

Nov. 27, 1962

M. C. YEASTING

3,065,825

ELEVATOR CONTROLS

Filed Oct. 27, 1959

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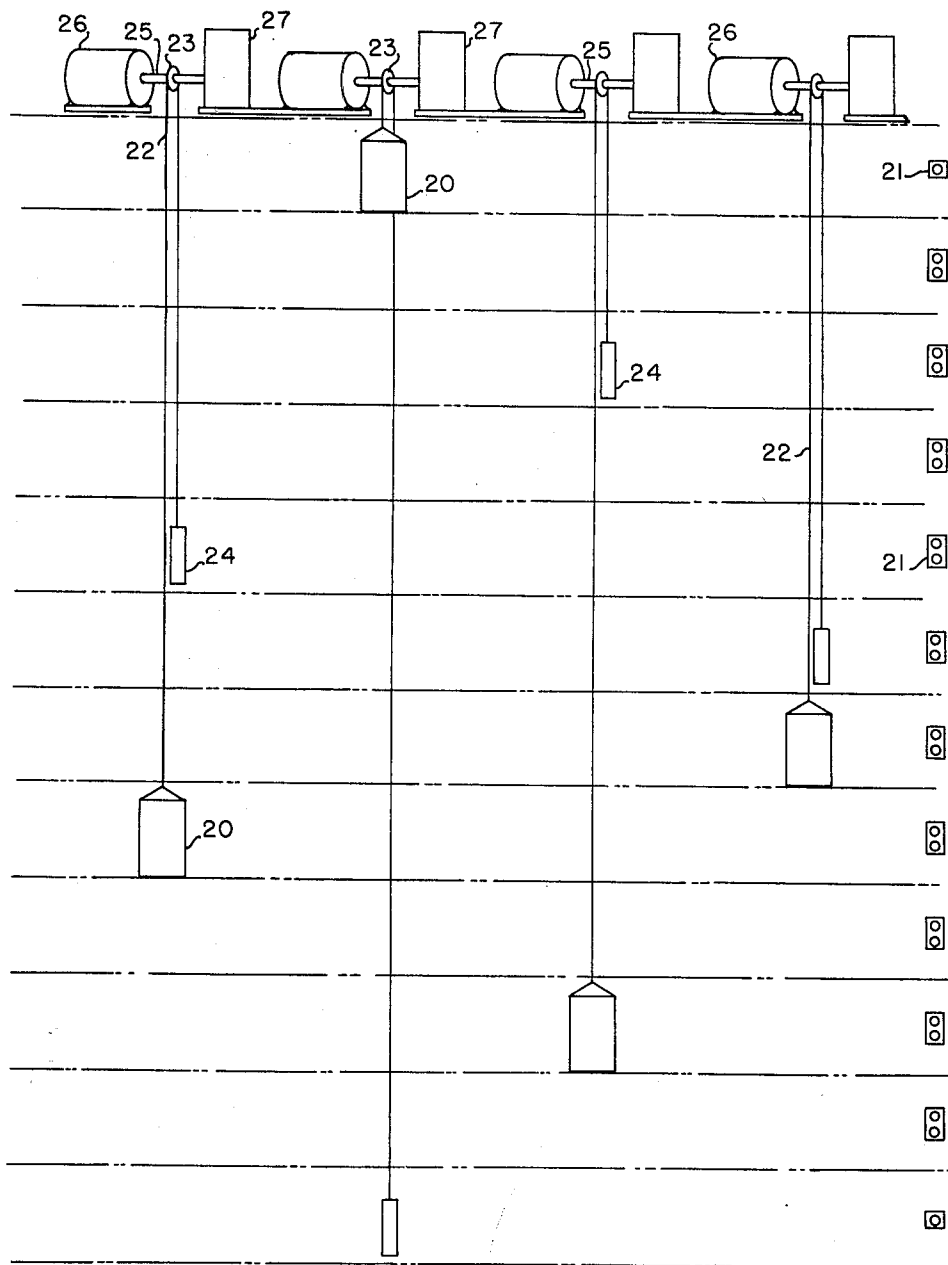


Fig. 1

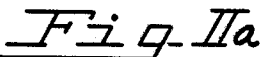
INVENTOR.
MAYNARD C. YEASTING

BY

Marshall, Marshall & Yeasting
ATTORNEYS

3,065,825

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Marshall, Marshall & Yeasting
ATTORNEYS

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M. C. YEASTING

3,065,825

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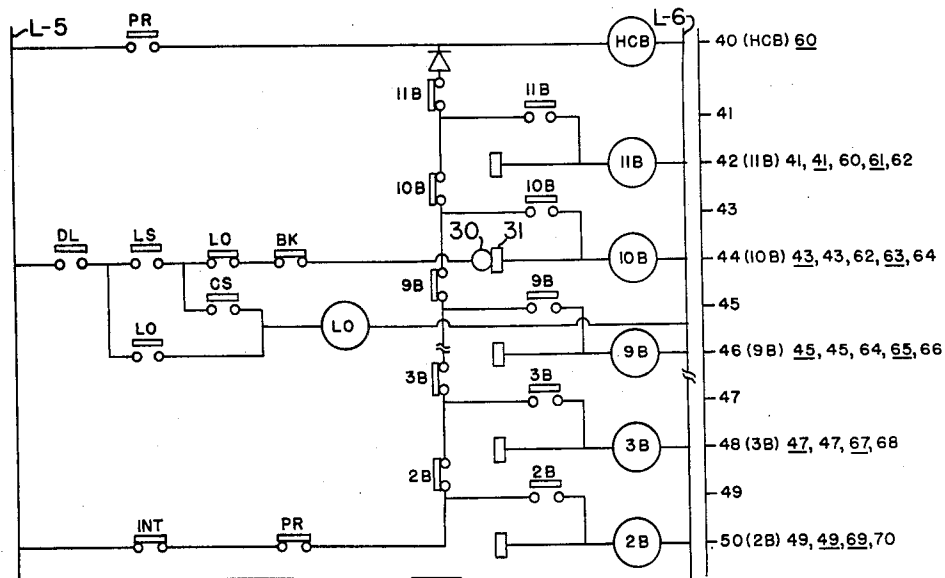


Fig. III

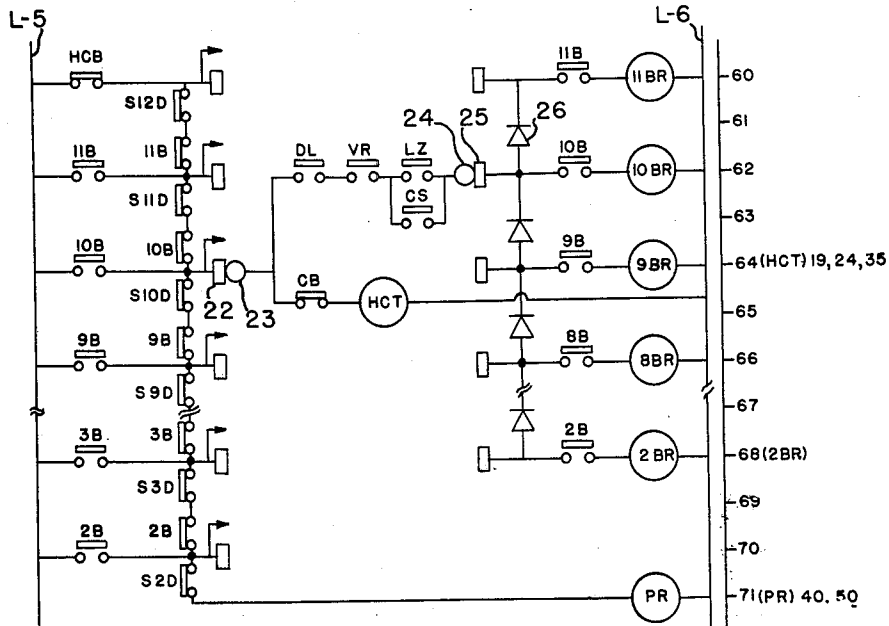


Fig. IV

INVENTOR.
MAYNARD C. YEASTING

BY

Marshall, Marshall & Yeasting
ATTORNEYS

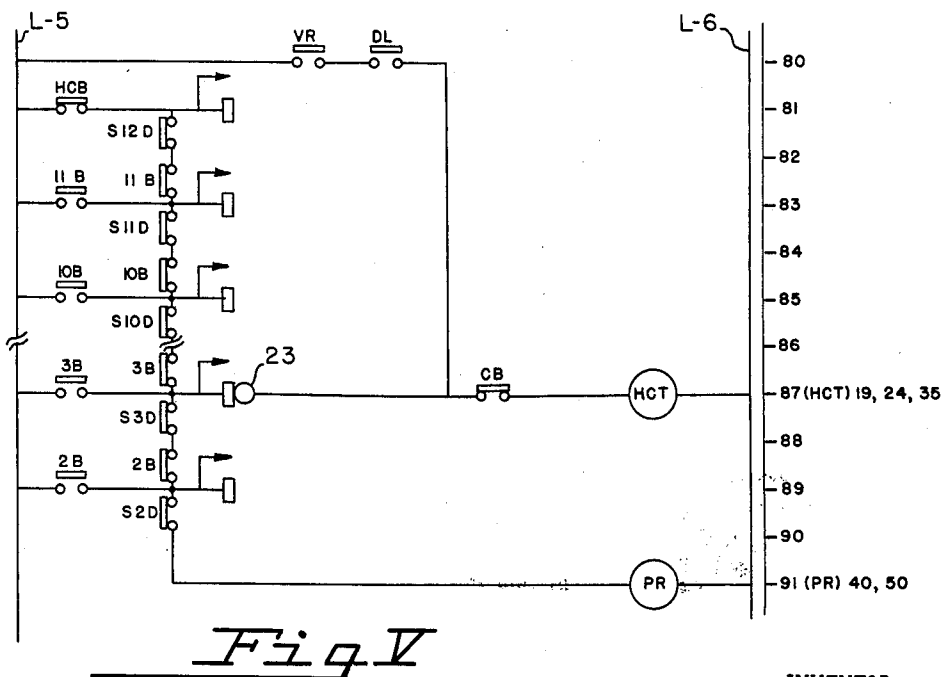
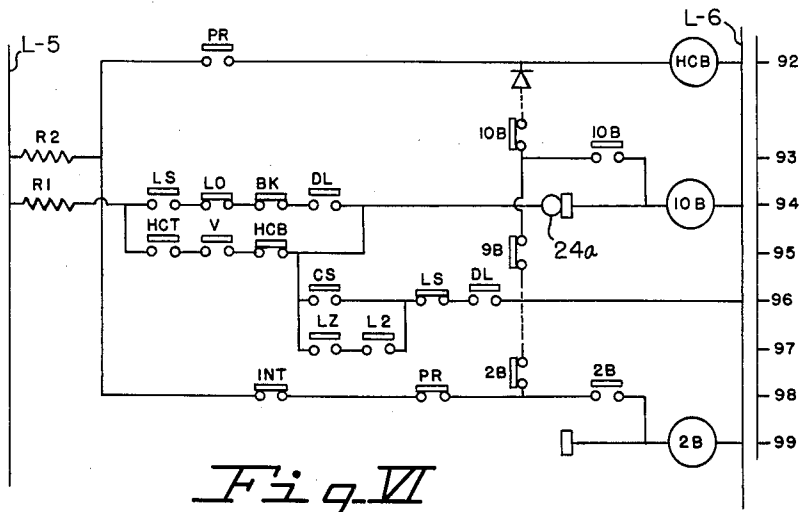
Nov. 27, 1962

M. C. YEASTING
ELEVATOR CONTROLS

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INVENTOR.
MAYNARD C. YEASTING

BY

Marshall, Marshall & Yeasting
ATTORNEYS

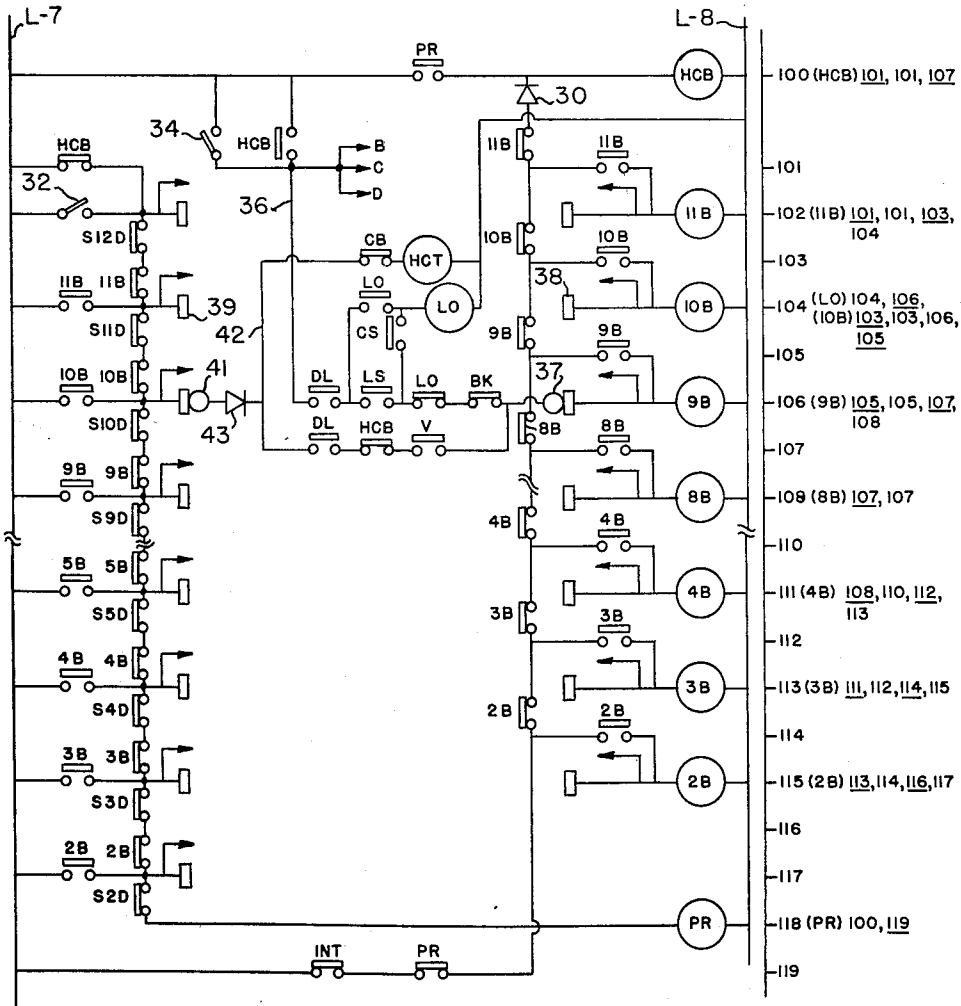
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M. C. YEASTING
ELEVATOR CONTROLS

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INVENTOR.
MAYNARD C. YEASTING

BY

Marshall, Marshall & Yeasting
ATTORNEYS

3,065,825

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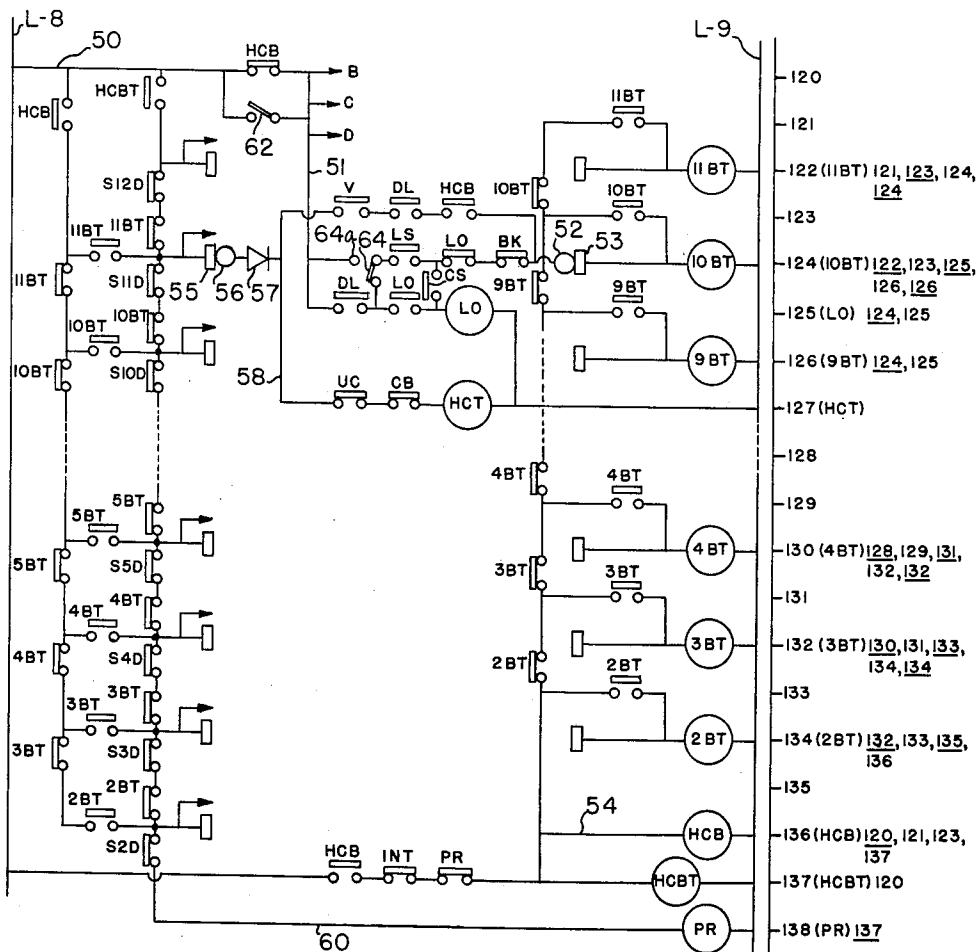


Fig. VIII

INVENTOR.
MAYNARD C. YEASTING

BY

Marshall, Marshall & Yeasting.

ATTORNEYS

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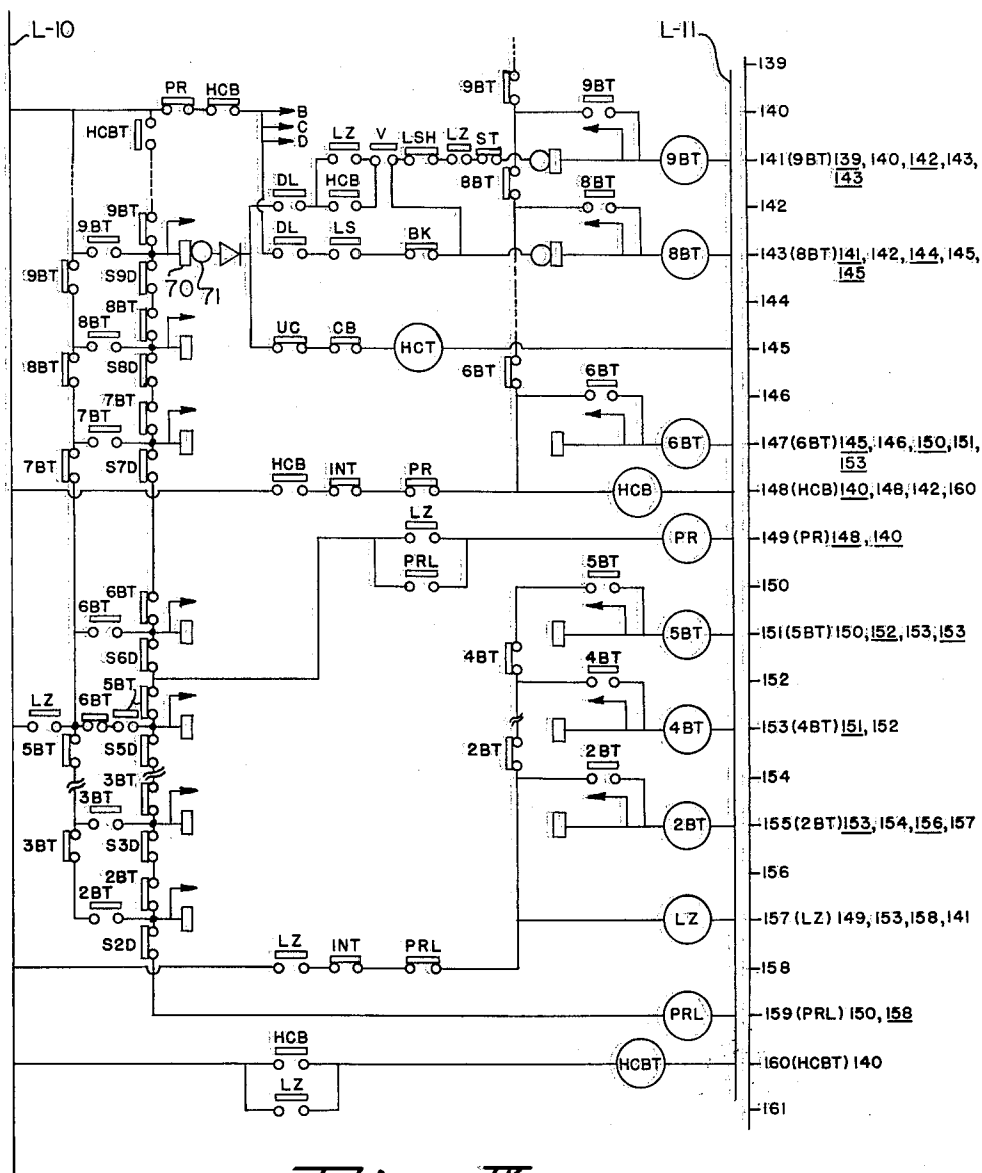


Fig. IX

BY

Marshall, Marshall & Yeasting
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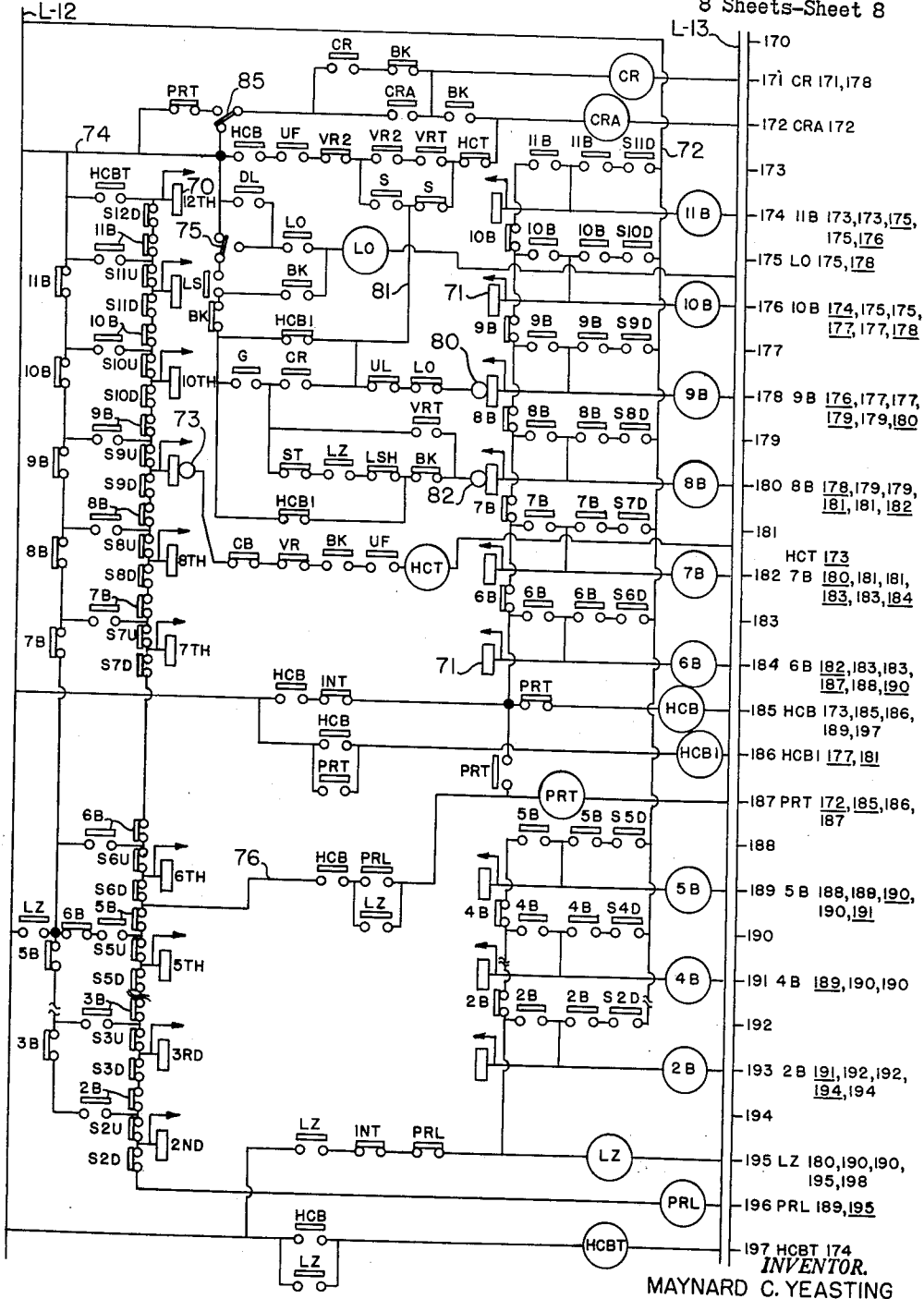


Fig. 1

BY
Marshall, Marshall & Yeasting
ATTORNEYS

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3,065,825

ELEVATOR CONTROLS

Maynard C. Yeasting, near Elmore, Ohio, assignor to Toledo Scale Corporation, Toledo, Ohio, a corporation of Ohio

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20 Claims. (Cl. 187—29)

This invention relates to elevator control circuits and in particular to circuits that are effective during heavy down traffic conditions for equalizing the time intervals that intending passengers are required to wait for service.

Most elevator systems are, during certain periods of each day, subjected to heavy demands of traffic from a plurality of floors to a given floor. In an ordinary office building this heavy demand of traffic is commonly called the "down peak" traffic and occurs when the building occupants are leaving the building at lunch time or at the close of the business day. In a hotel this condition may occur any time during the day and is expected in the morning hours when the hotel guests are leaving the hotel. It may also occur at other times during the day depending upon the usage of the hotel.

In the ordinary elevator system difficulty is often experienced during these periods of heavy down traffic in that the cars become fully loaded at the upper floors of the building and then bypass intermediate and lower floors without stopping for intending passengers waiting at such intermediate and lower floors. It often happens that all of the cars on successive trips become fully loaded on their downward trips before reaching a certain level and any intending passengers below such level must wait until all of the intending passengers on higher floors are served before a car becomes available to answer their call. Various schemes have been proposed to overcome this problem. Usually these schemes involve timing the duration of the registered hall calls and providing special service to those calls that have been registered for more than a given length of time. The usual difficulty with this approach to the problem is that cars assigned to special service usually operate at less than maximum efficiency thus actually degrading or decreasing the efficiency of the elevator system as a whole or enough high and intermediate level floors become long wait calls to still monopolize the elevator service.

The principal object of this invention is to provide control circuits or control means for a group of elevators for so regulating the movement of the cars that a maximum number of passengers may be served in a given time without requiring any of the passengers to wait an unduly long length of time.

Another object of the invention is to provide a system of control which immediately recognizes the existence of a heavy down traffic condition and responds to that condition to both minimize the travel of the elevators and equalize the length of time that intending passengers at various floors are required to wait.

Another object of the invention is to provide a control mechanism for a plurality of elevator cars which prevents the cars from successively serving certain floors of a building while other floors are totally deprived of service.

These and more specific objects and advantages may be obtained from control circuits constructed and operated according to the invention.

According to the invention control circuit means are provided which, in response to a down traveling car acquiring a full load at a floor, establishes a high call reverse ceiling or zone limit which, by design, may be at the next lower floor, the next lower floor having a down call registered, or at the highest down call then registered, so that the next available up traveling car reverses at

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the highest call at or below such ceiling. The high call reverse ceiling or zone limit is either canceled when the highest call at or below such ceiling is answered or, preferably, is shifted to the next lower floor or to the next lower floor at which a down call is registered and, when the ceiling is at a lower floor, is suspended as long as there is a car in service below the ceiling. Under some conditions the zone limit may be reset to a floor at which a call is registered prior to the departure of the car from that floor.

Several examples of elevator control circuits for providing the improved service according to the invention are illustrated in the accompanying drawings.

In the drawings:

FIG. I is a schematic diagram illustrating in general the type of elevator system to which the invention may be applied.

FIGS. II and IIa are schematic wiring diagrams, in simplified form, illustrating hall call registering circuits, and circuits for causing a car to respond to hall calls, including circuits for reversing a car upon receipt of a signal that it has reached the farthest call to which it should respond.

FIG. III is a schematic diagram showing circuit means for energizing the high call reverse ceiling relay for the floor below that at which a down traveling car acquires a full load.

FIG. IV is a schematic wiring diagram showing circuit means for causing an up traveling car to respond to the highest call at or below a high call reverse ceiling put into effect by the circuits shown in FIG. III and for canceling such ceiling when the highest call at or beneath such ceiling is answered.

FIG. V is a simplified schematic diagram illustrating a modified circuit for resetting or canceling the ceiling indication whenever the lowest down call is answered.

FIG. VI shows an alternative circuit for canceling the high call reverse ceiling by a car answering the highest call below the ceiling.

FIG. VII is a schematic diagram of another circuit arranged to establish a high call reverse ceiling at a floor at which an elevator car acquires a full load and, as the highest call at or below the ceiling is answered, to shift such ceiling to the floor next below such last answered call.

FIG. VIII is a schematic wiring diagram similar to FIG. VII showing an arrangement for temporarily suspending operation of the ceiling when the ceiling is at a lower floor.

FIG. IX is a fragmentary schematic diagram illustrating means for establishing a plurality of high call reverse ceilings.

FIG. X is a fragmentary schematic diagram illustrating means for establishing a plurality of high call reverse ceilings including ceilings at floors at which cars acquire full loads and leave intending passengers.

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

One of the difficult problems in the design of supervisory equipment for elevator systems is to provide a pattern or method of operation of the system that will equitably divide the service provided by the cars among the intending passengers waiting at a number of floors. This is the situation that occurs during the down peak traffic period in an ordinary office building. The usual difficulty in handling this type of traffic is that the cars, even though reversing at the highest call, became loaded to capacity at the upper floors of the building and, therefore, bypass intermediate and lower floors. Traffic is often heavy enough that all of the cars on successive trips become fully loaded before reaching the lower inter-

mediate or lower floors of the building. Attempts to correct this situation by reversing available up traveling cars at low or intermediate floors where a signal has been registered for more than a given length of time often result in the cars returning to the lobby floor with small loads since the number of passengers waiting at the lower floors may be few in number.

The control circuits according to the invention solve this problem by providing that, in general, no floor is served several times in succession while another floor goes without service. In one embodiment of the invention the control causes a group of elevator cars to simulate a multi car system one car of which has infinite capacity in that when a first car traveling down from the top of the building acquires a full load it establishes a high call reverse ceiling at the next lower floor at which the next up traveling car stops and reverses. The second car thus acts as a continuation of the first car in serving passengers at next lower floors. If the second car should also become fully loaded before reaching the lobby floor it in turn establishes a high call reverse ceiling or signal point to reverse the next up traveling car so that it in effect continues the operation of the second car in answering the calls for service at lower floors. In this form of control only the first up traveling car to reach such a high call reverse ceiling is stopped at such ceiling and reversed. That car, when leaving after the highest call at or below the ceiling cancels that signal and thereafter, until it becomes fully loaded, other up traveling cars are allowed to proceed to higher calls then registered in the system.

In another embodiment of the invention the control circuits are arranged in a manner such that when a first down traveling car that started from the top of the building becomes fully loaded it established a high call reverse ceiling at the next lower floor. The next car to reach the highest down call at or below such ceiling then answers such call and in doing so establishes a high call reverse ceiling at the next lower floor. This arrangement keeps all of the cars below the high call reverse ceiling except those cars which may be skipped as the ceiling is shifted downwardly from one floor to another.

This circuit provides very quick service for the lower floors of the building since all of the cars are utilized in answering these calls. This has the disadvantage however, that some of the cars, when the high call reverse ceiling gets down to one of the lower floors, return to the lobby with less than full loads. Since it is undesirable to keep all of the cars operating below a low floor high call reverse ceiling the circuit may be modified so that as a car answers the highest call at or below such a low zone ceiling it sets up a ceiling for the next lower floor but suspends operation of the ceiling circuit for a limited time or until the car leaves the floor after taking on the passengers. During such limited time the system is open for the cars to proceed uninterruptedly to the highest actual call.

In a third embodiment of the invention the circuit is arranged so that the ceiling or zone limit may be returned to or restored at a floor at which intending passengers, who are unable to board a first car that answers their call, reregister their hall call prior to the departure of the car.

An elevator system to which the invention may be applied may comprise a plurality of elevator cars 20 that serve a plurality of floors in response to signals set up by actuation of hall call buttons 21 or car calls set up by operation of destination buttons in each of the cars. The car buttons are not shown in the drawings. The cars 20 are suspended by cables 22 which pass over sheaves or pulleys 23 and are connected to counterweights 24. The sheaves 23 are mounted on armature shafts 25 of elevator drive motors 26. The armature shafts 25 are also mechanically connected to floor selec-

tor machines 27 which in cooperation with the hall call registering buttons 21 and supervisory control circuits, not shown, control the operation of the elevator motors 26 so as to move the cars from floor to floor as may be required.

In the following description of the circuits for distributing or controlling the response of the elevator cars during down peak operations only the relays and switches associated with such operations are described. It is to be understood that an actual elevator system will include many more control relays for other functions.

For convenience in following the description each of the wiring drawings is provided with a key along its right margin, this key specifying the line numbers of the drawings, the relay operating coil or coils that may be included in such line, and the line location of the contacts operated by such coil. In the drawings the contacts are all shown in the condition assumed when the operating coils are deenergized. Those contacts that are closed when the operating coil is deenergized, commonly known as back contacts, are identified in the key by underscoring the line number in which such contacts appear. To correlate the operating coils with their respective contacts the same reference characters are applied to each.

In the several embodiments of the invention illustrated in the accompanying drawings the relays having corresponding functions are given the same reference characters.

In any elevator control system some of the control relays and switches are common to all of the cars of the system while other relays and switches are duplicated for each car. In the following description those relays and contacts which are individual to a car and duplicated for each car include the following:

- BK—Brake (energized when brake is released)
- BP—Bypass
- CB—Car call above
- CS—Car start
- CR—Ceiling reset
- CRA—Ceiling reset auxiliary
- DF—Down field
- DL—Down directional preference
- HCR—High call reverse
- HCT—High call reverse timer
- L2—Leveling
- LBP—Load bypass
- LO—Lockout
- LS—Load switch
- MG—Car at lobby
- RB—Car button reset
- RL—Directional latch
- R-2—High call reverse ceiling selection
- S—Hall call stop
- SC—Car call stop
- SD—Highest hall call stop
- UF—Up field
- UL—Up directional preference
- V—Elevator stopping sequence
- VR—Elevator stopping sequence
- VR1—Elevator stopping sequence
- VR2—Elevator stopping sequence
- VRT—Elevator stopping sequence

Those relays and contacts that are in the control circuits common to all of the elevators include the following:

- INT—Intermittent service relay
- HCB—Hall calls bypassed
- HCB1—Hall calls bypassed auxiliary
- HCBT—Hall calls bypassed timing
- PR—Priority reset
- S#D—Down hall call
- S#U—Up hall call
- 2-B, etc.—High call reverse ceiling
- 2-BR, etc.—High call reverse ceiling reset coil
- 2-BT, etc.—High call reverse ceiling timed release

Where it is necessary to identify a relay or contacts as associated with a particular car the symbols (A), (B), (C) and (D) are appended to the reference characters those with the (A) referring to car A and those with the (B) to car B, etc.

FIGS. II and IIa

Circuits for registering hall calls and causing the cars to respond to such calls including reversal at a high call are illustrated in FIGS. II and IIa. Referring to FIG. II typical hall call registering relays are illustrated in lines 10 to 17 inclusive. In an installation each intermediate floor is provided with two of these relays and each terminal floor with one such relay. These relays marked S1U through S12D are latch relays which may be either electrically, magnetically or mechanically latched. Each is actuated to its "on" condition when the associated push buttons 1U to 12D (electrical switches operated by the push buttons 21 of FIG. I) is closed so that current may flow from a lead L1 through an operate coil of the relay and thence through the now closed contacts of the push button to a lead 10 connected to the return line L2. When a relay is so energized it closes its contacts in lines 20 to 28 so as to connect the power lead L1 to corresponding selector machine contact points 11.

An offset pointed arrow connected to a lead connected to a selector machine contact indicates a connection to the corresponding contact of each of the other floor selector machines.

Each of the selector machines has a carriage including a plurality of brushes that cooperate with the selector machine contacts. The stopping circuits are arranged so that the first car that approaches a floor at which a call is registered in a direction to answer such call automatically stops at that floor. These circuits are illustrated in lines 21 and 22 and include an up direction stopping brush 13 and down direction brush 14 that are connected respectively through up field relay contacts UF, line 21, or down field contacts DF shown in line 22 and thence through a circuit (line 22) comprising normally closed stopping sequence relay contacts VR2, normally opened but now closed bypass contacts BP, the coil of the hall call stopping relay S and normally open brake relay contacts BK to the return lead L-2. The up field or down field relay contacts UF or DF respectively are closed as long as the car is traveling in that particular direction. The contacts VR2 of the stopping sequence relay are closed as long as the car is not stopping. The bypass relay contacts are closed as long as the car is operating in normal condition and accepting calls. These contacts are opened as soon as the car becomes loaded to bypass hall calls. The brake relay contacts BK are closed as long as the brake is released so that the car may be moved under control of the elevator drive motor system. As soon as the stopping relay S is energized through this circuit it closes its contacts S in line 18 which in cooperation with normally open stopping sequence relay contacts VR1 complete a sealing circuit from the power lead L1 through the lead in line 18 to the hall call stop relay S. This circuit maintains stopping relay S energized as the stopping sequence relay VR2 opens its contacts in line 22. These sequence relay contacts VR2 in line 22 are included to prevent feedback from the now energized S relay coil to the selector machine contacts 11 or 12 which would thus energize the corresponding contacts on the other floor selector machines so that any other car then approaching such floor would also stop.

Part of the sequence relay chain employed in the stopping of the car includes contacts VR in line 13 which in cooperation with UF or DF contacts in lines 13 and 14 and brushes 15 and 16 cooperating with floor selector machine segments 17 or 18 complete circuits to the reset coils of the hall call stopping relays S1U through S12D. Ordinarily only a few hundredths of a second

elapse from the time that current first flows through the hall call stopping relay S in line 22 until the hall call at that floor is canceled to prevent other cars from stopping at that floor.

FIG. II also illustrates the energizing circuit for the highest hall call stopping relay SD appearing in line 24. This relay is energized whenever the car approaches a floor at which the highest down call is registered if the highest call timing relay HCT is also energized. The highest call timing relay HCT, which cooperates with the circuits to be described for controlling the operation of elevator cars during down peak traffic conditions, is energized whenever the elevator car is at or above the highest hall call. When this relay is energized it closes its contacts HCT in lines 19, 24 and 35, those contacts in line 35 cooperating with contacts of the highest hall call relay SD to energize the high call reverse relay HCR. It may be noted that the circuits for the high call reverse relay HCR are completed only when the car is approaching an actual call whether it be a car call or a high floor call. In the usual arrangements the high call timing relay HCT is energized only when the car is at or above both the highest car call and the highest hall call thus indicating that there are no higher calls to be answered.

When the high call reverse relay HCR is energized it closes its contacts in line 32 to complete a circuit from lead L3 through a coil of a car button reset relay RB, a directional latch relay coil RL, normally closed contacts of the down memory relay DL, the now closed high call reverse contacts HCR and normally closed MG contacts which are closed as long as the car is not at the lower floor. The directional latch relay RL thereupon releases so as to close its normally closed contacts in line 34 to energize the down direction memory relay DL and deenergize the corresponding up direction relay UL. Energization of the down memory relay DL closes its contacts in line 19 which in cooperation with the now closed high call timing relay contacts HCT complete a circuit to the hall call stop relay S in line 22. The car thereupon stops at that floor with its controls and signals set for down travel. It may be noted in these circuits that if a car is traveling upward toward a higher call and such call is answered by another car so that there is then no higher call to be answered the up traveling car, even though it has a high call reverse signal through its HCT relay, does not stop until it either reaches a subsequently registered call or the top of the building.

The directional latch relay RL is also operated through selector machine contacts 19 and 20 and brush 21 when the car reaches the extremes of travel so that it approaches the terminal floors with the directional latch relay reset to travel away from that floor. Since the direction indicating lanterns or other signals are subject to the control of the directional latch relay RL this means that the directional signals will indicate the next movement of the car even though the car may still actually be moving in the first direction.

Figs. III and IV

A first circuit for automatically zoning a group of elevator cars in response to bypassed calls is illustrated in FIGS. III and IV. When an elevator system is operating under the control of this circuit a high call reverse ceiling is established at the floor below the floor at which a down traveling car acquires a full load.

The term "high call reverse ceiling" is used to denote the top of a lower zone of floors to which operation of the system of elevators is restricted until such ceiling is canceled. When a high call reverse ceiling is in operation a car will go above such ceiling in response to car calls registered for higher floors and once above the ceiling will answer calls in the normal manner. Except for this one condition all up traveling cars are reversed at the

highest call at or below the ceiling as long as the ceiling is in effect.

In this particular control circuit a high call reverse ceiling is canceled either immediately that the highest call at or below such ceiling is answered or, if the ceiling is above a selected floor such as the fifth floor, is canceled as soon as the answering car leaves the floor after answering the signal. This difference in releasing time or canceling time tends to restrict more cars to the lower portion of the building when the ceiling is at a higher floor and to hold only one car below the ceiling when the ceiling is at a lower floor.

Referring specifically to the wiring diagrams illustrated in FIGS. III and IV a family of ceiling relays 2B through 11B are provided one for each of the intermediate floors of a 12 floor building. These relays in this embodiment are preferably of a double coil variety having an energizing coil and a canceling or release coil. The energizing coils are illustrated in FIG. III while the cancelling coils are illustrated in FIG. IV. The cancelling coils are identified by the letter R appended to each of the reference numerals. The ceiling relays 2B through 11B, when energized, establish a high call reverse ceiling for the corresponding floor. The ceiling relay 10B for the tenth floor may be energized for example when a car is standing at the eleventh floor and acquires a full load. When this occurs a circuit is completed from a supply line L5 through now closed down direction memory relay contacts DL, load switch contacts LS, normally closed contacts LO of the lockout relay, normally closed brake relay contacts BK to a selector machine brush 30 and selector machine contact 31 connected directed to an operating coil 10B of the tenth floor ceiling relay. The other side of this coil is connected to a return lead L6. When this relay is energized through this circuit it closes its contacts 10B in line 43 to complete a sealing circuit that may be traced from the lead L5 through now closed intermittent service relay contacts shown in line 50, normally closed priority reset relay contacts PR and thence through a chain of normally closed contacts of all of the ceiling relays 2B through 9B. This tenth floor relay 10B also opens its contacts 10B in line 43 to deenergize any ceiling relays above the tenth floor including a bypassed hall call relay HCB shown in line 40.

When this loaded car prepares to leave the eleventh floor its car start relay contacts CS close in line 45 so that current can flow through the now closed load switch LS through an operating coil LO of a lockout relay. This relay thereupon seals itself in through a circuit that includes the down direction memory relay contacts DL, lockout relay contacts LO in line 46 so that this relay remains energized until the car reverses. This relay is included solely to prevent a loaded down traveling car, having once established a high call reverse ceiling, from establishing a lower high call reverse ceiling when stopping at a lower floor in response to a car call. As long as the load switch on a car is operated to its closed condition it, through circuits not shown, opens the bypass relay contacts in the stopping circuit so the car will not respond to hall calls.

Referring now to the circuit shown in FIG. IV, which cooperates with that shown in FIG. III, the energization of the tenth floor high call reverse ceiling relay 10B divides a high call reverse signal circuit along the left side of the diagram into two segments and energizes the upper end of the lower segment by completing a circuit from a supply lead L5 through now closed contacts 10B in line 64 to energize the lower segment of the circuit comprising a chain of normally closed down stopping relay contacts S10D, etc. and normally closed high call reverse ceiling relay contacts 9B, 8B, etc. The opening of normally closed ceiling relay contacts 10B, just above line 64, isolates the upper segment of the high call reverse circuit.

When another car reaches the highest call at or below the high call reverse ceiling now established at the tenth

floor a circuit is completed from the tenth floor selector machine contact 22 through the selector machine brush 23, normally closed car call above contacts CB and the operating coil HCT of a high call reverse timing relay. This relay, if the car is set for upward travel, conditions the circuits to stop the car at that high call and reverses it for downward travel. If the car is traveling down from a higher floor this relay is without effect and the car makes a normal stop at the high call at or below the high call reverse ceiling. As the car answers this call in response to the signal it completes a circuit from the now energized brush 23 through the circuit shown in line 62 which includes down direction memory relay contacts DL, stopping sequence relay contacts VR and either low zone contacts which close at the fifth floor or car starting relay contacts CS thence to a selector machine brush 24 and contact 25 to energize the tenth floor point of a series of rectifiers 26. From the tenth floor point current flows through contacts 10B to energize a release coil 10BR of the tenth floor high call reverse ceiling relay. The series of rectifiers 26 are included to ensure cancellation of the high call reverse ceiling in the event the highest call was at a floor below the ceiling and there was no call at the ceiling floor itself. For example, the car might stop at the eighth or ninth floor when the tenth floor was actually the high call reverse ceiling and a reset circuit by way of one or more of the rectifiers 26 is required to energize the coil of the operated relay.

Referring back to FIG. III, as long as there is no high call reverse ceiling relay energized, the series chain of normally closed ceiling relay contacts is completed to energize the high call bypass relay HCB in line 40. When one of the relays is energized by a car becoming loaded it breaks the circuit to the high call bypass relay HCB so that it closes its contacts in line 60 thereby energizing the high call reverse circuit contacts shown in FIG. IV. When the high call reverse ceiling relay is deenergized to cancel the ceiling the system reverts to normal operation with the cars making full trips. This continues until another car becomes fully loaded at which time it energizes the high call reverse ceiling relay for the floor below its then occupied position. Ordinarily the next car to become so loaded is the car that reversed and canceled a previous ceiling in response to the previous high call below the ceiling. If this car becomes fully loaded before answering all of the down calls at or beneath it, it reestablishes a high call reverse ceiling for the floor below. If there are calls at or below such floor the normal sequence as just described continues when the next up traveling car stops at the highest call at or below such floor. In the event that there are no calls at or below that floor the energization of the high call reverse ceiling relay for that floor establishes a circuit through the high call reverse circuit of normally closed contacts including contacts of the down signal relay S2D for the second floor and thence through a lead in line 71 to energize a priority reset relay PR. This relay, when energized, opens its contacts in line 50 to immediately break the holding or sealing circuit to the then energized high call reverse ceiling relay. The priority reset relay PR immediately closes contacts in line 40 to energize the bypass hall call relay HCB which in turn opens its contacts in line 60 to restore normal operation rather than high call reverse operation for the bank of elevators. As soon as the bypassed hall call relay HCB operates to open its contacts in line 60, the priority reset relay PR is deenergized leaving the bypassed hall call relay energized by way of the chain of series contacts shown in FIG. III. The system is now returned to a condition in which it is ready to respond to another loaded car. In the absence of such loading the system continues to operate in normal operation with the cars traveling to the terminals and being regularly dispatched.

FIG. V

A slightly modified arrangement of the resetting circuit

which may be used either in conjunction with or in place of the resetting circuit shown in FIG. IV is shown schematically in FIG. V. In this modification the high call reverse brush 23 is connected to the lead L5 by normally open down direction memory relay contacts DL and stopping sequence relay contacts VR in line 80 so as to energize the high call reverse series of contacts at a point corresponding to the floor at which the car is stopping. If there are no calls below this floor this circuit through the chain of normally closed contacts of the ceiling and down hall call relays energizes a priority reset relay PR so that it then cancels any high call reverse ceiling. When this reset circuit is used in place of that shown in FIG. IV it suffers from the hazard that if the high call reverse ceiling be at a high floor it is quite possible that the group of elevator cars could operate for a substantial period of time beneath such high call reverse ceiling without answering the lowest registered call. If this occurs there is no way of serving the top floors of the building above the high call reverse ceiling point until the intermediate and lower floors had all been cleared of traffic. This circuit may be used in locations where this hazard is not present, i.e., where there is no substantial amount of lower intermediate floor traffic in comparison with the traffic from the higher floors. This circuit may also be used in conjunction with that of FIG. IV by adding this particular connection to the circuit shown in FIG. IV. This circuit would then serve as a corrective measure to correct any malfunctioning of the other reset circuit.

FIG. VI

In the circuit shown in FIG. IV which is employed to cancel any previously energized high call reverse ceiling relays the higher ceiling is reset as soon as the car leaves that particular floor. Another method of accomplishing substantially this same result is shown in FIG. VI. In this circuit the reset coils of the high call reverse ceiling relays are eliminated and instead the relays are energized through circuits including resistors and are deenergized by shorting or shunting the operating coils to reduce the current flow through the coil to a value less than that required to keep the relay energized. In this arrangement a ceiling relay such as the relay 10B in line 94 is energized when a down traveling car acquires a full load while standing at the eleventh floor. The energizing circuit may be traced from a lead L5, through resistor R1 and thence through the now closed load switch LS of the car, normally closed lockout relay contacts LO, normally closed brake relay contacts BK, and down direction memory relay contacts DL. Once this relay is energized it, through circuits similar to those illustrated in FIG. IV establishes a high call reverse ceiling for the tenth floor. This relay is held closed by current flow from the supply lead L5 through resistor R2 and normally closed contacts of each of the ceiling relays for floors below the tenth floor.

When the highest call at or below the tenth floor is answered by another car it completes a circuit by way of its high call reverse timer relay contacts HCT, shown in line 95, normally open stopping sequence relay contacts V and normally closed bypassed hall call relay contacts HCB to energize the high call reverse ceiling relay for the next lower floor. For this portion of the circuit it is assumed that the previous high call reverse ceiling was established by a car at the eleventh floor when the next car answers a call at the tenth. This shifts the high call reverse ceiling down to the floor below the just answered highest call.

The high call reverse ceiling is in effect for that floor until the car leaving the next higher floor starts without having acquired a full load. If the car leaves the floor above that at which the ceiling is established without acquiring a full load it completes a circuit from its brush 24a through its car start switch CS, normally closed load switch contacts LS, and down direction memory relay contacts DL in line 96 so as to shunt the operating coil of

the then energized high call reverse ceiling relay. This relay thereupon releases and the bypassed hall call relay HCB picks up thus leaving the system without a high call reverse ceiling. If the car leaves with a full load its load switch contacts LS in line 96 are open so that the relay is not deenergized and the high call reverse ceiling therefore remains in effect. To avoid trapping cars unnecessarily when a ceiling is established at a low floor, additional contacts of a low zone relay LZ and a leveling relay L2 are shown in line 97 in parallel with the car start switch contacts so as to complete the shunting circuit a moment after the relay was energized by prior closure of the stopping relay contacts V in line 95. The low zone relay LZ contacts in line 97 are arranged to be closed as long as the car is below the fifth floor for example. Therefore when the car answers the highest call at or below the high call reverse ceiling at or below the fifth floor the high call reverse ceiling is immediately canceled for all cars. However, should the car acquire a full load upon answering such call it, by means of the circuit shown in FIG. VI reenergizes the high call reverse ceiling relay for the next floor.

FIG. VII

A circuit for a second embodiment of the invention is illustrated in FIG. VII. Operation under the control of this circuit differs from that under the first circuit without the modification of FIG. VI in that as the highest call at or below a high call reverse ceiling is answered the high call reverse ceiling is shifted to the next floor below the position of the answering car. In this arrangement all of the cars are restricted to operation below the then existing high call reverse ceiling unless they are skipped during upward travel as the high call reverse ceiling position shifts downwardly.

This circuit includes a family of high call reverse ceiling relays 2B through 11B which may be conventional single coil relays. Each of these high call reverse ceiling relays is provided with a pair of normally open and a pair of normally closed contacts. Each ceiling relay, once energized, is held in by current flow from a supply lead L7 through program relay contacts that are closed on normal service and shown in line 119, normally closed priority relay contacts PR, and a series chain of normally closed contacts of all the ceiling relays for floors below. A rectifier 30 connected to the high floor end of this series of contacts passes current to a coil of a bypassed hall call relay HCB shown in line 100. When any one of these high call reverse ceiling relays is energized it breaks the circuit through this series chain of contacts to the bypassed hall call relay HCB and through one of its normally open sets of contacts connects the coil of the now energized relay to that circuit below the break. Thus any one of these relays, when energized, seals itself in at the same time that it breaks the sealing circuit for any relays for floors above.

The other contacts of each of the relays cooperates with hall call relay contacts to provide a conventional high call reverse circuit shown along the left side of FIG. VII. Each of the high call reverse ceiling relays when energized divides the chain of normally closed contacts into two segments at a point between the points corresponding to that floor and the floor above and connects the lower segment of the circuit to the supply lead L7. By breaking the sealing circuit the high call reverse ceiling relay also deenergizes the bypassed high call relay HCB so that it closes its contacts in line 101 to energize the upper segment of the high call reverse circuit.

If it is desired to continuously operate the system on high call reverse a manually operated switch 32, in line 102, is closed to continuously energize the upper end of the high call reverse circuit.

In this circuit a high call reverse ceiling is established whenever a car acquires a full load on its down trip. The circuit for establishing such a ceiling may be traced from the supply lead L7 through either a manually operated

switch 34 or normally open contacts of the hall call bypass relay HCB and thence through a lead 36, down direction memory relay contacts DL in line 106, load switch contacts LS, normally closed lockout contacts LO, and normally closed brake relay contacts BK for energizing the selector machine brush 37 cooperating with contacts 38 that are connected to the energizing coils of the high call reverse ceiling relays. If, for example, the car is standing at the tenth floor as shown in FIG. VII this circuit energizes the high call reverse ceiling relay 9B to establish a high call reverse ceiling at the ninth floor. When the high call reverse ceiling relay 9B is energized it breaks the sealing circuit for all high call reverse ceiling relays for floors above that point including the circuit for energizing the bypassed hall call relay HCB line 100.

Once a high call reverse ceiling relay such as the relay 9B in line 106 is energized two slightly different modes of operation follow depending upon whether or not the manually operated switch 34 shown just above line 101 is opened or closed. As long as this switch 34 is closed any down traveling car upon acquiring a full load energizes the high call reverse ceiling relay for the floor below and, if there are no other energized high call reverse ceiling relays below such floor, seals itself in to establish the high call reverse ceiling at the corresponding floor. If there is a high call reverse ceiling relay energized for a floor below the holding or sealing circuit for the higher energized high call reverse ceiling relay cannot be completed and this relay then drops out as soon as the car starts as it leaves such floor. When operating in this manner it is undesirable to allow a loaded down traveling car, when stopping for a car call, to energize the high call reverse ceiling relay for a lower floor. This undesirable operation is prevented by providing each car with a lockout relay LO, one of which is shown in line 104, which relay is energized as soon as both the load switch for the car and the car starting switch CS are closed as the car leaves the floor at which it acquired full load. This relay seals itself in through its contacts LO, line 104, and down memory relay contacts DL, line 106, so that it remains energized until the car reverses at the lower terminal. The lockout relay also opens its contacts in line 106 to prevent energization of any high call reverse ceiling relay.

A slightly different mode of operation results if the manually operated switch 34 is opened. In this case if there are no high call reverse ceiling relays operating when a car acquires a full load and the bypassed hall call relay HCB is energized to close its contacts in the circuit from the supply lead L7 to the lead 36 the loaded car then energizes the high call reverse ceiling relay in the manner just described. When such ceiling relay is energized it immediately breaks the circuit to the bypass hall call relay HCB and it, by opening its contacts HCB in line 101, prevents any car including the now loaded car from energizing, as a result of loading, any of the high call reverse ceiling relays until all such relays have been released. When operating in this manner with the switch 34 open the lockout relay LO does not have an opportunity to function since the energizing circuit through the lead 36 is broken before the car starts from the floor in response to closing its car starting switch CS. Therefore if the system is to be continually operated with the switch 34 opened the lockout relay may be omitted.

Each high call reverse ceiling relay, when operated, divides a high call reverse circuit appearing along the left side of FIG. VII into a lower and an upper segment and separately energizes the high end of the lower segment. This high call reverse circuit comprises a series chain of contacts including normally closed contacts of the down hall call relays S12D, S11D, etc., in order from the top floor and extending downwardly. Alternating with these contacts are normally closed high call reverse ceiling relay contacts 11B, 10B, 9B, etc. The

junction point below the normally closed high call reverse ceiling relay contact for a given floor and above the down hall call relay contact for that floor is connected to a selector machine contact 39. This junction is also connected through a normally open high call reverse ceiling relay contact to the lead L7. A selector machine brush 41 cooperates with the contacts 39. In this high call reverse circuit the registration of any hall call breaks the circuit at a point just below the selector machine contact representing the floor at which the call is registered. Therefore the only selector machine contacts 39 that are energized are those that correspond to the highest floors at which calls are registered in each of the zones, that is, the highest call at or below the high call reverse ceiling relay and the highest call in the building.

When a car traveling in either direction reaches a floor at which there is an energized selector machine contact 39 of the high call reverse circuit current flows through a brush 41 cooperating with the contacts 39, a lead 42, normally closed contacts CB of a car call above relay CB and operating coil of the high call timing relay HCT. If the car is already traveling in the down direction this particular portion of the circuit has no effect. However, if the car is traveling in the up direction this circuit initiates a reversal of the direction memory relays of the car provided there is an actual down call at the same floor. Ordinarily there is an actual down call at the floor at which the segment of contacts 39 are energized so that the car will make a stop at that floor. However, there are conditions under which this is not true. For example, if a car is traveling upwardly in response to a single down call at a higher floor and another car answers that call the high call timing relay HCT is energized without there being any calls above the car to be answered. In this event the car proceeds to the upper terminal before reversing. The same situation may occur in the circuit of FIG. VII in that the call at a floor may be canceled before the high call reverse ceiling relay for that same floor releases. In this case the car, instead of stopping at the high call reverse ceiling, proceeds on upwardly to the actual highest call in the system.

This circuit provides means for shifting the high call reverse ceiling downwardly as the highest call in the zone below such ceiling is answered. This circuit may be traced from the brush 41, which is energized whenever the car arrives at the highest call at or below the ceiling, by way of a lead shown in line 107 that includes down direction memory relay contacts DL and normally closed bypassed hall call relay contacts HCB, and thence through the normally open stopping relay contacts V to the selector machine brush 37 to energize the high call reverse ceiling relay for the floor below the position then occupied by the car. Thus the high call reverse ceiling moves downwardly as the calls are cleared from beneath it.

A diode or rectifier 43 is included in the lead in series with the selector machine brush 41 to prevent current feedback to the high call reverse circuit by way of the sealing circuit for the high call reverse ceiling relays, the brush 37, the stopping sequence relay contacts V, the contacts HCB and the down memory contacts DL. This is to prevent energizing the upper segment of the high call reverse circuit from the lower end thereof when the high call reverse ceiling relay for the floor above releases as the ceiling is shifted down.

In this circuit as described so far the only way in which an up traveling car can escape the high call reverse ceiling and proceed to the upper floors is if it has a higher car call registered which, by opening the contacts CB in line 103, prevents operation of the high call reverse timer relay HCT or if the car while traveling upwardly is between the old and new positions of the high call reverse ceiling as that ceiling shifts from the

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old to the new position. In this case the car is skipped and it then proceeds upwardly to the highest call.

This circuit thus tends to trap all of the cars beneath the high call reverse ceiling which may lead eventually to a number of partially loaded trips to the lobby floor, one such trip for each car. To avoid this possibility it is desirable to arrange the circuit so that the number of cars held below the high call reverse ceiling decreases as that ceiling moves downwardly through the building. One way of accomplishing this result is illustrated in FIG. VIII in which the high call reverse ceiling relays 2B, 3B, 4B etc. are of the slow dropout type, the dropout time being adjustable up to a maximum time interval which approximates the time required for a car to make a stop in answer to a call and then proceed on its way.

FIG. VIII

In the preceding circuit shown in FIG. VII the high call reverse ceiling, the top of the lower zone, moves down instantly when the highest call at or below the ceiling is answered. This makes it improbable that any car not having a higher car cell registered can escape the ceiling and, as a result, all of the cars are trapped below the high call reverse ceiling to the complete disregard for any hall calls in the upper zone above the ceiling. This condition is corrected by the circuit shown in FIG. VIII in which the high call reverse ceiling relays are of the slow or timed dropout variety, i.e. the relay releases a predetermined time after its coil is deenergized. The contacts of these relays are arranged in the circuit so that operation of the high call reverse ceiling is suspended after a shift from one floor to the next lower floor, until the ceiling relay for the higher floor has released. Thus a time delay is provided during which time up traveling cars are permitted to pass the ceiling to answer the highest actual down hall call in the system. By varying the time delay at the various floors the circuit may be adjusted so that when the high call reverse ceiling is at a low floor most of the up traveling cars are allowed to go by to serve the upper zone while if the high call reverse ceiling is approximately half way up the building or toward the upper part of the building more of the up traveling cars are intercepted and reversed by the high call reverse ceiling. In this manner the cars are assigned to the low and high zones more or less in accordance with the number of floors then included in each zone. This circuit is further arranged so that the high call reverse ceiling is canceled the instant the last call at or below the ceiling is answered. The system then operates for a period of time as an ordinary single zone high call reverse system.

As an added feature the circuit shown in FIG. VIII is arranged so that it automatically institutes and maintains the high call reverse program of operation during up peak traffic conditions. This is accomplished by energizing a time delay relay each time an up traveling fully loaded car makes a stop.

In the diagram a series of high call reverse ceiling relays 2BT through 11BT, one for each intermediate floor of a twelve floor building, are shown along the right side of the diagram. Each of these relays, once energized, seals itself in through an energizing circuit that includes, among other contacts, normally closed contacts of each high call reverse ceiling relay below it in the series and its own normally open contacts. The series of normally closed contacts are shown in a vertical lane near the right side of the diagram. The high call reverse ceiling relays are further provided with two sets of back contacts and one set of front contacts that are incorporated in a high call reverse circuit shown along the left side of the diagram. One set of back contacts divides the high call reverse circuit into two segments at the floor corresponding to the energized high call reverse ceiling relay while the set of front contacts energizes the lower segment by current flow through normally closed or back contacts of

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all of the high call reverse ceiling relays for floors above the energized relay and normally open HCB contact in line 121. In this arrangement the lower segment of the high call reverse circuit is de-energized as long as two high call reverse ceiling relays are in their operated condition. This condition exists during the timing out interval of any of the high call reverse ceiling relays.

This circuit also includes a bypassed hall call relay HCB shown in line 136, a hall call bypassed timing relay HCBT shown in line 137, a priority reset relay PR shown in line 138 and, individual to each car, a lockout relay LO shown in line 125 and a high call reverse timing relay HCT shown in line 127.

The operation of this circuit may be easily understood by following the sequence of events through the onset of a down peak traffic condition. Immediately prior to the down peak traffic condition there is often a lull during which no calls are registered and the system is idle. At this time all of the relays illustrated in FIG. VIII are in their de-energized condition. Assume that a moment later, at quitting time when everyone wishes to leave immediately, down hall calls are registered at most of the floors. The registration of the down hall calls opens the contacts S12D, S11D, etc. for all of the floors at which calls are registered. Next assume that the first down traveling car acquires a full load at the eleventh floor. When it acquires a full load it closes its load switch to complete a circuit from a supply lead L8 by way of lead 50 in line 120, normally closed hall call bypassed relay contacts HCB, lead 51, down direction memory relay contacts DL, the now closed load switch contacts LS, normally closed lockout relay contacts LO and normally closed brake contacts BK, line 124, to energize a selector machine brush 52. The brush 52 engages contacts 53 to energize the tenth floor high call reverse ceiling relay 10BT. As soon as this relay picks up, which occurs immediately, it completes a circuit by way of its contacts in line 123, normally closed contacts of all of the high call reverse ceiling relays for floors below, and lead 54 to energize a coil HCB of the bypassed high call relay HCB, line 136. This relay thereupon picks up to close its contacts in line 120. These contacts should be of the make-before-break variety so as to avoid any possibility of a buzzer action of the relay HCB. The buzzer action may also be avoided by bypassing the contacts HCB in line 120 with a series combination of a small resistor and a condenser. The closure of the bypassed hall call relay contacts HCB in line 137 completes a sealing circuit through intermittent service relay contacts INT and normally closed priority reset contacts PR to maintain the flow of current through the coil of the ceiling relay 10BT after the car leaves that floor.

The opening of the bypassed hall call relay contacts HCB in line 120 prevents any of the other cars from energizing the high call reverse ceiling relays in response to acquiring a full load through circuits duplicating the circuit shown in line 124.

The energization of the high call reverse ceiling relay 10BT causes it to close its contacts in line 126 to energize a tenth floor selector machine contact 55 by way of a circuit including normally open bypassed hall call relay contacts HCB shown at the left end of line 122 and normally closed contacts of all of the ceiling relays for floors above the tenth floor, in this case the normally closed contacts 11BT shown just below line 124. This circuit energizes the tenth floor high call reverse contact regardless of the presence of any higher hall calls. The tenth floor high call reverse ceiling relay 10BT also opens its contacts 10BT just below line 126 in the left lane of contacts to interrupt the flow of power to any lower high call reverse circuit contact. It also opens the circuit in the second lane of contacts to prevent any feed of power upwardly from the tenth floor of contact. Thus the operation of the high call reverse ceiling relay is effective

tive to divide the high call reverse circuit into two segments the lower segment of which is energized independently of the upper segment. The upper segment is energized from its upper end through bypassed hall call timer contacts HCBT shown just below line 120.

To explain the sequence of events that occurs as the high call reverse ceiling is shifted downwardly in response to the answering of the highest call below the ceiling it will be assumed in FIG. VIII that a high call reverse ceiling had previously been established at the eleventh floor, as by a preceding car becoming fully loaded at the twelfth floor, and it will be further assumed that the next car to arrive at the eleventh floor is traveling upwardly. When this car arrives at the eleventh floor, the then high call reverse ceiling, its brush 56 engages the energized segment 55 for the eleventh floor so that current flows through a rectifier 57, a lead 58, up hall call contacts UC that are open as long as there are higher up hall calls or the car has stopped for an up call, and car call above contacts CB, line 127, to energize a high call reverse timer relay HCT. It will further be assumed that a down call existed at the eleventh floor so that upon the energization of the high call reverse timer relay HCT the directional relays for the up traveling car are reversed as the car stops at the eleventh floor. As the car starts its slow-down for the eleventh floor current flows from the rectifier 57 through stopping relay contacts V, down direction memory contacts DL and now closed bypassed hall call relay contacts HCB to energize the tenth floor high call reverse ceiling relay 10BT. When this relay picks up it opens its contacts 10BT just below line 122 in the lane of contacts near the right of the diagram to break the sealing circuit to the eleventh floor ceiling relay 11BT. Also, as the car picked up the stopping signal for the eleventh floor and started its slowdown it canceled the signal at such floor thereby closing contacts S11D at about the same instant that contacts 10BT in series therewith opened. This breaks the circuit to the tenth floor high call reverse circuit contact to suspend operation of the high call reverse ceiling until the eleventh floor relay 11BT drops out to close its contacts in the left lane just below line 124 and complete a circuit from the lead 50 through normally open but now closed contacts 10BT to the tenth floor contact 55.

The high call reverse ceiling is thus suspended or inactivated for a period of time equal to the dropout time of the releasing high call reverse ceiling relay. The timing of the high call reverse ceiling relays 2BT through 11BT is preferably adjusted to short intervals for the relays corresponding to the upper floors of the building and longer intervals for the relays corresponding to the lower floors. Preferably the timing for the relays 2BT through 4BT should be generally equal to the length of time required for a down traveling car to stop and receive the passengers waiting at a floor and depart. With this timing there is only a slight chance of stopping an up traveling car below the high call reverse ceiling as long as there is a car in position to promptly answer the highest call below such ceiling. For example, suppose the high call reverse ceiling is located at the fifth floor and a call is registered at the fifth floor. As this call is answered and the fourth floor ceiling relay 4BT is energized it prevents any flow of current from the fifth floor segment to the lower segment by way of the now closed fifth floor down hall contact S5D at the same time that the now releasing fifth floor ceiling relay contact 5BT prevents any flow of power through the left lane of contacts and the now closed front contact 4BT connecting the left lane to the high call reverse circuit.

It may be observed that as long as the fifth floor high call reverse ceiling relay has not dropped out the corresponding floor selector segment is energized to operate a high call timing relay HCT. This is without effect, however, because there is no down call then registered at the

fifth floor and any up traveling cars proceed past this floor and on up to the highest actual call in the system. If the fifth floor ceiling relay release time is equal to or greater than the time required to answer the call at the fifth floor the car may proceed to the fourth floor and energize the third floor ceiling relay 3BT to deenergize the fourth floor ceiling relay 4BT before the fifth floor ceiling relay 5BT has released. This overlap in timing continuously holds the high call reverse ceiling out of action. Should a car be delayed in answering these calls or should it become fully loaded so as to leave one or more of these calls the release of the deenergized relay then reestablishes the flow of power to the floor selector machine contact to reestablish the high call reverse ceiling and thus stop the next up traveling car at the highest call at or below such ceiling. In this manner a number of cars, not needed for immediate service in the local zone, are permitted to serve the upper zone but an up traveling car is pressed into service for the lower zone as soon as it is needed.

When the last call below the high call reverse ceiling is canceled by a car answering that call a circuit is completed to the bottom end of the high call reverse circuit and thence through a lead 60 to an operating coil PR of a priority reset relay PR shown in line 133. This relay thereupon opens its contacts PR in line 137 to immediately deenergize any high call reverse ceiling relays that may then be energized as well as the bypassed hall call relay in line 136 and the timing relay HCBT in line 137. The bypassed hall call relay HCB immediately releases to open its holding contacts HCB in line 137 and its contacts HCB in line 122 to deenergize the lower segment of the high call reverse circuit. By opening its contacts HCB in line 122 the priority reset relay is deenergized so that it closes its contacts in line 137 to prepare the circuit for the next cycle of operation. Thus the circuit is immediately returned to single zone high call reverse operation even though one of the lower floor ceiling relay has not yet released. As soon as all of the ceiling relays are released a second cycle of operation may begin as a down traveling car acquires a full load.

It should be noted that the bypassed hall call timing relays HCBT shown in line 137 is arranged to hold its contacts in line 121 closed for an appreciable interval, in the order of 30 seconds to a minute or more depending upon circumstances, after the lowest call below the ceiling has been canceled. During this time which is probably still part of a down peak traffic period the cars operate in an ordinary single zone high call reverse program. This avoids the extra stops that may be incurred if the cars run to the upper terminal before reversing.

If a manually operated switch 62 shown in line 121 to bypass the normally closed bypassed hall call relay contacts HCB in line 120 is closed a slightly different mode of operation results. With the switch closed any car acquiring a full load energizes the ceiling relay for the floor below. If this tends to establish a ceiling lower than that already in effect the lower ceiling relay seals itself in to establish a new high call reverse ceiling. If this relay so energized is above a then energized ceiling relay it temporarily shifts the ceiling to the floor immediately below the floor at which that car is acquiring a full load. The effective high call reverse ceiling for the system is, therefore, at the highest call below the highest stopped loaded car and remains at such point until a short time after that car starts. This operation does not cancel a lower ceiling and such lower ceiling becomes effective upon the dropout of the higher ceiling relay.

When the switch 62 is closed and it is desirable to prevent a loaded down traveling car that is stopping for a car call from establishing a lower high call reverse ceiling a lockout relay LO, line 125, is provided. This relay LO is energized when the car starts downwardly

after acquiring a full load and seals itself in through its lockout contacts LO in line 125 so that it remains energized until the car reverses. As long as the lockout relay LO is energized it opens its contacts in line 124 to prevent that car from energizing any ceiling relay.

This circuit may also be used to establish high call reverse operation during up peak traffic conditions. Thus, if a double throw switch 64 in line 124 is operated to close its contacts 64a any loaded car stopping at a floor when there is no high call reverse ceiling in operation picks up the ceiling relay for the floor below and, through contacts of that and lower relays, energizes the bypassed hall call timing relay HCBT in line 137 as well as the bypassed hall call relay in line 136. Since there are probably no down hall calls registered during up peak traffic conditions the priority reset relay PR is immediately energized to open its contacts in line 137 to deenergize the bypassed hall call relay HCB as soon as the loaded car departs from a floor at which it picked up the ceiling relay. However, the bypassed hall call timing relay HCBT keeps the high call reverse circuit energized through its contacts HCBT just below line 120 for the duration of its timing period. Since this timing period is longer than the normal loading time of the next car it follows that as long as the loaded cars promptly move upwardly from the lower terminal and stop at their first car calls they successively reenergize the timing relay HCBT and thus extend the period of high call reverse operation during up peak traffic conditions. When the up traffic subsides so that the cars are no longer fully loaded and that condition is maintained for the drop-out time of the timing relay HCBT the system reverts to normal operation.

Fig. IX

The systems shown in FIGS. VII or VIII effectively divide, during down peak traffic conditions, the building into two zones, an upper and a lower, by a high call reverse ceiling functioning as the upper end of the lower zone which ceiling successively shifts down from floor to floor as the highest calls below the ceiling are answered. In tall buildings it may be desirable to further zone the system, for example, by having a possibility of three zones comprising a lower zone of a given number of floors, an intermediate zone extending from the top of the lower zone to a shiftable high call reverse ceiling and a top zone comprising the remainder of the building. This system may be thought of as an arrangement similar to that shown in FIG. VIII with the additional feature that as soon as the high call reverse ceiling of FIG. VIII is shifted downwardly past a selected lower floor such as the sixth floor of a building it permits the establishment of another high call reverse ceiling that shifts downwardly through the upper and intermediate portions of the building as the highest call below that ceiling is answered.

The circuit shown in FIG. IX provides this type of operation. The circuit shown in FIG. IX above and including line 143 is similar to the circuit shown in FIG. VIII except for some slight modifications of the car circuits shown between the brushes. A generally similar circuit of ceiling relays is provided for the low zone comprising the lower floors, in this case for the second to fifth floors inclusive, which relays are shown in lines 151 to 161.

Additional relays and contacts not previously listed but which are included in FIG. IX include:

LSH—Half load switch
ST—Stop timer
LZ—Low zone ceiling relay
PRL—Low zone priority reset

This circuit provides for shifting the high call reverse ceiling downwardly as the highest call at or below this ceiling is answered and also suspends the operation of the ceiling for a limited time after each shift. The provi-

sion of the limited suspension is accomplished in a slightly different manner in the circuit shown in FIG. VIII in that each of the high call reverse ceiling relays is provided with a time delay dropout interval that is slightly longer than the time required for the selector machine to move its brushes from one set of contacts to the next while making a one floor run. This time is ordinarily in the order of only a few seconds. To suspend operation of the high call reverse ceiling for a longer interval of time, contacts and an additional brush are added, as shown in line 141, for each of the cars. These contacts comprise a normally closed half load switch LSH that opens when the car acquires a half load, normally open low zone ceiling relay contacts LZ, and normally closed stop time relay contacts ST that open at the expiration of a predetermined time interval after the car stops at the floor and remain open until the car stops at the next call. These contacts may be part of the ordinary interference timer commonly used on automatic elevators to indicate that a car is being unduly delayed. The brush that is energized through these contacts is arranged to energize the ceiling relay for the floor at which the car is then standing provided it is answering the highest call at or below the then existing high call reverse ceiling. Thus in FIG. IX, assuming that a high call reverse ceiling had been established at the ninth floor and relays HCB and HCBT are energized current flows from a supply lead L-10 downwardly through the left lane of normally closed ceiling relay contacts to the ninth floor ceiling relay contacts 9BT in line 143 thence through a selector machine contact 70 and brush 71 and the circuit shown in lines 142 and 141 to energize the eighth floor ceiling relay 8BT in line 143. If the low zone ceiling relay LZ is also energized as the car stops at the floor and closes its timer contacts ST in line 141 it also energizes the ninth floor ceiling relay 9BT.

The simultaneous energization of two high call reverse ceiling relays establishes a potential high call reverse ceiling at the floor corresponding to the lower relay, in this case the eighth floor, and an actual high call reverse ceiling at the highest call at or below the higher ceiling relay. The actual ceiling is ineffective without a call since the cars will not stop at intermediate floors unless there is a call for the floor. Thus there is a potential high call reverse ceiling established at the eighth floor which becomes an actual ceiling as soon as the ninth floor relay is released. This release occurs either by the car being unduly delayed to open its stop time relay contacts ST or by the car acquiring a half load to open its contacts LSH in line 141.

This arrangement thus provides that a down traveling car which is answering the highest call at or below the ceiling suspends the operation of the ceiling as long as it is less than half loaded and is proceeding promptly in answering the calls. But as soon as it acquires its half load the ceiling becomes effective to stop the next up traveling car at the highest call below the down traveling car so that it may promptly assist the down traveling car in serving any calls below.

As the high call reverse ceiling is thus shifted downwardly the highest call below the ceiling eventually is at or below the sixth floor. When such call is answered, assuming it to be at the sixth floor, that car through its brush 71 and circuit including its relay contacts V energizes the fifth floor high call reverse ceiling relay 5BT. When this relay is energized it immediately closes its contacts 5BT in line 150 to complete a circuit to the low zone relay LZ in line 157 so that it may close its contacts in line 158 to provide a sealing circuit for the fifth floor ceiling relay. The low zone relay LZ closes its contacts in line 153 to energize the low zone segment of the high call reverse circuit thus immediately establishing a high call reverse ceiling at the fifth floor. Operation of this relay does not by itself deenergize any higher high call reverse relays since their sealing circuit is completed by

the bypassed hall call relay contacts HCB and priority reset relay contacts PR in line 148 which serve the sixth and higher floor ceiling relays. However, upon the cancelling of the sixth floor down call a circuit is completed through a lead, line 152, tapped into the high call reverse circuit just below the sixth floor normally closed contact S6D so that current may flow through this lead and now closed low zone relay contacts LZ to energize the priority reset relay PR shown in line 149. The reset relay PR opens the sealing circuit for the sixth floor and higher ceiling relays. It may be noted that even though the priority reset relay PR has opened its contacts PR in line 148 the bypassed hall call relay HCB does not drop out as long as the car is standing at the sixth floor and keeps its contacts shown in line 141 closed to energize the sixth floor ceiling relay. As soon as the car leaves the sixth floor, its normal stopping time expires, or it acquires at least a half load it opens the circuit to the sixth floor ceiling relay which in releasing deenergizes the bypassed hall call relay HCB since the priority relay PR is now energized. This leaves the upper series of high call reverse ceiling relays all deenergized and therefore in condition to start another high call reverse ceiling at an upper floor of the building.

If it should happen that there are no calls registered in the lower zone at the time that the last call in the higher zone at or below the high call reverse ceiling is answered the low zone priority reset relay PRL is immediately energized when that last call below the ceiling is answered and it, in turn, by closing its contacts in line 150 energizes the upper zone priority reset relay PR. As soon as the car answers the last call below the ceiling and the reset relays RPL and PR are energized the bypassed hall call relay HCB in line 148 drops out as well as any then energized ceiling relays so that the system reverts to normal high call reverse without zoning during the duration of the timing period of the bypassed hall call relay timer relay HCBT.

This circuit thus provides efficient service for a down peak traffic condition in that as soon as a down traveling car acquires a full load it establishes the high call reverse ceiling for the next lower floor. The highest call at or below this ceiling may then be answered by either an empty up traveling car or a down traveling car and when such call is answered the ceiling is shifted down to the floor immediately below the just answered call. Furthermore the circuit provides that, during the normal stopping time of a car, up traveling cars are permitted to pass that particular ceiling and to proceed to either the highest actual call in the system or to a high call reverse ceiling that may then be in effect. This particular circuit also has the added feature as previously explained that any high call reverse ceiling is put into effect immediately below a car that is answering the previous highest call and has also acquired a half load.

A system may be divided into a greater number of zones than that shown in FIG. IX by repeating the circuit illustrated in lines 149 to 159 for each such added zone. Furthermore a high call reverse ceiling once started in the upper zone continues to move down as the highest call below the ceiling is answered and progresses from zone to zone without interruption. In this respect it is similar to the circuit shown in FIG. VIII but differs in that additional high call reverse ceilings may be instituted in a higher zone as the preceding ceiling shifts from one zone to the next.

FIG. X

While the preceding circuits provide improved service during peak traffic conditions they do not adequately meet some conditions. One particularly serious deficiency is the lack of adequate service to a floor having a large amount of traffic while the other floors have light traffic, particularly when such floor is located in the lower portion of the building. With the preceding circuits the high

call reverse ceiling moves down from floor to floor as calls are cleared from beneath it but once a floor has received service, even with a nearly loaded car, it cannot be served again until all of the other floors have been served.

This means that quite often a floor, particularly a lower floor, may be served by the partially loaded down-traveling car that has space to receive only two or three of the many waiting passengers at that particular floor. Since the circuit senses that the floor has been served and does not take into account the fact that many passengers may have been left it leaves these intended passengers stranded until the next cycle of operation when again the floor may be served by a partially loaded car.

The preceding circuits cannot be modified by merely shifting the ceiling relays up one floor so as to always reestablish the ceiling at the floor which was just served because in that case a heavy traffic at an intermediate floor would monopolize the service by maintaining the ceiling at that floor until all of those intending passengers have been served.

The circuit shown in FIG. X solves this problem by providing that, as long as the stranded intending passengers promptly reregister down calls the high call reverse ceiling will be held at that floor until that call is served by an up-traveling presumably empty car reversing at the floor. The up-traveling car reversing at the floor shifts the high call reverse ceiling to the floor below and is not eligible to reestablish the ceiling at the higher floor thereby preventing the higher floor from monopolizing the elevator service. This circuit is based on the theory that the up-traveling car stopping and reversing at the high call reverse ceiling will be empty and therefore the floor having a heavy traffic demand will be served, once each cycle of the high call reverse ceiling system, with an empty car although it may have been served several times by other down-traveling cars. The other down-traveling cars are those cars which were in the upper part of the building when the ceiling program started or which escaped the high call reverse ceiling during the short time intervals that the ceiling is suspended as each call is answered to prevent trapping all of the cars at the low floors of the building.

The circuit shown in FIG. X in combination with the circuits shown in FIGS. II and IIa in general provides that no floor shall be served a number of times in succession while calls at other floors remain unanswered except that provision is made for repeatedly serving a floor at which intending passengers are stranded until such floor is served by an up-traveling car reversing at that floor. Any intending passengers stranded after the arrival of an up-traveling car reversing at that floor must wait until the calls at floors below have been cleared and the cycle repeated starting from the higher floors.

This circuit thus combines the control features of the preceding circuits with the addition of means to provide additional service to floors having exceptionally high demands without allowing such floors to completely monopolize the elevator service.

In the circuit shown in FIG. X a number of relays have been added over the number used in the circuits shown in the preceding figures. These relays which are individual to and repeated for each of the cars are:

CR—Ceiling reset

65 CRA—Ceiling reset auxiliary

Relays that are common to all of the cars include:

HCB1—Sequence relay for HCB

PRT—Priority reset timer

The ceiling reset relay CR appearing at line 171 of FIG. X, when energized, prepares the circuits so that if a car, when answering the highest call at or below the previous ceiling, becomes fully loaded and a down call is immediately reregistered at the floor that car, on leav-

ing that floor, reestablishes a high call reverse ceiling at that point.

The bypassed hall call sequence relay HCB1 is used to prevent possible buzzing of the bypassed hall call relay HCB under certain conditions of operation. The priority reset timer relay PRT is used in place of the priority reset relays PR shown in the previous circuits to prevent a high frequency cycling of several of the relays under certain possible conditions of operation and to prevent repeated reestablishment of a ceiling at a low floor to the detriment of service to higher floors.

In the control circuit as shown in FIG. X the ceiling reset relays CR and CRA, lockout relay LO, the high call timer relay HCT and the circuits connected to these relays are repeated for each of the cars. The remainder of the circuit is common to all of the cars of the system. As shown in the diagram a high call reverse circuit for signaling each car that it is at or above the highest call below a high call reverse ceiling or below the top of the building is shown along the left side of the diagram. A family of high call reverse ceiling relays and the circuits for energizing such relays are illustrated along the right side of the diagram. The circuits individual to and repeated for each of the cars appear principally between the vertical rows of selector machine segments.

The high call reverse circuits on the left of the diagram comprise, in the leftmost position, a series chain of normally closed contacts of the high call reverse ceiling relays for the various floors. This series chain of normally closed contacts are energized from a lead L-12 connected to the top floor end of the series of contacts.

The next vertical lane of contacts includes a chain of normally closed contacts of the hall call relays and normally closed contacts of the high call reverse ceiling relays. These contacts, starting from the top floor end of the series and include, in order, the down hall call stopping relay contacts S12D for the top floor, the eleventh floor high call reverse ceiling relay contacts 11B, then the eleventh floor up hall call stopping relay contact. Similar contacts for each of the remaining floors are provided in regular rotation. The junction points between the up and down hall call relay contacts for a particular floor are connected to selector machine segments 70 for that floor. Also the junction points between the high call reverse ceiling relay contacts and the up hall call relay contacts for each floor are connected through normally open ceiling relay contacts to the left hand series chain of normally closed ceiling relay contacts at a point between the normally closed ceiling relay contacts for that floor and for the floor above. In this arrangement the energization of any of the high call reverse ceiling relays, the relays 2B through 11B, divides the high call reverse circuit into two segments and separately energizes the upper end of the lower segment. This circuit further provides by means of a low zone relay LZ in line 195, that is energized as long as a ceiling relay in the low zone is energized, that the left hand series of normally closed ceiling relay contacts shall be separately energized through contact LZ at line 190 to feed the low zone end of the high call reverse circuit independently of the upper portion of the circuit.

The high call reverse ceiling relays 2B through 11B are shown along the right side of the diagram. These relays are arranged to be energized by current supplied through selector machine segments 71 and, once energized, may be locked in through either of two circuits, the first comprising normally open contacts of the energized ceiling relay plus normally closed contacts of all of the ceiling relays for floors below but in the same zone. The high zone locking circuit is completed at line 185 by way of normally closed intermittent program relay contacts INT and normally opened bypassed hall call relay contacts HCB. The corresponding locking circuit for the low zone high call reverse ceiling relays 2B through 5B is completed in line 195 through normally

open low zone relay contacts LZ, normally closed intermittent program relay contact INT and normally closed low zone priority reset contacts PRL. The second locking circuit comprises normally open contacts of the particular ceiling relay and normally open down hall call relay contacts for that floor. These contacts are connected in a series between the lead from the relay coil and a lead 72 which is a branch lead from the supply lead L-12. Thus any high call reverse ceiling relay, once energized, remains locked in as long as there is a down hall call registered for that floor or there are no lower high call reverse ceiling relays in that zone then energized.

The circuits individual to the various cars of the system cooperate with the high call reverse circuit and the system of high call reverse ceiling relays to provide that a high call reverse program of operation is put into effect as soon as a loaded car stops at an intermediate floor or becomes fully loaded while stopping at an intermediate floor. Simultaneously with the initiation of the high call reverse program a high call reverse ceiling is established at the floor below the position then occupied by the loaded car. As in the previous circuits, the high call reverse ceiling is shifted downwardly each time the highest call below it is answered. As soon as there are no remaining calls below the ceiling all of the ceiling relays are de-energized and a limited time later the high call reverse program is canceled.

This circuit also provides three high call reverse ceiling conditions which may be called a normal ceiling, a suspended ceiling and a reset ceiling. A suspended ceiling occurs when two ceiling relays in the same zone are both energized and there is no hall call at the floor corresponding to the upper one of the energized ceiling relays. As will be recalled from the circuits in FIGS. II and IIa a car will not high call reverse unless it simultaneously receives a down stopping signal from a hall call relay and a high call reverse signal from the high call reverse circuit. Thus the simultaneous energization of any two of the high call reverse ceiling relays in a zone interrupts the flow of power to the high call reverse selector machine segment 70 corresponding to the lower energized relay so that it is deenergized and since there is no call corresponding to the upper energized relay the car will pass that point without stopping. Thus while two ceiling relays are energized the circuit is not responsive to them, thus providing a suspending ceiling.

A normal ceiling occurs when a single ceiling relay is energized in a particular zone.

A reset ceiling occurs when a car, which, in answering the high call at or below the ceiling, shifts the ceiling to a lower floor, becomes fully loaded and stranded intending passengers reregister a down call so that the high call reverse ceiling relay for that floor is reenergized and locked in as the car leaves the floor.

The circuits individual to each of the cars are arranged so that a car answering calls above any energized ceiling relays is not eligible to energize any of the ceiling relays, down-traveling cars answering calls at reset ceilings are eligible to again reset the ceilings at those floors, down-traveling cars answering calls at or below normal ceilings are not only eligible to reset the ceilings at those floors but also shift the ceilings down to the next floors as they answer the calls. Up-traveling cars reversing at the highest call at or below a normal ceiling shift the ceiling to the next lower floor and are also eligible to reset the ceiling at the same floor in the event they become loaded while up-traveling cars reversing at a reset ceiling are ineligible to shift the ceiling or to reset the ceiling.

The circuits individual to each car for accomplishing this program of operation are shown in the upper center portion of the diagram of FIG. X.

These circuits comprise a high call sensing circuit shown connected to a brush 73 cooperating with the selector machine segments 70 and connected through a circuit shown in line 182 to operate the high call timing relay

HCT whenever the brush 73 contacts an energized segment 70 while the car is traveling upwardly without a car call above and has not started its slowdown for a floor. This particular circuit includes normally closed car button relay contacts CB that are closed as long as there are no higher car calls to be answered, normally closed stopping sequence relay contacts VR that are closed as long as the car is not stopping, normally open brake relay contacts that are closed as long as the car is running, and normally opened up field relay contacts UF that are closed as long as the car is running upwardly.

The circuit also includes in line 171 a ceiling reset relay that is energized under certain conditions to allow the car to reset the ceiling in the event that stranded intending passengers promptly reregister a down call.

In the operation of this circuit it will be assumed first that the system is operating under ordinary conditions and that none of the relays illustrated in FIG. X are energized. It will first be assumed for up-peak traffic that an up-traveling car from the lobby has acquired a full load at the lobby indicative of the start of an up-peak traffic demand. As the car proceeds upwardly to its first car call at an intermediate floor and arrives at that floor a circuit is completed from the supply lead L-12 through a branch lead 74, a manually operated switch 75, normally opened but now closed contacts of a load switch LS, normally closed contacts BK of a brake relay that close as soon as the car stops, and thence through normally closed auxiliary hall call bypassed relay HCB1 in line 181 and normally closed brake relay contacts BK in line 180 to energize the high call reverse ceiling relay for the floor below that at which the car is then making its stop. In the circuit illustrated the brushes are shown with the car at the ninth floor and the circuit completes or energizes the eighth floor ceiling relay 8B. This relay immediately closes its contacts 8B in line 179 to complete a circuit through normally closed contacts of the lower ceiling relays and normally closed contacts PRT (line 185) of the priority reset timing relay to energize the bypassed hall call relay HCB in line 185. This relay immediately closes its contacts in line 185 to provide a locking circuit that maintains the eighth floor ceiling relay energized and at the same time closes its contact in line 186 to energize auxiliary bypassed hall call relay HCB1. This latter relay opens its contacts in line 181 for each of the elevator cars so that the other cars are then ineligible to energize a ceiling relay through their corresponding circuits. The bypassed hall call relay HCB when energized immediately energizes the bypassed hall call timing relay HCBT line 197 which in turn closes its contacts in line 174 to energize the high call reverse circuit. The timing interval for this relay HCBT is set to exceed the normal loading time of cars during up-peak operation so that it maintains the high call reverse program in operation to promptly return cars to the lower terminal for their next loads. The energization of the high call reverse ceiling relay 8B causes it to close its contacts on the left side of the diagram to energize the segment of the high call reverse circuit extending down from the eighth floor. If there are no lower hall calls the circuit is completed from the lead L-12 through the normally closed high call reverse ceiling relay contacts in the left hand lane, the normally open contacts of the energized high call reverse ceiling relay 8B and the lower segment of the high call reverse circuit to the low zone priority reset relay coil PRL in line 196. This relay immediately closes its contacts in line 189 to complete a circuit through lead 76 to energize the priority reset timing relay PRT in line 187. The timing interval of relay PRT, as explained later, is made approximately equal to the time required for a car to make a stop and receive passengers at a floor. This relay, when energized, opens its contacts in line 185 to deenergize the bypassed hall call relay HCB which by opening its contacts in line 185 breaks the holding circuit to the energized ceiling relay 8B.

This restores the system to normal except that the high call reverse circuit is still energized through the bypassed hall call timing relay contacts HCBT in line 174 during the timing period of this relay.

Occasional hall calls during up-peak operation do not interfere with the operation of the system because the cars are subject to car calls during their upward travel which takes them above the energized ceiling relay and the few hall calls are cleared in the normal manner.

The operation during down-peak traffic conditions may be followed by first assuming that none of the relays shown in FIG. X are energized and that a down-peak traffic condition is just starting. Under this condition the first car to acquire a full load while standing at a floor, assumed to be the ninth floor, completes a circuit from the supply lead L-12 by way of the lead 74, switch 75, load switch contacts LS, brake relay contacts BK, bypassed hall call relay contacts HCB1 (line 181) and brake relay contacts BK in line 180 to energize the high call reverse ceiling relay 8B for the floor below that at which the car is then standing, i.e. the ninth floor. This relay, upon closing its contacts 8B connected to its energizing lead, locks itself in to the chain of normally closed ceiling relay contacts appearing just to the left of the coils of the relays and energizes the bypassed hall call relay coil HCB in line 185. This relay HCB, by closing its contacts HCB in line 185, maintains a locking circuit for the now energized relay 8B. As in the previous circuits, such as those shown in FIGS. VII, VIII or IX, the energized high call reverse ceiling relay divides the high call reverse circuit into two segments and separately energizes the lower segment.

Simultaneously with the energization of the high call reverse ceiling relay 8B and before the operation of the bypassed hall call auxiliary relay HCB1, a circuit is completed through normally closed contacts HCB1 in line 177, lead 81, normally closed stopping relay contacts S in line 174 and normally closed high call timing relay contacts HCT in line 173 to energize the auxiliary ceiling reset relay CRA in line 172. This relay closes momentarily to close its contacts in line 172 to energize the ceiling reset relay CR in line 171. Since the car is standing still with the brake relay deenergized this relay locks itself in through its contacts CR in line 171.

As soon as the ceiling reset relay CR is energized it closes its contacts in line 178 to prepare a circuit from the supply lead 74 by way of the load switch contacts LS, normally closed brake relay contacts BK, gate relay contacts, normally closed up-directional relay contacts UL and normally closed lockout relay contacts LO in line 178 to momentarily energize the ninth floor ceiling relay 9B as the gate relay contacts G close just before the brake relay opens its contacts as the car closes its doors. If the car in acquiring a full load leaves passengers at the ninth floor and if these passengers press the down hall call button after the car has acquired a full load and before it starts from the floor, the ninth floor down hall call relay contacts S9D shown in line 177 are closed when the ninth floor ceiling relay is momentarily energized. Therefore this relay locks itself in from a lead 72 so as to remain energized independently of the operation of the lower high call reverse ceiling relay 8B which is also energized at this time. The circuit is now set up with a normal high call reverse ceiling at the eighth floor by energization of the ceiling relay 8B and a reset ceiling at the ninth floor because of the subsequent energization of the ninth floor relay 9B. Furthermore the car that has just acquired a load and is departing from that floor has its lockout relay LO, shown in line 175, energized when its brake relay closes while the load switch is closed. This relay locks in through its contacts on line 175 and down-directional memory relay contacts DL in line 174 and remains energized until the car reverses. As long as the lockout relay LO is energized it opens its contacts in line 178 so that that car cannot energize any of the

ceiling relays. If it were not for the lockout relay the car would establish a high call ceiling at a low floor if it stopped there in response to a car call.

The energization of the ninth floor ceiling relay 9B, by opening its contacts in the left lane at line 180, breaks the circuit to the lower segment of the high call reverse circuit while the energization of the ninth floor down hall call relay and the eighth floor ceiling relay break the high call reverse circuit so that the ninth floor segment of the high call reverse circuit is the lowest energized segment. The ninth floor call therefore appears as the highest call for up-traveling cars and since there may be other cars above the loaded car in position to answer the ninth floor call during their down travel that call may be answered by either an up-traveling car reversing at that floor or by a down-traveling car depending upon which gets there first.

It is assumed that down-traveling car is the first to arrive. Since it may already be partially loaded it is desirable that it be eligible to reestablish the high call reverse ceiling in the event it cannot accommodate all the waiting passengers. As it travels down and its brush 80 contacts the floor selector machine segment 71 corresponding to the ninth floor ceiling relay 9B a circuit is momentarily completed from energized lead 72 and the segment 71 through the lockout relay contacts LO, normally closed up-direction memory relay contacts UL in line 178, and thence upwardly through the lead 81, stopping relay contacts S, and normally closed high call timer relay contacts HCT to energize the auxiliary ceiling reset relay CRA so that it may energize the ceiling reset CR in line 171. The segments 71 of the selector machine for this lane are made slightly longer than the segments 11 or 12, shown in FIG. II, employed in the regular stopping circuits so that the ceiling reset relays CR and CRA are energized before the stopping relay operates in the normal stopping sequence in response to a floor signal. The high call timer relay HCT does not operate for down-traveling cars since the up-field contacts UF are open. As the down-traveling car picks up the down stopping signal and its stopping sequence is initiated it also cancels, by way of the circuit shown in the upper portion of FIG. II, the down hall call at that floor thus opening the contacts S9D in line 177. This immediately deenergizes the ceiling relay for the ninth floor since there is a lower ceiling relay already energized. Since the ceiling reset relay CR is energized at this time this car is ready to reset the ceiling at the ninth floor in the event that it acquires a full load without accepting all of the intending passengers and a down call is registered before the car leaves.

To trace the operation of the circuit in response to a normal ceiling it will be assumed that the car is not fully loaded, is traveling down toward the ninth floor, that the ninth floor ceiling relay is the only one registered in that zone and that there is a down call at the ninth floor. This car is thus a down-traveling car answering a normal high call reverse ceiling call. As the brush 80 contacts the selector machine segments 71 for the ninth floor it completes a circuit by way of the lead 81 to energize the ceiling reset relay CR and CRA before the stopping relay S is operated. In this case since the ninth floor ceiling relay 9B is locked in through the bypassed hall call relay contacts HCB in line 185 and the normally closed contacts of the lower claiming relays it is not deenergized as the hall call at the ninth floor is canceled during the normal stopping sequence. Therefore the ninth floor selector machine segment remains energized during the stopping sequence so that current may flow from the brush 80 now contacting an energized segment 71, through the normally closed lockout contacts LO, normally closed up memory relay contacts UL, now closed ceiling reset relay contacts CR in line 178, and thence through stopping sequence timer relay contacts VRT in line 179 to energize the brush 82 during this

stopping sequence. The brush 82 at this time is in contact with a selector machine segment 71 for the eighth floor ceiling relay so as to energize that relay which immediately locks in through its contacts. The relay 8B breaks the locking circuit to the ninth floor relay 9B by opening its contacts 8B in line 179 so that the relay 9B is deenergized as soon as the stopping sequence relay VRT opens its contacts as the car stops.

The stopping sequence timing relay VRT, the coil of which is not shown, is arranged to close its contacts a short time after the hall call relay at the floor has been deenergized to open its contacts. Thus the ceiling is shifted when a normal ceiling call is answered but not when a reset ceiling call is answered.

It may happen with a ceiling relay energized as a normal high call reverse ceiling that there are no calls at that or several lower floors. Assume for the moment that there are no calls at the seventh, eighth or ninth floors and that the ninth floor ceiling relay is energized. As the brush 80 of a down-traveling unloaded or partially loaded car arrives at the selector machine segment 71 corresponding to the now energized ninth floor ceiling relay 9B a circuit is completed from the brush 80 through the lead 81 to energize the ceiling reset relays CR and CRA. The relay CRA locks itself in by way of its contacts in line 172 and the normally open but now closed brake contacts BK so that this relay remains energized as the brush 80 runs off of the ninth floor segments 71. The car does not stop at the ninth floor because there was no hall call for that floor. With the ceiling reset auxiliary relay CRA energized as the car is running down it feeds current from the lead 74 by way of its contacts CRA, now closed BK contacts in line 172, normally closed contacts HCT in line 173, stopping relay contacts S in line 174, lead 81 so as to maintain power on the brush 80. As this brush contacts the selector machine segments 71 for the eighth and seventh floors as the car runs past these floors it energizes the ceiling relays 8B and 7B successively each of which locks itself in through its contacts connecting its coil to the locking circuit. As each relay is energized it deenergizes the ceiling relay for the floor above. Thus the normal high call reverse ceiling is swept downwardly by the down-traveling car after it passed the previous ceiling and there are no calls registered for the floors that it is passing.

It is assumed that the next call is at the fifth floor so that as the car reaches the fifth floor a regular stopping sequence is initiated. Since the fifth floor is in the low zone, assuming the system shown in FIG. X is zoned similarly to that shown in FIG. IX, the energization of the fifth floor ceiling relay 5B, as the brush 80 contacts the corresponding selector machine segment, causes that relay to close its contacts in line 188 so as to complete a circuit through now closed contacts 5B and normally closed contacts of the lower ceiling relays to the low zone relay LZ in line 195. This relay immediately picks up to lock itself in through the contacts shown to the left in line 195. The now energized fifth floor ceiling relay appears as a normal high call reverse ceiling so that the car, while stopping energizes its brush 82 to energize the next lower ceiling relay, in this case the ceiling relay 4B. Thus the high call reverse ceiling has been shifted from the upper zone into the lower zone of floors, the zone below the sixth floor.

As soon as the ceiling has been shifted into the low zone another circuit comes into operation, namely the circuit connecting the brushes 80 and 82 by way of ceiling reset contacts CR in line 178, stopping time contacts ST in line 180, the now closed low zone contacts LZ and normally closed half load switch contacts LSH shown in line 180. This circuit connects the brushes 80 and 82 for a limited time after the car stops at a floor provided the car has less than a half load. Thus for the car which stopped at the fifth floor and energized the fourth floor ceiling relay this circuit provides a flow of power

to energize the fifth floor ceiling relay so that two consecutive relays are thus energized. Furthermore, since the car is standing at the fifth floor to receive passengers and does not have a half load there can be no hall call registered at the fifth floor so that any up-traveling cars then can escape the fourth floor ceiling. This follows because the high call reverse ceiling circuit on the left of the diagram cannot be energized below the lower of the energized ceiling relays and because there is no call at the floor corresponding to the higher of the energized ceiling relays.

The energization of the low zone relay LZ also causes it to close its contacts in line 190. Furthermore, since the sixth floor ceiling relay 6B is energized independently of the circuit to the fifth floor ceiling relay the sixth floor ceiling relay remained energized as the ceiling moved down into the low zone. However, the low zone relay LZ by closing its contacts LZ at the left of the diagram in line 190 and the absence of a call at the sixth floor provides for energization of the lead 76 which through contacts HCB and now closed low zone contacts LZ energizes the priority reset timer PRT in line 187. This relay by opening its contacts in line 185 deenergizes the bypassed hall call relay HCB thus deenergizing the sixth floor ceiling relay and conditioning the circuit for the upper zone so that it may respond to the full loading of the next down traveling car in that zone.

It will thus be noted that the circuit provides that a down traveling car stopping at a floor at which the high call reverse ceiling relay is energized cancels the high call reverse ceiling at the floor at which the car is stopping but is eligible to reset that ceiling in the event that the stranded passengers promptly register a down call. If the stop is at a normal ceiling the ceiling is shifted to the floor below and if the car in traveling down passes a normal ceiling and there are no calls at that floor or lower floors it shifts the ceiling down with it until it does reach a down call.

An up-traveling car stops and reverses whenever its high call timer HCT is energized as it approaches a down call as indicated in the description of FIG. II. This reversal may occur at the highest call below the normal ceiling, at a call at a normal ceiling or at a call at a reset ceiling. If the highest call is at a floor below a normal ceiling the car, as it approaches the call first energizes its high call timing relay HCT in line 182 which prepares a circuit to the down stop relay SD, line 24, FIG. II, so that that relay is energized when the down stop brush touches the down call contact for that floor. The energization of both the high call timing relay HCT and the down stop relay SD causes the high call reverse relay HCR, FIG. IIa, to shift the direction memory circuits to condition the car for down travel. When this occurs at a floor below a normal high call reverse ceiling, the ceiling is first shifted to that floor and then to the lower floor. The shift of the ceiling to that floor occurs as a circuit is completed from the supply lead 74 through contacts in line 173 comprising normally opened bypassed hall call relay contacts HCB, normally open up field relay contacts UF, normally closed stopping sequence relay contacts VR2, normally open stopping relay contacts S in line 174, thence through lead 81 and now closed up memory relay contacts UL and normally closed lockout relay contacts LO to energize the ceiling relay for that particular floor. This particular circuit is completed momentarily during the time that elapses from the time that the stopping relay S is energized until the sequence relay VR2 operates. Since this call was assumed to be the highest call below the ceiling it follows that there were no lower ceiling relays operated so that this momentary energization of the ceiling relay, for example the ninth floor relay 9B in FIG. X, causes it to lock itself in. As it locks itself in it deenergizes all higher ceiling relays that are locked into this same circuit. An instant later as timing sequence relay VRT operates, the high call tim-

ing relay HCT having been deenergized by the opening of sequence relay contacts VR, the circuit is completed from the ninth floor ceiling relay coil and selector machine segment 71, the brush 80, lead 81, the normally open but now closed stopping relay contact S in line 174, and thence through the now closed stopping sequence relay contacts VR2 and the stopping sequence timing relay contacts VRT to energize the auxiliary ceiling reset relay CRA in line 172. This relay energizes the ceiling reset relay CR in line 171 so that it closes its contact in line 178 to complete the circuit from the brush 80 to the brush 82. This circuit from the energized segment 71 of the ninth floor relay 9B through contacts VRT energizes the eighth floor ceiling relay 8B thus shifting the ceiling down and breaking the locking circuit to the ninth floor relay.

If there were a ceiling relay energized in the low zone such that the low zone relay LZ in line 195 is operated a second circuit is completed at this time from the now energized brush 82 through the contacts LSH, LZ and ST in line 180 and back through the contacts CR, UL and LO in line 178 to again energize the ninth floor ceiling relay to suspend the eighth floor ceiling and allow up traveling cars to pass until the car either acquires a half load so as to open its contacts LSH in line 180 or has stopped at the floor a sufficient length of time for the timing interval of the stop time relay ST to elapse and the relay open its contacts ST. As soon as either of these contacts open the ninth floor ceiling relay is deenergized so that the eighth floor ceiling becomes effective to stop up-traveling cars. Since the ceiling reset relay CR was operated as part of the stopping sequence in reversing and arriving at this floor the car is eligible to reset the ceiling at the ninth floor in the event passengers left at that floor promptly reregister the call after the car becomes fully loaded.

The sequence of the events for stopping and reversing at a call at a normal ceiling is identical with those just described except that the circuit which first operates to shift the ceiling to that floor is unnecessary because the ceiling is already at the floor. The remaining operation is the same in that the ceiling reset relays CR, CRA are operated in the stopping sequence thereby causing the car to shift the ceiling down to the next lower floor and also render the car eligible to reset the ceiling in the event resetting is necessary.

The last condition occurs in the event that the highest ceiling relay to be energized in a particular zone is a reset ceiling and there is a lower ceiling relay energized. For example, assume that the seventh floor ceiling relay 7B is energized as a normal ceiling and the ninth floor ceiling relay 9B is energized as a reset ceiling, the relay 9B being locked in through its contacts 9B and hall call stopping relay contacts S9D, shown in line 177. Since the higher ceiling relay by opening its contacts in the high call reverse energizing circuit takes precedence in establishing the high call reverse point, the next up-traveling car ignores the high call reverse ceiling at the seventh floor and proceeds upwardly to the ninth floor. As its brush 80 contacts the energized segment 71 for the ninth floor nothing happens immediately because the up-direction memory relay contacts UL in line 178 are open. However, at the same time the high call reverse brush 73 has contacted the high call reverse energized segment 70 corresponding to the ninth floor so that the high call timer relay HCT is energized. The energization of this relay and the presence of a down call at the ninth floor causes the car to immediately reverse its direction memory circuits and to make a stop. While making this stop the ceiling reset relays CRA and CR are not energized because the high call timing relay contacts HCT in line 173 are open until after the normally closed stopping relay contacts S in line 174 are opened and the down hall call at the ninth floor is canceled before a circuit is completed through the normally open stopping relay contacts S in line 174 and

the stopping sequence relay contacts in line 173. Therefore the car makes a normal reversing stop without resetting the ceiling to a lower floor or becoming eligible to reset the ceiling to the same floor.

The circuits so far described provide that no floor may be served successively by a number of cars while calls remain to be answered at other floors except that a floor at which passengers are stranded, i.e. unable to board a car which answered their call, may be served either by a next down traveling car and may be served once by a car making a high call reverse stop at that particular floor.

While in general this circuit without the use of timing relays provides for good distribution of elevator service it does require, for best service, that the top zone or upper zone priority reset relay PRT be of a timed dropout variety. The reason for this is that if a ceiling is reset and there is no lower ceiling relay energized that energized ceiling relay, circuit wise, responds as a normal ceiling rather than a reset ceiling. As a result an up-traveling car making a high call reverse stop at that particular ceiling shifts the ceiling down and at the same time becomes eligible to reset the ceiling again. As long as there were no calls below, passengers at a floor could monopolize the service as long as they fill each car that stops.

As soon as there are no lower calls in the zone and a ceiling has been established in the lower zone the priority reset relay PRT in line 187 operates to de-energize the bypassed hall call relay coil HCB and its auxiliary relay HCB1 in lines 185 and 186. The de-energization of the bypassed hall call relay HCB by opening its contacts in line 185 deenergizes any normal ceiling relays that may be energized so that the circuit is then ready to receive or accept the signal from a car at a higher position that it acquired a full load. To prevent the successive resetting of the ceiling at a low floor, as may occur when there are no calls below the heavy traffic demand floor and the bottom of that zone the priority reset timer relay PRT is provided with normally open contacts in line 186 so that once it is energized by the absence of a call below the ceiling and the establishment of a ceiling in a lower zone it then becomes eligible to be reenergized as long as there is a reset ceiling relay energized in the upper zone. A normal ceiling relay cannot maintain itself energized unless there is a hall call at the same floor. The dropout time of the priority reset timer relay PRT is normally made approximately equal to the time required for a car to make a stop, take on the full load of passengers, and leave a floor. Therefore, supposing that a car has made a down stop at the ninth floor and that there are no calls below and a ceiling has been previously established in the lower zone such that the relay LZ is energized, then upon the cancellation of the ninth floor down hall call a circuit is completed to energize priority reset timer PRT which in turn deenergizes the bypassed hall call relay HCB so that it opens the contacts in lines 185 and 187 thereby deenergizing the locking circuit for the upper zone high call reverse ceiling relays as well as the priority reset timer relay PRT. This car, having made a normal stop has its ceiling reset relay CR energized so that it is eligible to reset the ceiling in the event that it leaves stranded passengers. If it does so prior to the dropout of the priority reset timer relay PRT, a circuit is completed from the ninth floor ceiling relay 9B through the normally closed contacts of the ceiling relays below and through a now closed contact PRT of the priority reset timing relay in line 186 to reenergize the priority reset timer and hold it energized until the ninth floor signal is cancelled. If this signal is cancelled by an up-traveling car reversing at that floor such up-traveling car, as previously explained, is ineligible to reset the ceiling at that floor after reversal. Furthermore the priority reset timer relay by closing its contacts in line 187 holds the aux-

iliary bypassed hall call relay HCB1 energized so that another fully loaded car is not eligible to establish or attempt to establish a high call reverse ceiling. Thus the up-traveling car making a high call reverse stop for the ninth floor signal when there are no lower calls, cancels all of the high call reverse ceilings for that zone and at the expiration of the timing interval of the timing relay PRT the circuit again becomes responsive to any car acquiring a full load.

While the just described method of preventing low floor passengers from monopolizing service by successively resetting the ceiling for that floor is the preferred system, the circuit may be arranged by throwing the switch 85 in line 172 to its other position, the position not shown, so that operation of the priority reset timer relay PRT deenergizes the ceiling reset relays thus making the car which answers the lowest call in the zone and at which the ceiling has been established ineligible to reestablish a reset ceiling at that floor. In this arrangement the lowest call in the zone will be answered once and only once for each complete cycle of operation.

The low zone may be equipped with a timing relay in place of the low zone priority reset relay PRL so as to provide the same type of operation for the lowest call as is provided in the higher zone. However this is not considered necessary because as soon as there is a ceiling registered in the low zone the circuit shown in lines 178 to 180 connects the brushes 89 and is completed for each car. Therefore as long as there is a car in the low zone and answering calls the low zone ceiling is suspended and cars are allowed to serve the upper zone. This circuit thus allows each floor to be served once by a reversing car during each cycle of operation.

Various modifications of the circuit may be made without departing from the spirit or scope of the invention.

Having described the invention, I claim:

1. A control system for a group of elevators that serve a plurality of floors, comprising, in combination, a plurality of elevator cars, means for registering calls for service from the various floors, means for moving the cars to serve the calls, a high call reverse circuit, a plurality of ceiling relays one for each of at least some of the floors of a zone, each ceiling relay being adapted to divide the high call reverse circuit and having contacts cooperating with normally closed contacts of higher ceiling relays to complete a separate energizing circuit for the lower portion of the high call reverse circuit to establish a high call reverse ceiling, a locking circuit for each ceiling relay that includes normally closed contacts of each lower ceiling relay in the zone, a second locking circuit for each ceiling relay that includes contacts of a hall call relay for that floor, means for energizing the relay if the car departs with a hall call registered at the floor, circuit means for energizing the ceiling relay for the floor below when a car acquires a full load and no ceiling relay in the zone is energized, and means responsive to the absence of calls below the energized ceiling relay in the zone for de-energizing the ceiling relays in the zone.

2. In a control system for a group of elevator cars according to claim 1, circuit means for each car comprising a relay that is responsive to the direction of travel of the car and the approach of the car to a floor having an energized ceiling relay, a load switch, and circuit means prepared by said relay and said load switch for energizing the ceiling relay for the floor from which the loaded car is departing.

3. In a control system for a group of elevator cars according to claim 1, circuit means for each car responsive to the approach to a floor having an energized ceiling relay adapted to energize another of the ceiling relays.

4. In a control system for a group of elevator cars according to claim 1, circuit means for each car respon-

sive to the direction of travel of the car for connecting the locking circuit of an energized ceiling relay to the coil of another ceiling relay.

5. In a control system for a group of elevator cars according to claim 1, circuit means including a load switch and timer contacts arranged to connect the locking circuit of one ceiling relay to the coil of another ceiling relay.

6. In a control system for a group of elevator cars according to claim 1, circuit means for each car including a load switch, a timer, and relay contacts of a relay responsive to the energization of certain ceiling relays arranged to connect the locking circuit of one ceiling relay to the operating coil of a higher ceiling relay.

7. In a control system for a group of elevator cars according to claim 1, a ceiling reset relay for each car, circuit means for energizing the reset relay as the car travels downwardly, and circuit means including load switch contacts and reset relay contacts arranged to energize a ceiling relay for the floor from which the car departs with a full load.

8. A control system for a group of elevator cars that serve a plurality of floors, comprising, in combination; a plurality of elevator cars; means for registering calls for service from the various floors; means for moving the cars to serve the calls; a high call reverse circuit; means for each intermediate floor arranged to energize the high call reverse circuit at a point corresponding to that floor, deenergize the circuit for floors below and deenergize such means for floors above; means responsive to a loaded car standing at an intermediate floor for energizing said means for the floor below; memory means responsive to a down traveling car answering the highest call below the energized point of the high call reverse circuit; and means responsive to the memory means and the hall call means for reenergizing the means for the floor from which the car is departing.

9. A control system for a group of elevator cars that serve a plurality of floors, comprising, in combination, a plurality of elevator cars, means for registering calls for service from the various floors, means for moving the cars to serve the calls, a high call reverse circuit, control means for each intermediate floor, means for energizing at least one of said control means when a car acquires a full load, each said control means being arranged to energize the high call reverse circuit at a point corresponding to that floor and to deenergize any control means for higher floors having no down calls registered, each said control means being arranged to render any lower energized control means ineffective to energize the high call reverse circuit, memory means for each car responsive to the direction of car movement as it responds to the highest call at or below the energized control means, means to energize the next lower control means when the highest call below a previously energized control means is answered, and means subject to said memory means and the load in the car for reenergizing the control means for the floor from which the car is departing.

10. An elevator control system comprising, in combination, a plurality of elevator cars that serve a plurality of floors, means for registering calls for service, means for moving the cars to serve the calls, means for registering a demand for preferred service, means responsive to a demand for preferred service for defining a zone of floors within said plurality of floors, means for limiting the travel of available cars from such zone, means for reducing the zone as calls for service at the limit of the zone are answered, and means for expanding the reduced zone in the event a call is registered at a previous zone limit prior to the departure of the car from such previous limit.

11. An elevator control system comprising, in combination, a plurality of elevator cars that serve a plurality of floors, means for registering calls for service, means

for moving the cars to serve the calls for service, means for registering a demand for preferred service, means responsive to a demand for preferred service for establishing a zone of floors to receive preferred service, means for restricting said elevator cars to said zone of floors, means for eliminating floors from the zone as the calls at the floors are answered, and means for reinstating a floor to the zone if a call is registered at the floor prior to the departure of the car answering the previous call.

12. An elevator control system comprising, in combination, a plurality of elevator cars that serve a plurality of floors, means for registering calls for service, means for moving the cars to serve the calls for service, means for registering a demand for preferred service, means responsive to a demand for preferred service for establishing a zone of floors to receive preferred service, means for limiting the travel of the available elevator cars from said zone of floors, means for eliminating each floor in the zone from the zone as the call thereat is answered, and means for reinstating such eliminated floor in the event a call is registered at such floor prior to the departure of the car, and means for canceling the zone limits as the last registered call within the zone is answered.

13. An elevator control system comprising, in combination, a plurality of elevator cars that serve a plurality of floors, means for registering calls for service, means for moving the cars to serve the calls for service, means for registering a demand for preferred service, means responsive to a demand for preferred service for establishing a zone of floors to receive preferred service, means for limiting the travel of the available cars from said zone of floors, means for eliminating each floor in the zone from the zone as the call thereat is answered, and means for reinstating such eliminated floor in the event such floor was at the limit of the zone and a call thereat is registered prior to the departure of the answering car.

14. An elevator control system comprising, in combination, a plurality of elevator cars that serve a plurality of floors, means for registering calls for service, means for moving the cars to serve the calls for service, means for registering a demand for preferred service, means responsive to a demand for preferred service for establishing a zone of floors to receive preferred service, means for limiting the travel of the available cars from said zone of floors, means for eliminating each floor in the zone from the zone as the call thereat is answered, means for reinstating such eliminated floor in the event such floor was at the limit of the zone and a call was registered prior to the departure of the answering car, and means for cancelling the zone when the last call therein is answered.

15. An elevator control system comprising, in combination, a plurality of elevator cars that serve a plurality of floors, means for registering calls for service, means for moving the cars to serve the calls for service, means for registering a demand for preferred service, means responsive to a demand for preferred service for establishing a zone of floors to receive preferred service, means for limiting the travel of cars tending to leave the zone to the last call within the zone, means for eliminating each floor from the zone as the call thereat is answered, and means responsive to a car entering the zone to serve a call and a reregistration of the call prior to the departure of the car for reinstating the floor of such call in said zone after its elimination therefrom.

16. An elevator control system comprising, in combination, a plurality of elevator cars arranged to serve a plurality of floors, means for registering calls for service, means for moving the cars to serve the calls, means for registering a demand for preferred service, means responsive to a demand for preferred service for establishing a zone of floors to receive preferred service, means for limiting the travel of cars tending to leave the zone to the last call in the zone, means for reducing the zone to eliminate the floor of such last call as the call is answered,

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and means for restoring preferred service to such eliminated floor in the event a call is registered at such floor prior to the departure of the car answering such last call.

17. An elevator control system according to claim 16 in which the restored preferred service is terminated when such call is answered by a car approaching from the reduced zone.

18. An elevator control system according to claim 16 in which means responsive to a car answering a call at a floor while traveling toward said zone of floors and the reregistration of the call at such floor prior to the departure of the car restores said floor to the zone of floors to receive preferred service.

19. An elevator control system comprising, in combination, a plurality of elevator cars arranged to serve a plurality of floors, means for registering calls for service, means for moving the cars to serve the calls, means for registering a demand for preferred service, means responsive to a demand for preferred service for establishing a zone of floors to receive preferred service, means for limiting the travel of cars tending to leave the zone to the last call in the zone, means for reducing the zone to

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eliminate the floor of such last call as the call is answered, and means for each car responsive to the car serving a call at a floor at the limit of the zone adapted to restore preferred service to such floor in the event a call is registered thereat prior to the departure of the car.

20. An elevator control system comprising, in combination, a plurality of elevator cars arranged to serve a plurality of floors, means for registering calls for service, means for moving the cars to serve the calls, means for registering a demand for preferred service, means responsive to a demand for preferred service for establishing a zone of floors to receive preferred service, means for limiting the travel of cars tending to leave the zone to the last call in the zone, means for reducing the zone to eliminate the floor of such last call as the call is answered, means for each car responsive to the car serving a call at a floor at the limit of the zone adapted to restore preferred service to such floor in the event a call is registered thereat prior to the departure of the car and means for canceling the zone as the last call therein is served.

No references cited.