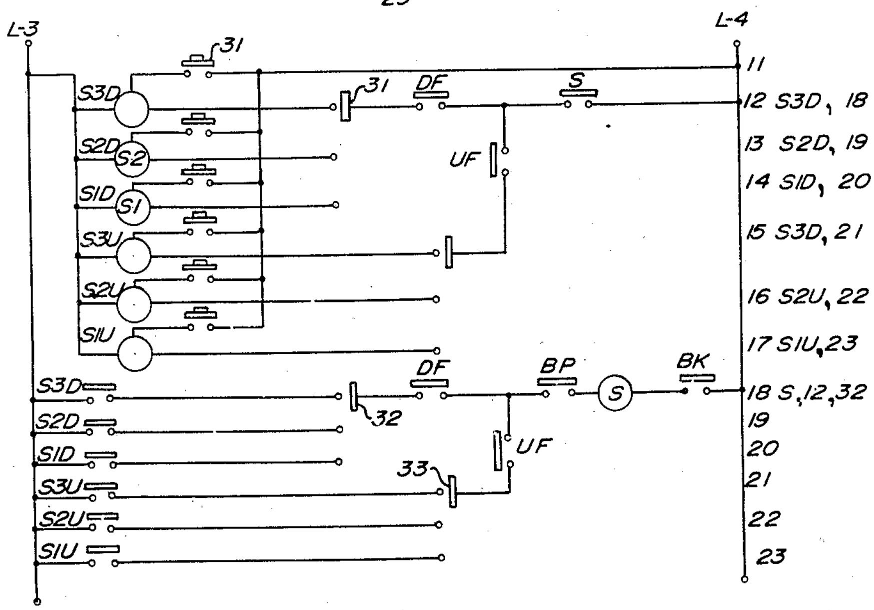

Fig. II

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TRAFFIC ADJUSTED STANDING TIME CONTROL

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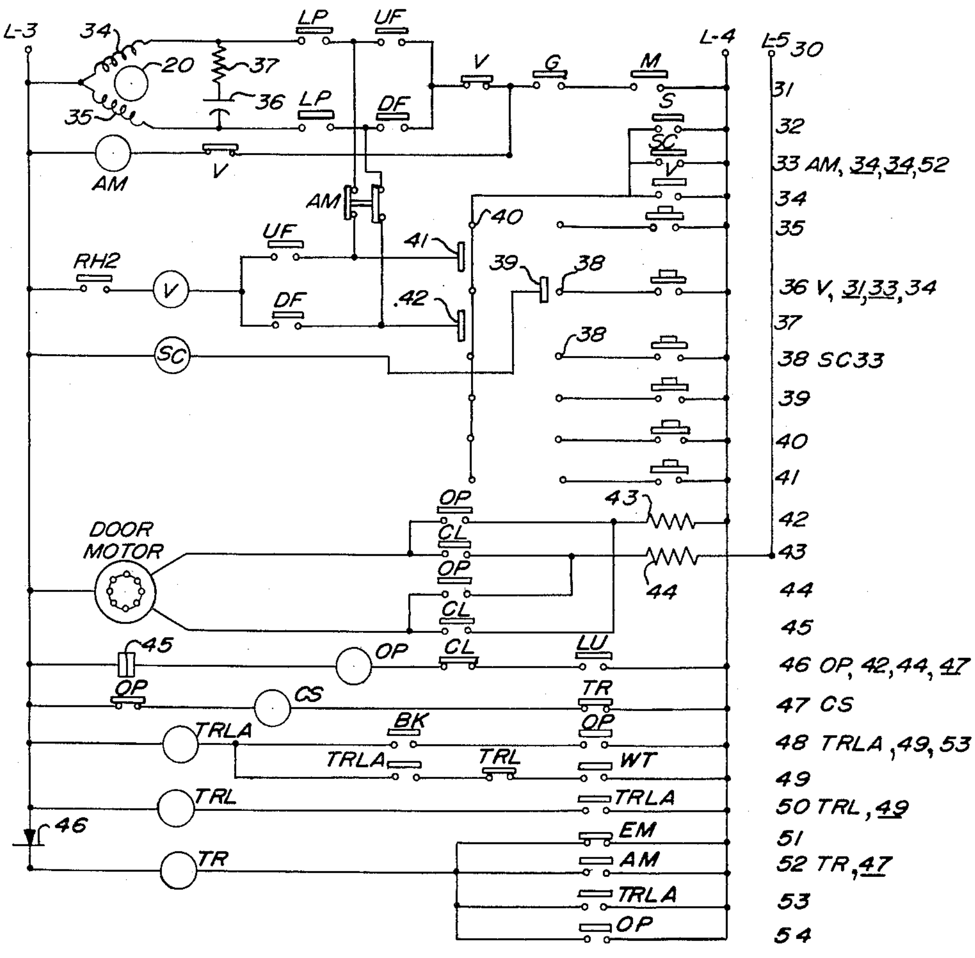

Fig. III

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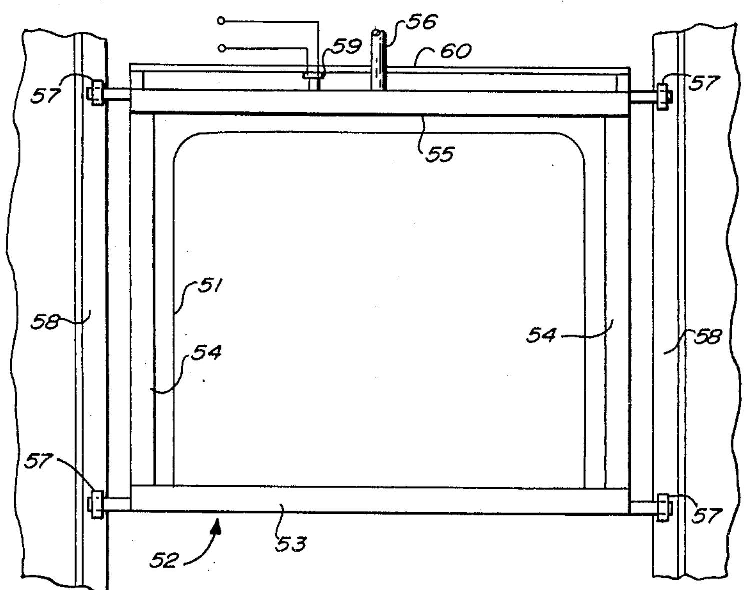

Fig. IV

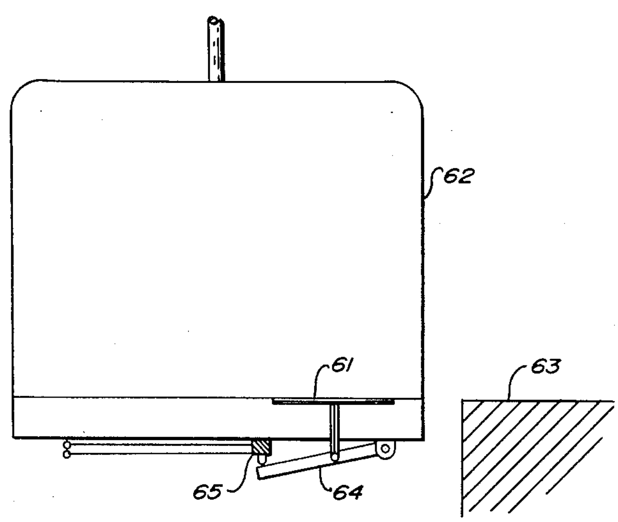

Fig. V

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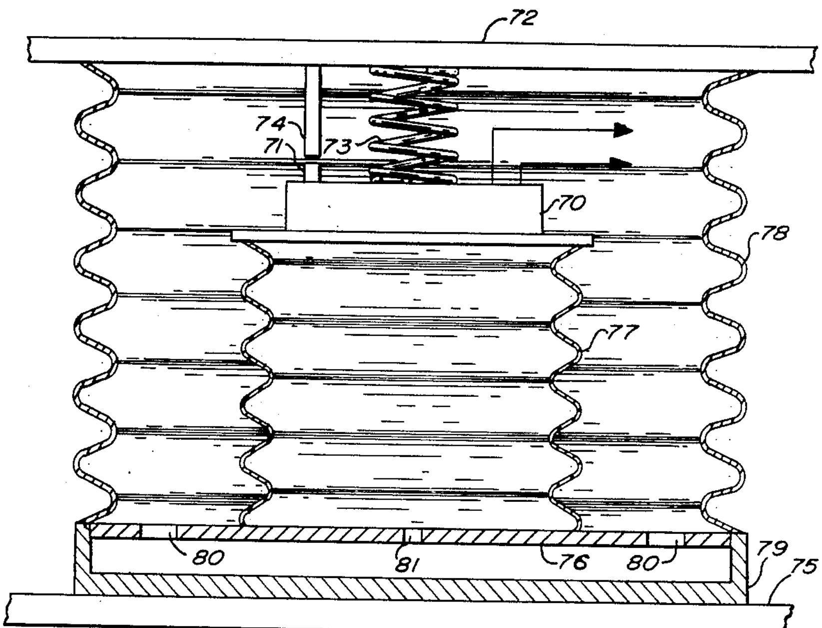

Fig. VI

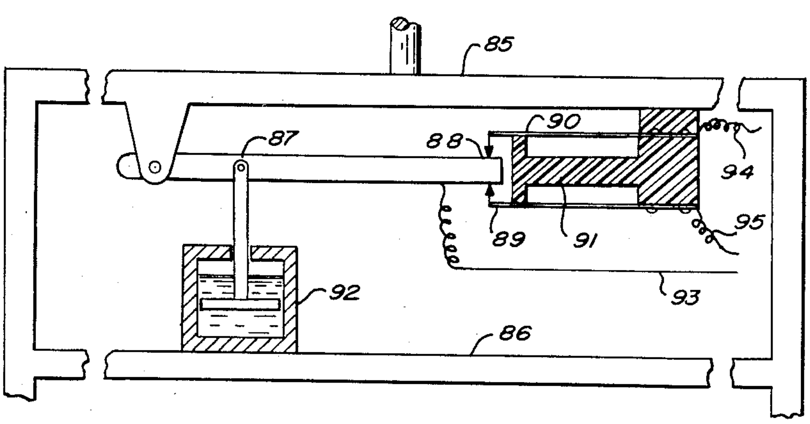

Fig. VII

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TRAFFIC ADJUSTED STANDING TIME CONTROL

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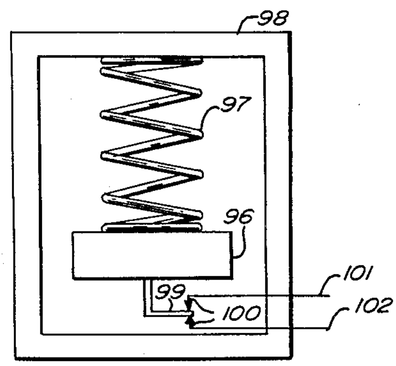

Fig. VIII

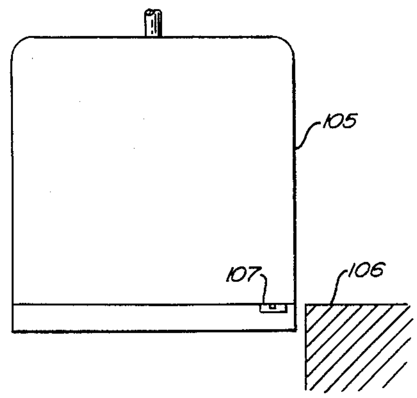

Fig. IX

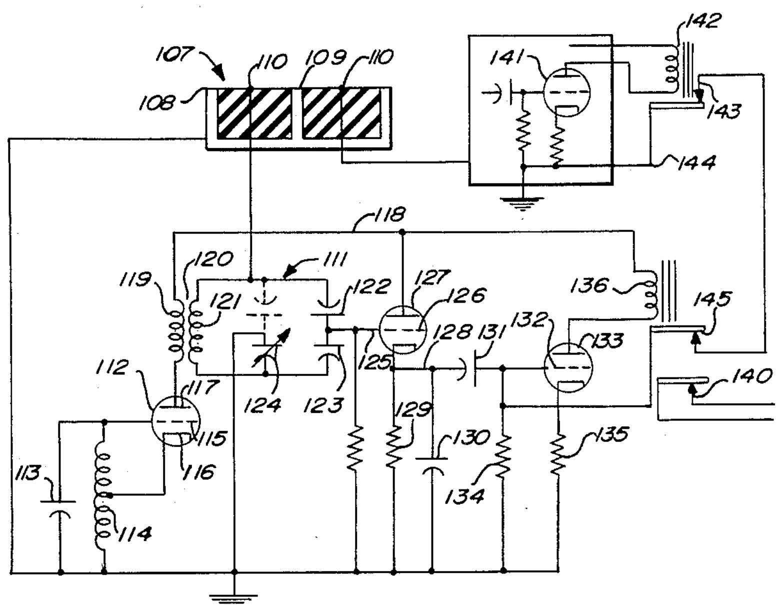

Fig. X

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TRAFFIC ADJUSTED STANDING TIME CONTROL

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Application August 9, 1956, Serial No. 602,981

8 Claims. (Cl. 187—29)

This invention relates to automatic elevators and in particular to improvements designed to reduce the standing time during which an elevator stands at a floor after a passenger has entered or left the car.

One noticeable difference in the operation of a completely automatic or passenger operated elevator as compared to an attendant operated elevator is the time that elapses after a passenger has entered or left the car before the car doors close. In the completely automatic system the car door must be held open at each stop for a time long enough for the slowest passenger to enter or leave the car as the case may be. However, when a passenger promptly enters or leaves much of this waiting time is wasted. In the attendant operated car the attendant notes the entrance or exit of the passenger and immediately closes the doors and proceeds to the next stop.

The principal object of this invention is to provide means operating directly or indirectly through the floor or threshold of the car for sensing the exit or entrance of a passenger from or into the car together with means for cutting short the waiting or standing time that the elevator waits at a floor before proceeding to the next floor.

Another object of the invention is to provide weight sensitive means in the floor of the car in order to sense the exit or entrance of a passenger from or into the car.

Another object of the invention is to provide means acting directly or indirectly through the floor or threshold of the car for detecting and distinguishing between passengers entering the car and those leaving the car for controlling the waiting time intervals accordingly.

According to the invention the entrance or exit of a passenger into or from the elevator car is detected by the pressure or presence of a passenger's foot on the threshold of the car or the floor of the elevator car or the apparent change in weight of the car. The detecting means may take the form of transitory load weighing devices, i. e. load weighing devices responsive to a change in load rather than the total load, or to electrostatic devices located in the threshold of the car and actuated by the presence of or passage of an object close to the surface of the threshold. The pressure responsive devices may take the form of weighing devices that carry the entire weight of the car and load, weighing devices in which the floor of the car is the platform of the weighing device, treadles adjacent the door of the car, or thresholds supported by weighing devices. The detecting means may also take the form of inertia operated devices which respond to the movement of the car as permitted by the elasticity of the supporting cables as a person enters or leaves the car. Regardless of which type of sensing device is employed the device responds momentarily to an addition or subtraction of load or to the presence of a person on or moving across the threshold of the car and responds by interrupting the operation of one of the timing relays used to determine the standing time that a car waits at the floor.

An improved form of the invention is illustrated in the accompanying drawings.

In the drawings:

Figure I is a simplified schematic illustration of an operating system for a single elevator car.

Figure II is a schematic diagram illustrating suitable stopping circuits for stopping the car at various floors in response to landing calls registered at such floors.

Figure III is a simplified schematic diagram of a portion of the elevator control including the means for registering and responding to car calls and for operating the door mechanism of the car.

Figure IV is a simplified schematic diagram of an elevator car and sling illustrating the location of a switch for sensing changes in the load in the car.

Figure V is a similar arrangement of an elevator car with a load weighing mechanism that occupies only a portion of the floor of the car.

Figure VI is a greatly enlarged diagrammatic view of a transitory switch suitable for use according to the invention.

Figure VII is a schematic illustration of another form of switch suitable for use according to the invention.

Figure VIII is a simplified schematic diagram of an inertia operated device suitable for detecting changes in load in the elevator car.

Figure IX is a simplified schematic view of an elevator car showing the location of an electrostatic threshold used for detecting the entrance or exit of passengers.

Figure X is a simplified schematic wiring diagram of electrical circuit suitable for use with the electrostatic threshold.

These specific figures and the accompanying description are intended merely to illustrate the invention and not to impose limitations on the claims.

In a typical elevator system an elevator car **1** is suspended by cables **2** that are trained over a drive sheave **3** and connected to counterweights **4**. The car is driven up and down by means of elevator drive motor **5** having an armature shaft **6** on which the drive sheave **3** is mounted. A brake **7** is arranged to operate on a brake drum **8** mounted on the armature shaft **6** to hold the elevator stationary as long as the motor **5** is deenergized.

For smooth control it is preferable to use variable voltage direct current for the elevator drive motor **5** such current being supplied from a generator **9** having armature **10** connected to the elevator drive motor **5**.

The drive motor **5** has a shunt field **11** that is continuously energized from direct current power lines L1 and L2 by way of leads **12** and lead **13**. The variable voltage generator **9** has a shunt field **14** that is connected to the lines L1 and L2 by way of reversing contacts UF and DF, a rheostat **15** and a lead **16** connecting the reversing contacts to the rheostat **15**.

The rheostat **15** is arranged to increase the current flow through the shunt field **14** as its slider **17** is moved either way from a center position.

The position of the slider **17** on the rheostat **15** and thus the speed of the elevator is controlled by a differential gear **18** operating between the elevator drive motor shaft **6** and a shaft **19** driven by a constant speed advance motor **20**. The advance motor **20** also drives a floor selector machine **21** which serves to switch the various circuits required for car position signals and for the control of the elevator car as it travels up and down the elevator shaft. The selector machine **21** includes a brush carriage **22** that is carried on chains **23** up and down over the face of a contact board or contact strips **24** substantially in synchronism with the movement of the car in the shaft.

In a system using an advance motor such as the advance motor **20** the floor selector machine **21** is driven directly by the motor and the car controls cause the car to follow with a positional lag depending upon the speed. The sequence of events as the car moves from one floor and travels to another begins with the advance motor starting first to drive the brush carriage 22 toward the contacts on the board 24 representing the destination floor. As the advance motor drives the floor selector machine it also drives the differential 18 and thus moves the slider 17 in a direction tending to energize the field 14 of the generator 9 and thus provide voltage to drive the elevator motor 5 such that the motor 5 moves the car from the previous floor toward the selected floor. When the elevator is still at rest and the advance motor started, the slider 17 moves fairly rapidly away from the central position on the rheostat. Then as the elevator motor 5 starts and accelerates the shaft 6 drives the differential 18 in a direction tending to cancel the drive from the advance motor shaft 19 thus slowing up the movement of the slider 17 until it finally stops when the speeds of the elevator motor 5 and the advanced motor 20 correspond. At this time the slider 17 is displaced substantially its maximum amount from the central position thus corresponding to full speed movement of the car and because of the differential action the position of the selector machine brush bar 22 actually leads the equivalent position of the elevator car 1 by such a distance as may be required for a slow down for the next stop.

When the brush carriage 22 reaches the contacts representing the next floor at which a stop is to be made the advance motor 20 stops quickly thus stopping the shaft 19. The elevator however, is still moving at its full speed and thus drives the differential 18 back in a direction tending to drive the slider 17 to the central part of the rheostat 15 thus reducing the voltage supplied to the shunt field 14 and thus the voltage generated in the generator 9. This reduces the voltage supplied to the elevator drive motor 5 causing it to smoothly decelerate as the car approaches the floor at which the stop is to be made.

The advance motor 20 is preferably a synchronous single phase alternating current motor, preferably of the inductor type, so as to ensure rapid starts and stops as well as constant speed while in operation. In a high speed elevator system the differential is arranged so that the position of the brush bar 22 leads the equivalent position of the elevator car 1 by as much as one and one-half or two floors of the building. This is the distance required to stop without causing the passengers objectionable discomfort.

When the car 1 levels at a floor, such as is represented by the section of floor 25, a door operating mechanism 26 opens the car doors 27 so as to permit the ingress or egress of passengers. As indicated in Figure I the elevator car 1 may have its floor 28 carried on a load responsive device including a switch 29 arranged to electrically control circuits through leads 30 according to the weight or changes in weight on the platform 28. When operated according to the invention the switch 29 is of a transitory nature having means so that it operates in response to a change in load rather than in a continued steady load and is arranged to vary the standing time at a floor in response to passenger movements.

Figures II and III illustrate circuits for registering landing calls and causing the elevator to respond thereto and for registering car calls and causing the elevator to respond to such calls as well as portions of the circuit for operating the doors and determining the time interval during which the doors shall remain open. While only a few of the relays are shown in Figures II and III it is to be understood that an ordinary elevator system contains many more relays used to secure the various operations required in normal service. The relays whose coils are shown in the figures include:

S3D, S1U—Landing call storing relays
S—Landing call stopping relay
AM—Advance motor relay
V—Advance motor stopping relay
SC—Car call stopping relay
OP—Door opening relay
CS—Car starting relay
TRLA—Maximum waiting time auxiliary relay
TRL—Maximum waiting time timer
TR—Minimum standing time relay

Relays whose contacts appear in the drawings but whose coils are not shown include:

UF, DF—Directional control relays
LP—Protective circuit control relays
G—Gate relay, energized when the gate is closed
M—Main motor control relay
CL—Door close relay, controlled by operation of CS
RH2—Relay controlled by the operation of the rheostat permits operation of the advance motor stopping relay V when the drive motor is running
BK—Brake relay
BP—By-pass relay arranged to be normally energized so that the stopping relay S responds to landing calls
LU—Leveling control relay energized while a car is stopping at a floor
WT—Weight control or transient weight control relay to respond by opening its contacts when a passenger enters or leaves a car
EM—Emergency control relay, energized when it is safe to operate the car

In order to identify the various relays and their contacts the coils and contacts are given similar symbols and in a code column at the right of each figure is listed the line number in the figure in which a coil or contact appears, the identification of any relay coils appearing in the line, and the line numbers at which the contacts operated by that particular coil are shown. Thus the stopping relay S appearing in line 18 of Figure II has contacts located in lines 12 and 32. Contacts which are closed when the coil is deenergized are identified by underscoring the line number designation.

Referring specifically to Figure II, landing calls are registered on the SU and SD series of relays which preferably are latch type relays that are tripped, to register a call, by operation of push buttons 31 and which are restored to non-registering position, as the call is answered, by a circuit that is completed, at line 12, from lead L3 through the restoring coil of the relay, a selector machine brush 31, up or down directional relays UF or DF, and the stopping relay contact S. By thus cancelling the call as soon as the stopping relay S operates, which operates as soon as a brush 32 of the selector machine reaches the contact designating the particular landing call, other cars operating in the same system will not stop for the same landing call. The stopping relay S in line 18 responds to registered landing calls as brushes 32 and 33 connected through contacts DF or UF in lines 18 or 20 touch energized contacts corresponding to registering landing calls. This circuit, in line 18, includes contacts of the by-pass relay BP and brake relay BK so that the stopping relay S cannot be energized if the car is loaded and is by-passing signals or when it is stopped with the brake set and its coil deenergized.

Referring now to Figure III, the advance motor 20 drives the floor selecting machine and the rheostat controlling the elevator drive motor generator whenever a circuit is completed from lead L3 through windings 34 or 35 of the advance motor 20; contacts LP of the protective relays, the up or down directional relays UF or DF, and series connected contacts of the stopping relay V, the gate relay G, and main motor relay M to lead L4. The advance motor 20 is preferably a single phase inductor motor having the two fields 34 and 35, the separate leads of which are interconnected by a condenser

36 and resistor 37 so that depending upon which of the contacts UF or DF is closed one field of the motor 20 is energized directly and the other is energized in series with the condenser and resistor thus providing the required phase shift to control the direction of rotation of the motor. This circuit for the advance motor is thus completed in the proper direction when the directional relays have been set and the gate relay energized in response to closing of the gates. The main motor relay M is energized when the start signal was given. Completion of this circuit also completes a circuit through contacts V in line 33 to energize the advance motor relay AM. This relay controls auxiliary circuits that must be energized or deenergized whenever the advance motor is operating.

The car button circuit for registering destination calls is shown in Figure III, lines 35 to 41, wherein the push buttons shown at the right in lines 35 to 40 are car buttons installed in the car for registering calls for the particular floors. If the system is to operate on regular dispatching and through trip operation such that the cars always travel to the terminal floors the car buttons for the terminal floors may be omitted and the leads continued direct from the lead L4 to the car call contacts of the selector machine represented by the small circles 38 cooperating with a selector machine brush 39. When the car is running and the selector machine brush 39 reaches an energized contact 38 it completes a circuit from the lead L3 to the lead L4 through the car call stopping relay SC. No latch relays are employed in connection with the car button relays but rather holding coils are arranged directly behind each of the buttons in the assembly in the car to magnetically hold the buttons in depressed condition once they are depressed. These coils are not strong enough to draw the buttons to depressed positions and thus the buttons remain open or circuits deenergized until the calls are actually registered. The circuit to the holding coils, not shown in the drawings, is arranged to be momentarily broken each time the car is reversed. Thus all the car calls are canceled at that time.

When either the car call relay SC or the landing call stopping relay S is energized in response to the answering of a call, it closes its contacts SC or S in lines 33 or 32 so as to energize a series of selector machine stopping contacts 40, there being one such contact for each floor and these being connected in parallel. These now energized contacts 40 through brushes 41 or 42, depending upon the direction of travel, energize the stopping relay V in line 36. The contacts RH2 also shown in this line are closed as long as the elevator is in motion. As soon as the relay V is energized it opens its contacts in lines 31 and 33 to deenergize the advance motor 20 and the advance motor relay AM. This relay immediately drops out and, to accurately position the brush bar 22 of the floor selector machine, closes its contacts AM in the vertical leads at the level of line 35 so as to connect the advance motor 20 through these now closed AM contacts to the brushes 41 and 42. Assuming that the car had been traveling down such that the brush 42 was on an energized contact 40 current is maintained to the advance motor until the brush 42 leaves the contact 40. Should the advance motor overrun, the following brush 41 reaches the energized contact and energizes the advance motor for reverse rotation. Until the elevator stops after the advance motor stopped the elevator motor drives the differential in a direction to drive the rheostat back to center and the reaction torque from the differential is applied to the advance motor. Occasionally, this reaction torque is sufficient to drive the advance motor and selector machine away from the proper position if it were not for the current supplied through the brushes 41 or 42 to the advance motor as soon as it departs from its selected position with the energized contact between but not in contact with either the brushes 41 or 42. Thus the selector machine brush carriage and advance motor are electrically held in their correct position while the elevator is coming to a stop at the selected floor.

As mentioned, the same operations take place when the car stops in response to a landing call when the relay S closes its contact in line 32. Furthermore, since the relay S operates only momentary the relay V is arranged with contacts in line 34 parallel with the S contacts in line 32 so as to maintain the circuit through the selector machine brushes to the advance motor even though the relay S drops out as the call is being answered.

As the car approaches the floor at leveling speed, approximately a foot or 18 inches away from the floor, the leveling relay contact LU in line 46 closes so as to complete a circuit to a door opening relay OP which controls the door motor to effect opening the doors. When the relay OP is energized it closes its contacts in lines 42 and 44 so as to connect the door motor, shown in line 44, to the leads L3, L4, and L5. Resistances 43 and 44 are included in the leads from the supply leads L4 and L5 in order to reduce the starting torque and permit the motor to stall if the door sticks. As soon as the door reaches its fully open position it opens a limit contact 45 shown in line 46 so as to break the circuit to the door opening relay OP.

Door opening relay OP, in addition to operating the door motor, controls contacts shown in lines 48 and 54. The contacts in line 48, in series with brake contacts BK operate the auxiliary timing relay TRLA which establishes or determines maximum time interval that the car will wait for a passenger before initiating a door closing operation sequence. Relay TRLA seals itself in through a circuit shown in line 49 which comprises a pair of normally open TRLA contacts, a pair of normally closed TRL relay contacts, and a pair of normally open WT contacts which are part of the passenger sensing equipment. The WT contacts are closed in normal operation and opened momentarily as a passenger enters or leaves the car. The auxiliary timing relay TRLA also closes its contacts TRLA in line 50 to complete a circuit to a motor driven timing relay TRL which is arranged to open its contacts TRL in line 49 at the expiration of the maximum waiting time. This time can be cut short by the entry or exit of a passenger which causes momentary opening of contacts WT. Once the circuit in line 49 is broken after a stop has been made the relay TRLA drops out and cannot be reenergized until the doors are again opened while the car is arriving at a floor.

The door closing and car starting sequence of operation is controlled or initiated by a second timing relay TR shown in line 52 of Figure III. This relay, of the flux decay timing variety, is energized through a rectifier 46 from the lead L3 and through parallelly connected contacts of the emergency relay EM in line 51, advance motor relays AM in line 52, timing relay TRLA in line 53, and door opening OP in line 54. Thus the timing relay TR is energized as long as the emergency relay EM is deenergized so as to close its contact in line 51, or the advance motor is operating, or the TRLA timing relay energized, or the door opening relay is energized during the door opening operation. The timing relay TR times a short interval following the simultaneous opening of all of these contacts and at the end of such short time interval closes its contacts TR in line 47 so as to complete a circuit to the car starting relay CS shown in line 47. If the doors are not opening so as to open the contacts OP in line 47 relay CS is energized and immediately begins a car starting sequence which begins by operating a door closing relay which in turn closes its contacts CL in lines 43 and 45 to operate the door motor in a direction to close the door. As soon as the door is completely closed the gate relay closes contacts G in line 31 to start the advance motor and the elevator motor.

The timing relays TRL and TR constitute sequentially operating timers the first of which times a maximum waiting time interval measured from the start of the opening of the doors as the car stops at a floor. This is effected by the closing of the OP contacts in line 48. The second timing relay TR constitutes a second timing means for measuring a second time interval which is measured from the completion or interruption of the operation from the first timing relay as evidenced by the opening of the TRLA contacts in line 53 or the opening of the OP contacts should the doors have started to close and been reopened by the entrance of a passenger during the closing time. The presence of the other contacts in lines 51 to 54 cause the second timing relay TR to time its interval from the instant that the car starting sequence may be safely initiated. This time interval ordinarily is in the order of a second or slightly less since that is the average or safe time that may be employed to allow a passenger to safely clear the door before the door starts to close.

The timing interval established or measured by the first timing relay TRL may be cut short by the entrance or exit of a passenger which causes momentary separation of WT contacts in line 49. These contacts are preferably constructed as part of a transitory switch operated in conjunction with load weighing equipment or as part of a sensitive treadle sensitive either to the weight of a person stepping on it at the threshold of the car or by change of an electrostatic field resulting from a passenger's foot on the threshold or passing close above the threshold. In any event the timing of the maximum time interval as measured by the first timing relay TRL is cut short or interrupted as soon as a passenger enters or leaves the car.

Figures IV and V illustrate two of several locations that may be selected for the transitory load weighing switch. Figure IV shows an elevator car or elevator cab 51 supported on a sling 52 that comprises a bottom beam 53, side rails 54 and a cross head 55 to which a hoisting cable or cables 56 is attached. The sling 52 is guided by rollers 57 that engage vertical rails 58 in the hatchway. The transitory switch 59 is mounted on a secondary cross head 60 in position to measure the deflection of the cross head 55 as the load in the car changes. The transitory switch 59 has contacts WT shown in line 49 of Figure III and arranged when separated or open to interrupt the operation of the first timer relay TR1. In this arrangement as shown in Figure IV the transitory switch 59 may have contacts arranged to operate whenever a passenger enters or leaves the car. When a passenger enters the weight in the car 51 is increased so as to increase the deflection of the cross head 55 to which the hoisting cable 56 is attached. This additional deflection results in a decrease in distance between the cross heads 55 and 60 at the switch location and a consequent operation of the switch. When a passenger leaves the car the load is decreased, the deflection of the cross head 55 is decreased and the spacing between the cross heads 55 and 60 is increased which again may be sensed by the switch 59. When this position for the transitory switch is selected it is essential that the car be guided by rollers rather than friction guide shoes running on the vertical rails 58. Friction of the ordinary guide shoes particularly if the load in the car is not centered under the hoisting cables results in enough friction force between the guide shoes and the rail to resist movement of the car during addition of the weight of a single passenger. Thus the device is inoperative unless the friction force is kept small.

The passenger responsive means may also take the form of treadle 61, Figure V, located adjacent the door of an elevator cab 62 so as to be in position to lie across the path of a passenger entering or leaving the car 62 at a landing 63. The treadle 61 may be arranged to operate, through a linkage 64, a transitory switch 65 indicated generally as being attached to the lower portion of the car 62. Again it is necessary that the switch respond only momentarily to the presence of a passenger entering or leaving a car and in this case as in that shown in Figure IV, a transitory switch is employed, i. e., one that is arranged to open or close its contacts momentarily as a load is applied and maintained.

While Figure V shows the treadle as a small platform supported on a linkage it is to be noted that the ordinary form of electric mat is also suitable for this purpose, such a mat usually being constructed of rubber with electrical conductors embedded in the mat and arranged to be closed or form a closed circuit when pressure is applied to the mat. The transitory nature of such a mat may be achieved by connecting the leads through a timing relay that will hold a contact closed momentarily for each energization and locating the mat close to the door so that persons would not ordinarily remain standing on it.

While many forms of load sensitive electrical controls may be employed, such as piezo-electric crystals or strain gauges, a simple dashpot form of transitory switch is preferred.

Two examples of such transitory switches are illustrated in Figures VI and VII. In the form illustrated in Figure VI an electrical switch 70 having an operating plunger 71 is mounted from an upper cross head member 72, corresponding to the auxiliary cross head 60, by means of a stiff spring 73. A stud 74 depending from the cross head 72 cooperates with the operating plunger 71 to operate the switch whenever the spring 73 is compressed. The switch 70 is also connected to the lower cross head 75 by means of a mounting plate 76 and a hydraulic bellows 77. The mounting plate 76 is also connected to the upper cross head 72 by a second bellows 78 large enough in diameter to completely enclose the first. Likewise, the mounting plate 76 is spaced from the cross head 75 by a shallow cup shaped member 79 so as to form a hydraulic chamber beneath the mounting plate 76. Orifices 80 and 81 connect the interiors of the bellows 78 and 77 respectively to the chamber formed within the cup-shaped member 79 so as to provide for the flow of fluid from one bellows into the other.

The system is usually filled with fluid at least to the level of the switch 70 with the inner bellows 77 completely filled with fluid and an air space left above the fluid in the outer bellows 77.

This assembly is used as the transitory switches 59 in Figure IV or 65 of Figure V and arranged so that the cross head members 72 and 75 or linkage assembly with the system as used in Figure V approach each other or deflected toward each other with an increase in load. The switch is operated momentarily in this arrangement when the load is applied so as to force the cross head members 72 and 75 toward each other because the hydraulic fluid trapped within the bellows 77 provides a momentary firm resistance to any relative movement between the switch 70 and the lower cross head 75 so that the spring 73 is deflected or compressed enough to allow the stud 74 to operate the plunger 71 of the switch 70. As the hydraulic fluid leaks through the orifices 81 and 80 from the bellows 77 to the bellows 78 the spring extends so as to release the force between the plunger 71 and stud 74 thus opening the switch. Should the load be increased a second time the same action occurs again and so on for subsequent operations as additional passengers enter the car. The flexibility of the bellows 77 is much greater than the spring 73 so that over the normal operating range the static position of the switch 70 is fixed relative to the upper cross members 72 and is deflected only momentarily as hydraulic fluid is forced from the bellows 77.

When the load in the car is decreased by passengers leaving the car the spring 73 draws the switch 70 upward so as to cause hydraulic fluid to flow back into the bellows 77 thus conditioning it for response to the next entering passengers. This same structure may be used in place of the switch 65 by suitably arranging the supporting members or cross head members 72, 75 as part of the linkage arrangement supporting the treadle 61.

The switch illustrated in Figure VII works on the same principle in that it is operated by relative motion or deflection between an upper member 85 and a lower member 86 which may be portions of the cross heads of the car or of the linkage supporting the sensitive treadle. A lever 87 fulcrumed from the upper member 85 has its end 88 embraced between leaf contacts 89 and 90 which are spaced by an insulator 91 so that each of the contact leaves 89 and 90 contact the lever 88 but such that contact with one or the other is broken by a relatively small movement of the lever in either direction. The insulator 91 is also attached to the upper member 85 so as to move with that member.

The lever 87 is also connected to the lower member 86 through a dash pot 92 which is adjusted to be rather stiff in its response or resistance to relative movement between the lower member 86 and the lever 87 but which has very little static friction so that the leaf contacts 89 and 90 may overcome the residual or static friction of the dash pot 92 so as to hold both contacts closed in the normal static condition. Assuming the members 85 and 86 to be separated by increase in load the switch operates to break the connection between the common lead 93 and a lead 94 connected to the upper leaf spring contact 90 whenever the load increases and to break the contact between the common lead 93 and a lead 95 connected to the lower leaf spring contact 89 whenever the load in the car decreases.

The switch 70 or the circuit taken through the leads 93, 94 or 93, 95 correspond to the WT contacts appearing in line 49 in Figure III so as to break the circuit to the maximum standing time interval timer TRLA as soon as a change in load in the car occurs.

If it is desired to have the circuit respond to either the entrance or exit of a passenger the leads 94 and 95 are connected to the WT contacts so that opening of either set of contacts breaks the circuit. However, if it is to be desired to have the timer interval cut short only in response to the entrance of a passenger into a car the circuit is connected between the common lead 93 and the lead 94 which circuit is broken when a person enters a car but is not broken by the exit of a passenger.

This circuit is thus responsive to the direction of travel of the passenger as to whether he is entering or leaving and affects the circuit accordingly.

The switches shown in Figures VI and VII are merely representative of structure that may be used to produce the desired results of momentary circuit interruption as the load in the car is changed. Other types of equipment may serve the same purpose, for example many of the electrical load weighing devices using strain gauges, piezoelectric crystals, inductive devices, etc. can be arranged to respond to changes in load as well as to the total load.

It is also possible to use the stretch in the cables supporting the elevator car as a measure of the change in load in the car. In such a case the entrance or exit of a passenger causes a small change in length of the cables and is evidenced by a sudden small lift or drop of the car as the passenger departs or enters. Such motion may be detected by a resiliently supported mass arranged to operate a switch. Such a structure is schematically illustrated in Figure VIII and comprises a mass 96 that is resiliently supported by a weak spring 97 attached to a case 98 arranged as part of the elevator car. A moving switch member 99 cooperating with leaf spring contacts 100 is arranged to break the circuit between leads 101 and 102 whenever relative motion between the mass 96 and the case 98 occurs in response to the movement of the elevator car with change in load.

The sensitive floor or threshold of the car may also, as suggested earlier, be of an electrostatic nature such that changes in the electrostatic capacity of a sensing lead to ground varies according to the presence of an object on or immediately above the threshold. Figures IX and X illustrate structure employed for this type of operation. In Figure IX an elevator car 105 is shown positioned adjacent a landing 106 and is equipped with an electrostatic threshold 107 arranged in the path of a passenger entering or leaving the car. The threshold is sensitive to the passage of objects either in contact with it or closely adjacent to it. Circuits used in conjunction with the threshold are illustrated in Figure X.

As shown in Figure X the threshold 107 comprises a U-shaped channel 108 of an electrically conductive material divided into two troughs by a center partition 109. Each section is filled with insulating material and near the surface is provided with a conductor 110 extending lengthwise of the threshold and arranged to be energized by a high frequency alternating current.

The high frequency current for energizing the conductors 110 is obtained from a capacitive bridge circuit 111, one for each conductor 110. Each bridge circuit is fed by an oscillator 112 which may be of any conventional type. A cathode or electron coupled type is illustrated. In this type, a tank circuit comprising condenser 113 and an inductance 114 is connected between a grid 115 of the oscillator 112 and ground. A cathode 116 of the oscillator is connected to a tap on the inductance 114. A plate 117 of the oscillator is connected to a B+ lead 118 through a primary 119 of a coupling transformer 120. The transformer has a secondary 121 that feeds the bridge circuit 111. The bridge circuit 111 comprises two condensers 122, 123 serving as ratio arms, a variable condenser 124 serving as a tuning adjustment and the fourth arm of the bridge is made up of the capacitance of the connected conductor 110 to ground. The equivalent capacitance of the conductor 110 to ground is indicated by the dotted condenser symbol included in the layout of the bridge 111. The output voltage of the capacitive bridge 111 is taken through a lead 125 to a grid 126 of a detector tube 127 that is operated as a cathode loaded electronic voltmeter to develop a direct current voltage on its cathode lead 128 corresponding to the voltage developed in the bridge circuit.

The cathode lead 128 is connected to ground through a parallel combination of a resistor 129 and condenser 130 having a time constant long in comparison with the time of one cycle of the oscillator 112. The voltage developed at the cathode 128 which varies according to the capacitance to ground of the conductor 110 which in turn varies according to the presence or absence of objects immediately above the conductor, is coupled through a coupling condenser 131 to a grid 132 of a relay control tube 133. The grid 132 is also grounded through a resistor 134 which in combination with the condenser 131 provides a time constant in order of one quarter to one half second. The value of a cathode or a fixed bias preferably is selected so that a relay 136 in the plate circuit is in its non-operating condition when there is no change in the voltage at the detector cathode 128. An unbalanced condition of the bridge circuit 111 produces a signal that drives the grid positive to increase the flow of current through the tube and thus operate the relay. Because of the capacitive connection from the detector to the relay tube 133 the relay responds only to changes in capacity and not to a steady unbalance. The relay includes normally closed contacts 140 corresponding to the WT contacts that are included in the first timer circuit to interrupt the operation of that timer when a person crosses the threshold.

A similar circuit including oscillator, bridge and detector is used in conjunction with the second sensing conductor 10 of the sensitive threshold and its output relay tube 141 is connected to operate a second relay 142. As shown the relay is normally deenergized to open its contacts 143 as long as there is no change in signal voltage from the sensitive threshold. However, when there is a change in voltage resulting from a change in capacitance at the threshold the relay is momentarily energized so as to close its contacts 143.

In the circuit shown, if it is satisfactory to interrupt the timing regardless of the direction of movement of a passenger across the threshold, the circuit including the relay 136 with its contact 140 is all that is required. However, if it is desired to sense the direction of movement of the passenger across the threshold as well as the fact that a passenger has crossed the second relay 142 and its control circuit must also be used. When the second relay 142 alone is energized a circuit is completed from a grounded lead 144 through contacts 143 of the second relay 142, contacts 145 of the first relay 136 to the grid 132 of the first relay tube 133. This circuit prevents a first relay tube 133 from operating in response to change capacitance in its bridge circuit. Thus the second relay 142 always responds but the first relay responds only if the second has not. In use, the threshold is mounted so that the left hand conductor 110 of Figure X is adjacent the landing so that a person entering the car will cause the relay 136 to operate in advance of the relay 142 and thus interrupt the timing. Thus the operation of the relay 136 by opening its contact 145 removes the grounding circuit from the grid 132 of the relay tube 133 and permits it to operate in response to its change of capacitance of signal. Thus the circuit responds to a person entering a car.

When a person leaves a car and operates the relay 142 before the relay 136 operates the grounding circuit is completed and the first relay 136 does not operate. Thus the circuit does not respond to the exit of a passenger.

When this directional preference is employed the circuits are arranged so that the first timer relays TRL and TRLA operate only if the car stops in response to a landing call or combination of landing and car calls. The preference is required when the car stops for a landing call and a passenger leaves the car. If the departing passenger interrupted the timing it is doubtful if the prospective passenger could reach the doors before they started to close. The directional responsive system provides the required time for the entering passenger under any circumstance.

Various modifications may be made in the specific circuits and structure and still obtain the advantage of controlling the standing time timers by means acting directly or indirectly through the floor of the elevator car.

Having described the invention, I claim:

1. In an elevator control system, in combination, means for stopping a car at a floor for which a call is registered, means for opening the doors of the car as it stops at a floor, means for reclosing the doors and starting the car for travel to the next stop, first timing means arranged to delay the reclosing of the doors for a time interval measured from the opening of the doors as a stop is made, second timing means for delaying the reclosing of the doors for a minimum time interval measured from the end of the first time interval, and transitory weight sensing means arranged to detect changes in load in the car, said weight sensing means being connected to the first timing means to terminate the operation of the first timing means upon the occurrence of a change in load in the elevator car.

2. In an automatic elevator control system, in combination, means for opening the doors of an elevator car as the car stops at a floor, means for reclosing the doors, a first timer arranged to delay the reclosing of the doors for a time interval measured from the opening of the doors as a stop is made, a second timing means for delaying the reclosing of the doors for a minimum time interval measured from the end of the first time interval, transitory weight sensitive means supporting at least a portion of the floor of the elevator car, and means connected to the transitory weight sensitive means and the first timer for terminating the operation of the first timer immediately upon a change in load in the car.

3. In an automatic elevator control system, in combination, means for opening the doors of an elevator car as the car stops at a floor, means for reclosing the doors, a first timer arranged to delay the reclosing of the doors for a time interval measured from the opening of the doors as the car stops, a second timer for delaying the reclosing of the doors for a minimum time interval after termination of the first time interval, transitory weight sensing means for supporting the elevator car, and means connected to the weight sensing means and responsive to a change in weight for terminating operation of the first timer.

4. In an automatic elevator control system, in combination, an elevator car arranged to serve a plurality of floors of a building, hall call means for registering calls for service from the various floors, car call means for registering destination calls, means for opening the doors as the car stops at a floor, means for reclosing the doors, a first timer arranged to delay the reclosing of the doors for a time interval measured from the opening of the doors when a stop is made in response to said hall call means, a second timer for delaying the reclosing of the doors for a minimum time interval measured from the opening of the doors, when a stop is made in response to the car call means or the expiration of the first timer interval whichever is later, transitory weight sensing means responsive to the load in the elevator car, and means connected to the weight sensing means and the first timer adapted to interrupt the operation of the first timer immediately upon an increase in load in the car.

5. In an automatic elevator control system, in combination, an elevator car arranged to serve a plurality of floors, hall call and car call means for registering calls for service, means for stopping the car at a floor in response to a call, means for opening the doors as the car stops at a floor, means for reclosing the doors, a first timer arranged to delay reclosing of the doors for a first time interval measured from the opening of the doors when the car stops in response to a hall call, transitory load weighing means responsive to changes in load in the elevator car, said load responsive means being arranged to interrupt operation of said first timing means, and second timing means for delaying reclosing of the doors for a minimum time interval after interruption or expiration of the first time interval or opening of the doors in response to a car call.

6. A control system according to claim 5 in which the weight sensitive means includes a resiliently supported mass and means for detecting movements of the car with respect to said mass.

7. In an automatic elevator control system, in combination, an elevator car arranged to serve a plurality of floors, means for opening the car doors when the car stops at a floor, means for reclosing the doors, a first timer arranged to delay reclosing of the doors for a first time interval measured from the opening of the doors, a pressure sensitive tread extending across the path of a person passing through the door way of the car, said sensitive tread being connected to the first timer and arranged to terminate the first time interval, and a second timer arranged to delay reclosing of the doors for a minimum time after opening of the doors or termination of the first time interval whereby the doors are held open to await the entrance or exit of a passenger and promptly closed after the entrance or exit of the passenger.

8. In an automatic elevator control system, in combination, an elevator car arranged to serve a plurality of floors, hall call means and car call means for registering calls for service, means for opening the doors as the car stops for a floor, means for reclosing the doors, a first timer arranged to delay reclosing of the doors for a first time interval measured from the opening of the

doors in response to a hall call, a sensitive tread arranged in the elevator car, said tread being divided to be directionally sensitive and connected to the first timer to terminate the first time interval when the tread responds to a passenger entering the car, and a second timer adapted to delay reclosing of the doors for a minimum time interval following opening of the doors in response to a car call or following expiration or termination of the first time interval.

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