

Oct. 28, 1969

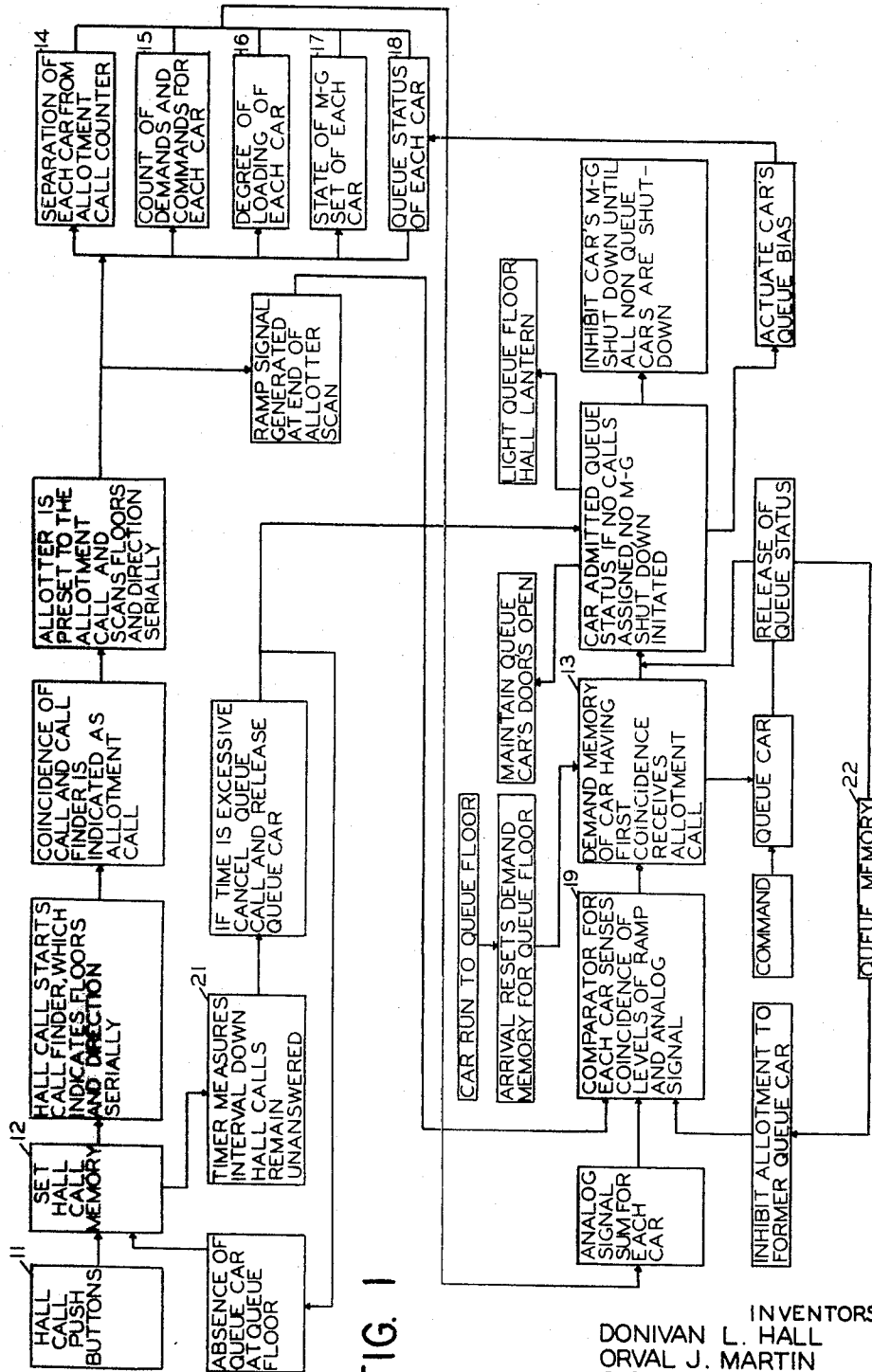
D. L. HALL ET AL

3,474,885

QUEUEING CONTROLS FOR A GROUP OF ELEVATORS

Filed Jan. 20, 1967

6 Sheets-Sheet 1



INVENTORS
DONIVAN L. HALL
ORVAL J. MARTIN
GERALD D. ROBASZKIEWICZ
BY

Fraser, Wilson & Fraser
ATTORNEYS

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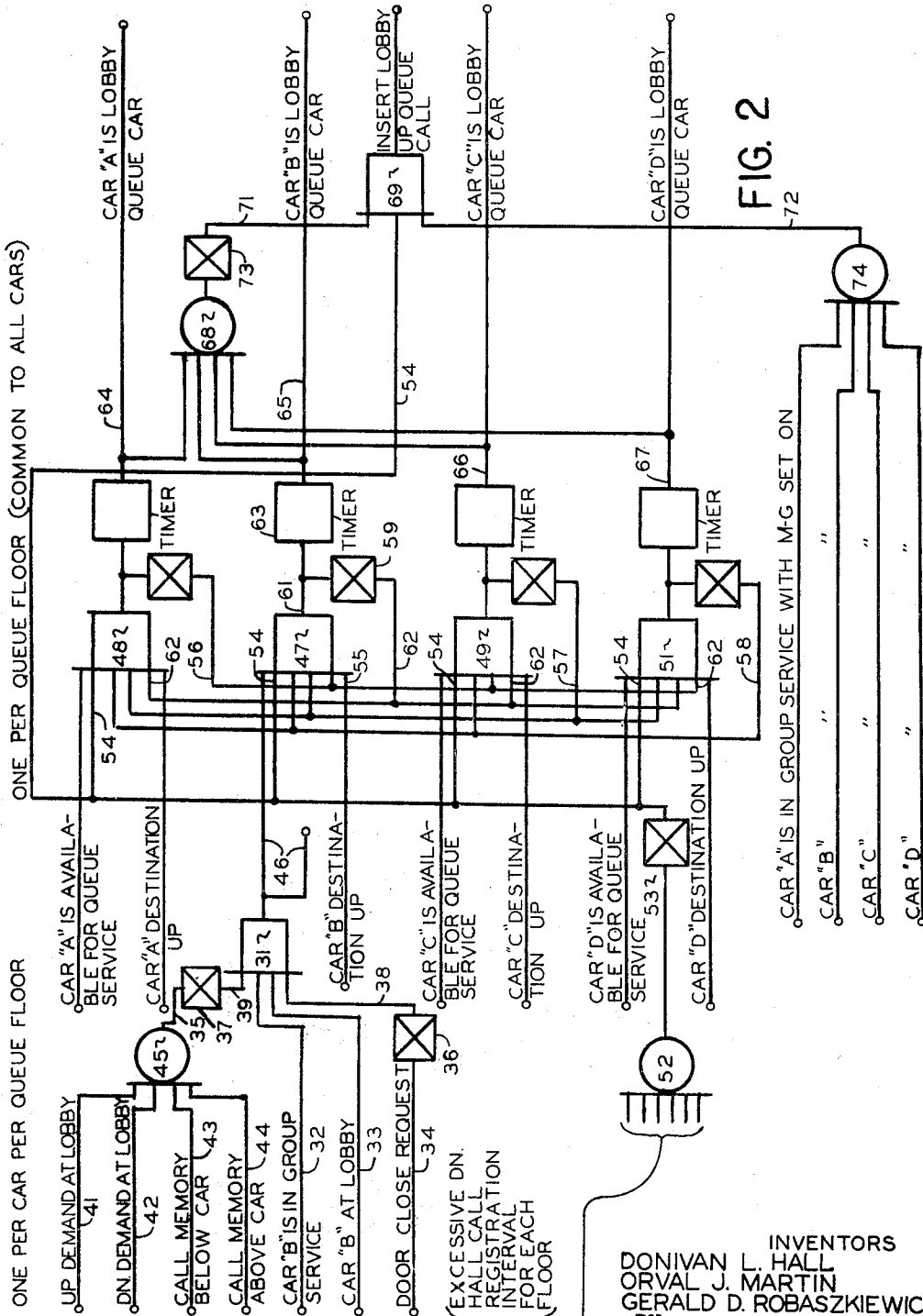
D. L. HALL ET AL

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6 Sheets-Sheet 2



INVENTORS
DONIVAN L. HALL
ORVAL J. MARTIN
GERALD D. ROBASZKIEWICZ
BY
Fraser, Wilson & Fraser
ATTORNEYS

Oct. 28, 1969

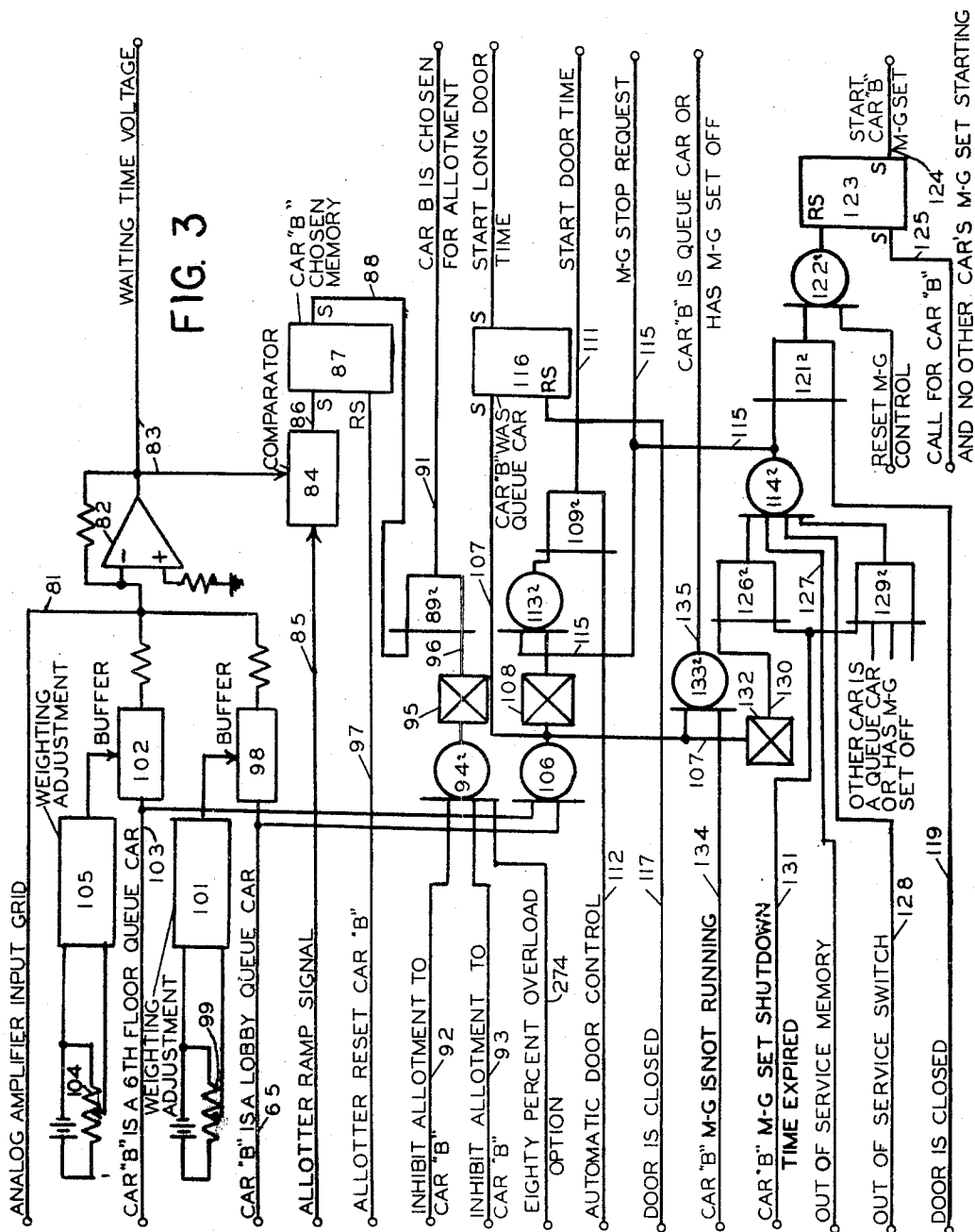
D. L. HALL ET AL

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6 Sheets-Sheet 3



INVENTORS
DONIVAN L. HALL
ORVAL J. MARTIN
GERALD D. ROBASZKIEWICZ
BY

Fraser, Wilson & Fraser
ATTORNEYS

Oct. 28, 1969

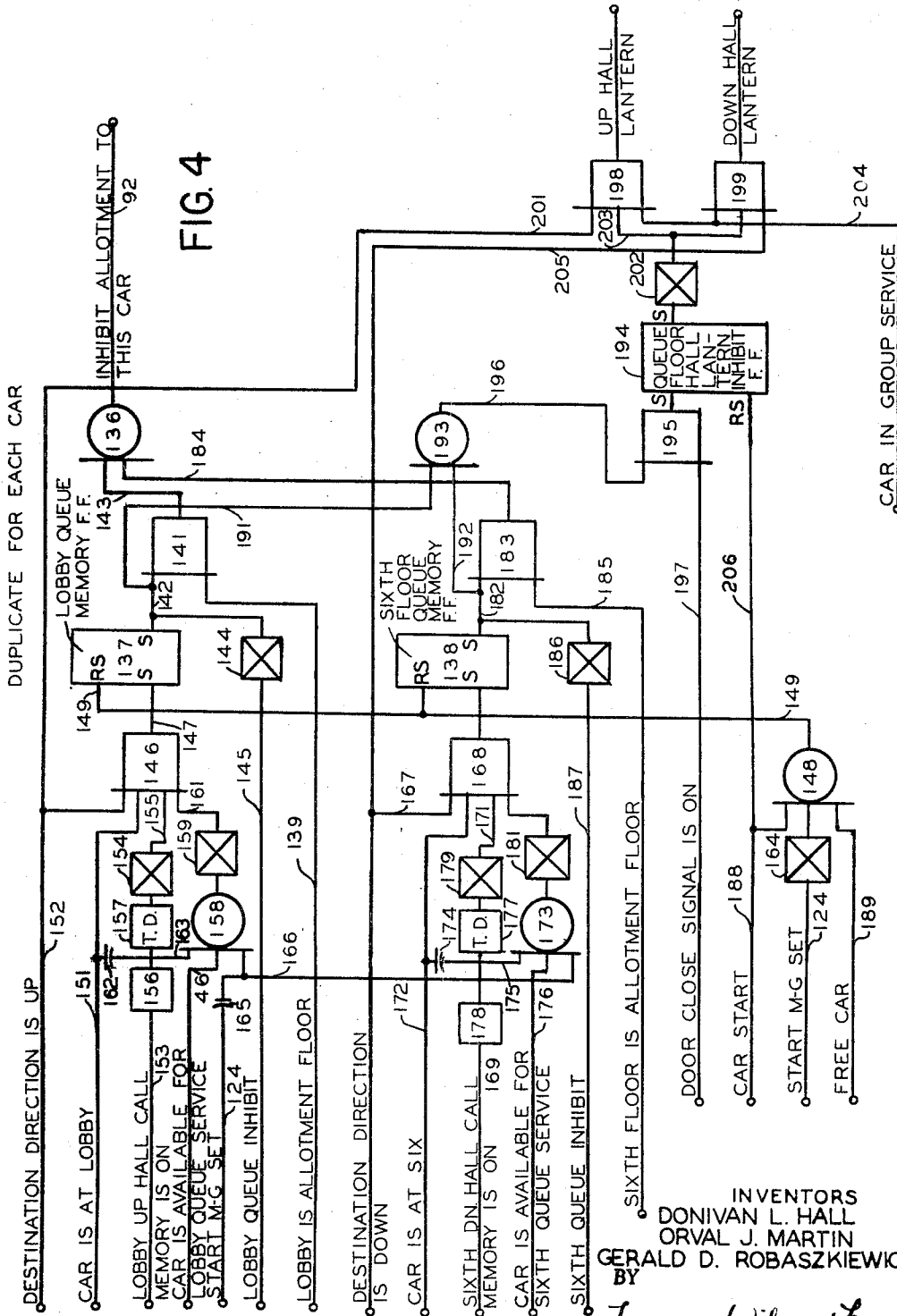
D. L. HALL ET AL

3,474,885

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6 Sheets-Sheet 4



INVENTORS
DONIVAN L. HALL
ORVAL J. MARTIN
BY GERALD D. ROBASZKIEWICZ
Fraser, Wilson & Fraser
ATTORNEYS

Oct. 28, 1969

D. L. HALL ET AL

3,474,885

QUEUEING CONTROLS FOR A GROUP OF ELEVATORS

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6 Sheets-Sheet 5

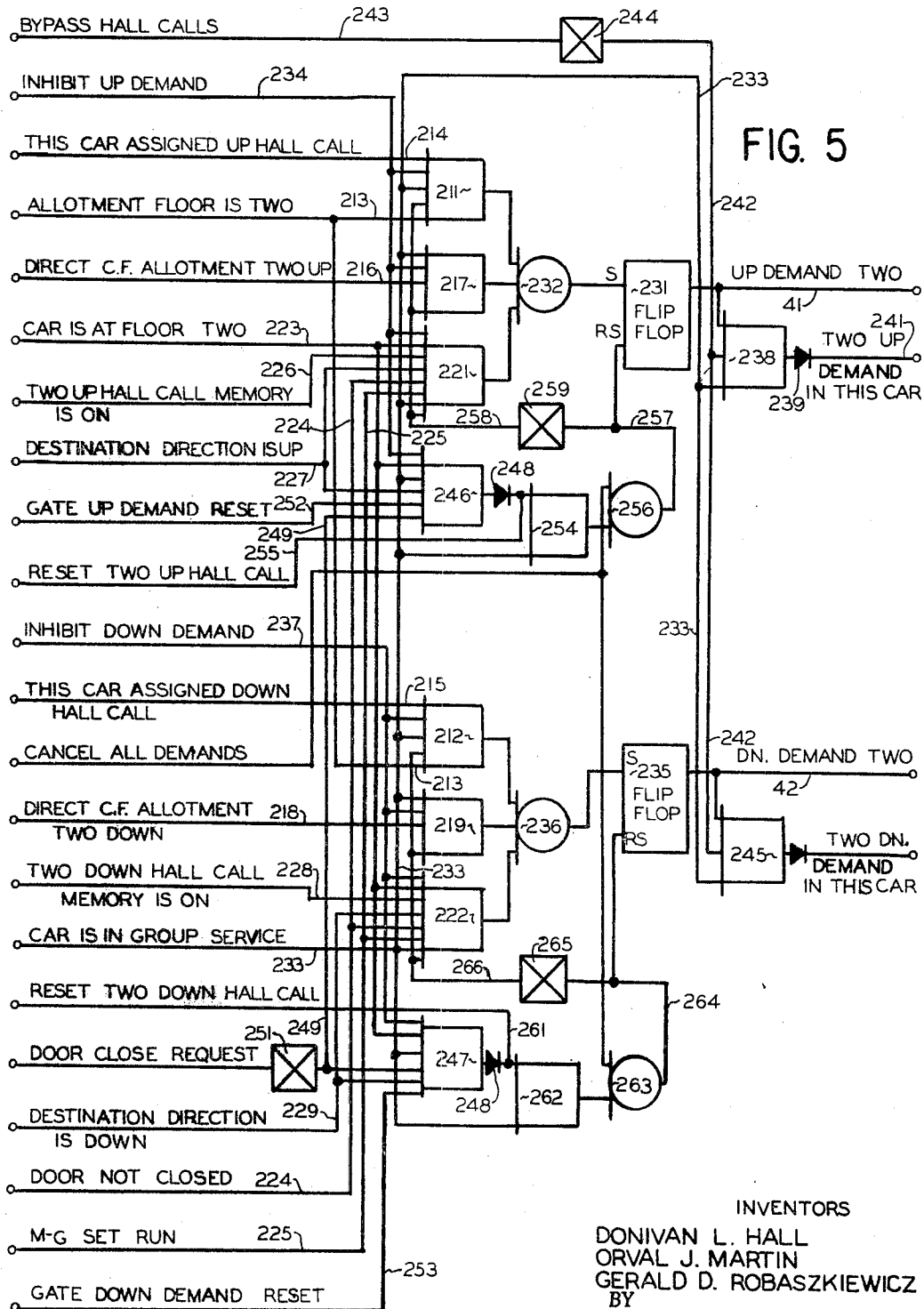


FIG. 5

INVENTORS

DONIVAN L. HALL
ORVAL J. MARTIN
GERALD D. ROBASKIEWICZ
BY

Fraser, Wilson & Fraser
ATTORNEYS

Oct. 28, 1969

D. L. HALL ET AL

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6 Sheets-Sheet 6

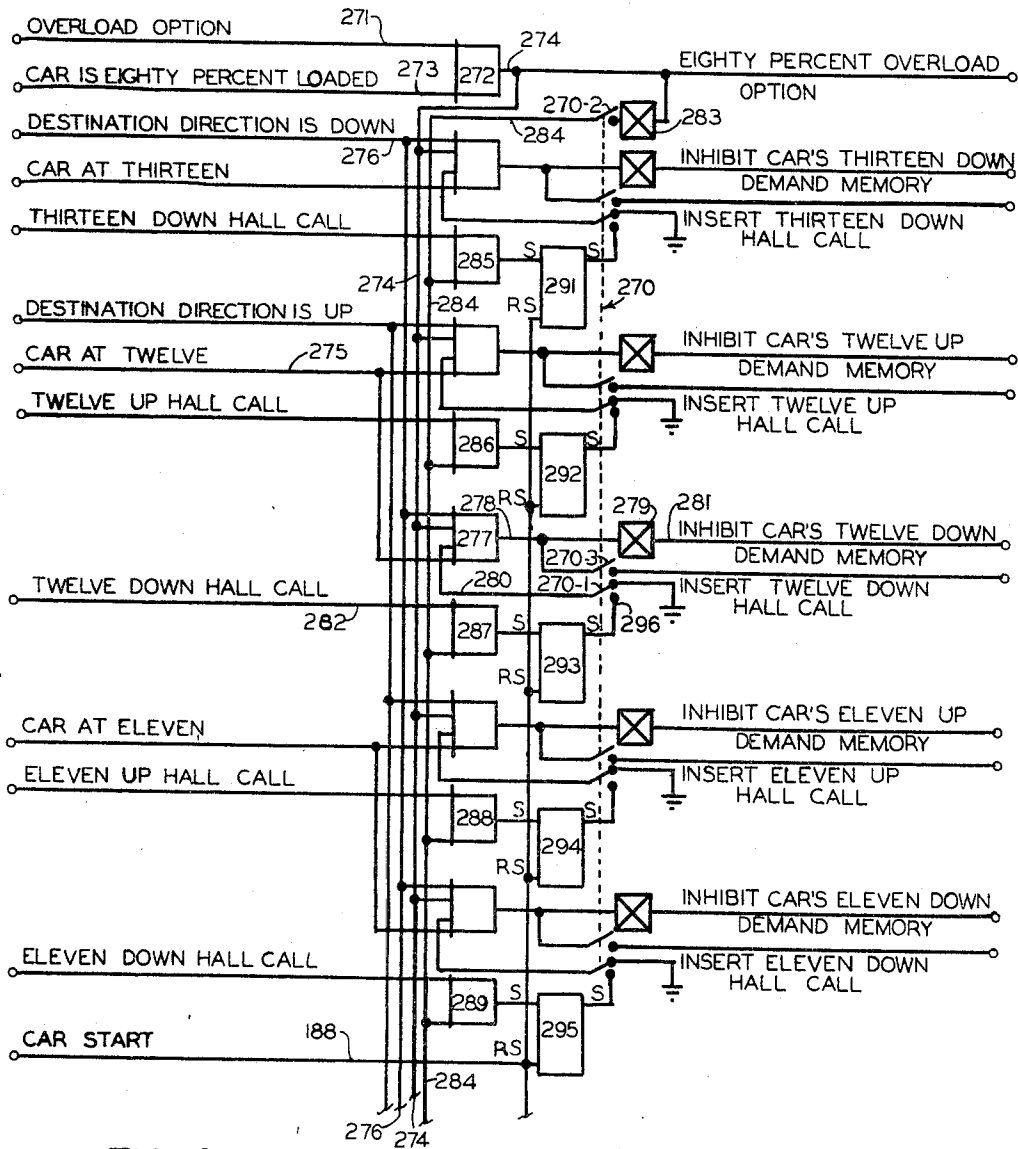


FIG. 6

INVENTORS
DONIVAN L. HALL
ORVAL J. MARTIN
GERALD D. ROBASKIEWICZ
BY

Tramm, Wilson & Fraser

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3,474,885

QUEUEING CONTROLS FOR A GROUP OF ELEVATORS

Donivan L. Hall, Orval J. Martin, and Gerald D. Robaskiewicz, Toledo, Ohio, assignors to Reliance Electric Company, Euclid, Ohio, a corporation of Delaware
Filed Jan. 20, 1967, Ser. No. 610,523
Int. Cl. B66b 1/28

U.S. Cl. 187—29

16 Claims

ABSTRACT OF THE DISCLOSURE

A control for a group of elevators which imposes a hall call in anticipation of a need for service, allots that call to a single car, causes that car to run to the floor of the call, and cancels the call upon arrival of the car. In one embodiment the car upon arrival at the floor of the call with no further calls imposed upon it enters into a preferred status. This car remains at the floor until a car call or an allotted hall call requires its travel. A hall call is allotted to a preferred status car only if the remaining cars are conditioned to be delayed serving the call for a predetermined interval. Cars which arrive at floor of a service anticipating hall call and which are not placed in the preferred status and cars which are released from preferred status are barred from receiving an allotment of a new service anticipating call and are permitted to run from the floor to their other calls following a normal stop interval.

This invention concerns elevator group supervisory controls for automatically providing service to predetermined landings and for retaining an elevator car available at such landings in preference to other locations in the elevator travel.

Heretofore plural car, operatorless elevator systems have been arranged to insure the availability of a car at a floor at which intense service is anticipated. Usually the lower main landing or lobby of a building is such a floor as is the upper main landing in some buildings. Cars are caused to run to these intense service floors by arranging them to start automatically after each stop at all floors except the intense service floors and providing special controls which release the cars from the intense service floors under special circumstances such as the expiration of a dispatch time interval. They can also be called to intense service floors by artificially inserted calls for service to cause them to park at such floors until other controls place them in operation. Generally, the release or start of cars from a parked state has been instituted after an interval sufficient to permit them to be loaded and in response to a requirement for their service as indicated by a car call registered by a passenger within the car or a hall call located to be served by the car as at the parking floor, at a floor in a zone of floors assigned the parked car, or behind the next nearest car in the system.

Generally the prior art systems have employed rigid constraints on the generation of the call which attracts a car to the intense service floor and the assignment of a car to serve that floor.

The present invention is an improved control for causing any car of a plurality to travel to a service preference floor, enter a service preference status at that floor if no other need for its service is imposed at the time it becomes available at that floor, and retain it in a service preference status until service requirements indicate that it should be employed otherwise. More particularly the invention is advantageously applied to a system wherein cars run only when calls are registered which they can serve and otherwise park at the floor at which they complete their assigned service. It is illustrated as employed

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in the system of United States patent application Ser. No. 493,973 for "Elevator Controls" filed in the names of Donivan L. Hall and William C. Susor on Oct. 8, 1965 wherein an assignment is developed between individual calls and individual cars and each car runs only to satisfy its calls. In such a system no means of making a car available at a floor other than a registered call for service is provided. Calls are normally allotted to the car having a service capability with respect thereto within certain limits, as the closest car to the call having less than a predetermined load and less than a predetermined number of calls, or to the car having the optimum service capability with respect to the call.

Systems of the type described equalize service by the cars thereby tending to place cars at preferred service floors in motion under conditions in which substantially equal service quality can be maintained by retaining a car at the preferred service floor and developing the assignment between the call and other cars.

The present additions to the type of system of the aforementioned patent application attracts the car best situated to serve the preference floor to that floor since the artificial call is registered as a hall call which can be served by any car. That call is imposed automatically as long as no car assumes a state in which it provides preferential service at the floor. A car can assume such service only under conditions where it has no further service to perform. Thus a car allotted an artificially imposed call for a floor will release that allotment upon arrival at the floor and either enter the preferential service status and cancel the artificial call, or if it has other service requirements, it will release the artificial call so that it is allotted to another car to cause that car to run to the floor. Once the car enters the preferential service state it is released therefrom by the shutdown of the car's hoist equipment where no use of the car occurs for a substantial period, by continuous registration of a hall call for an interval characteristic of a delay in service for the system, by a car call registered by a passenger entering the car from the preferential service floor, or by a hall call allotted to the car only under conditions where any other car operating in the system has a service burden imposed which exceeds some level (advantageously of the order of that required for a car to make a round trip).

The prime object of the present invention is to improve group supervisory controls for plural car elevator systems.

Another object is to make a car available at a preferred service floor when it can be made available without significant detriment to the service provided by the system.

A third object is to retain a car at a preferred service floor despite the presence of calls which it has the capacity to serve more expeditiously than other cars.

A fourth object is to retain a car at a preferred service floor in the presence of calls only until all other cars have a certain service burden imposed.

Another object is to retain the car providing preferred service in operation until all other cars are shut down.

A further object is to permit a number of preferred service floors up to the number of cars in the system subject to group supervisory control and to adjust the minimum service capability level at which each car is withdrawn from its preferred service status.

Another object is to prevent the readmission of a car to preferred service status immediately following its release therefrom.

In order to facilitate discussion of the invention, preferred service floors will be hereafter be termed "queue floors," calls imposed to provide preferred service at queue floors will be termed "queue calls," and cars conditioned at a queue floor to be retained for preferred

service are termed "queue cars". The term "queue" is significant in respect to the intended function of the car when at the preferred service floor of serving a waiting line or anticipated waiting line of prospective passengers which accumulates at that floor. Thus a lobby or floor at which a main entrance to the elevator system is located can have its apparent service enhanced by being treated as a queue floor according to this system.

One feature of this invention is a control for developing a queue call which is effective upon but a single car for any queue floor. A queue call is generated only if at least one car has its hoist equipment energized, no car is subject to a hall call which has remained unanswered beyond a predetermined time interval, and no car is a queue car.

A queue call is processed as a manually registered hall call for the floor and direction of queue service. It is selected by a call finder, an apparatus which serially selects calls common to the cars in order to preset the allotter, the apparatus to ascertain the service capability of each car and develop the assignment according to that capability, and to serialize the call with other calls which have not been subjected to assignment. It is then utilized as the basis from which the capacity of the cars to serve it is ascertained. In a preferred embodiment the separation of each car from the queue call floor, the other calls imposed on each car, and the load within each car is ascertained and combined as a measure of the service capability of each car with respect to the call. That car having the best capability is then set to respond to the call.

In the normal course of its operations a car subject to the assignment will run to the queue call. The preferred system in accordance with the disclosure of the aforementioned application Ser. No. 493,973 and that of United States patent application Ser. No. 610,574 entitled "Group Elevator Control Having Car Call Reset of Advance Hall Call Assignment" which was filed herewith in the name of James H. Kuzara includes means to reallocate hall calls as the service burden imposed upon cars having assigned hall calls changes. Hence, the queue call can be released from a car and reallocated to another car any number of times if the car to which the queue call is allotted has its service burden changed.

It is desirable to assign a car to queue status only if it is not conditioned to serve additional calls. If at the time a car arrives at a queue floor and thereby cancels its assignment of the queue call, that car has additional calls to serve, it will be barred from queue service and the queue call will be sustained in the hall call memory of the system. The retained queue call will be allotted immediately following its cancellation from the car at the queue floor if that car is prevented from entering queue status. At this time the car in the best condition to serve as a queue car will be allotted the queue call. Thus even the car which has cancelled its allotted queue call can again be allotted to it so that it will again return to the queue floor following its service to the remaining call. However, in most cases another car will be allotted the queue call.

A feature of this invention is the means for admitting a car to queue car status when it is at the queue floor, is in group service, has no door close request, and has no call assigned.

Another feature is to release a car from queue car status in response to registration of a car call in the car or allotment of a hall call to the car.

Another feature resides in applying a bias to a queue car in the allotter evaluation process whereby the queue car receives a call assignment only when no other car has a service capability below the bias level. In the preferred system where the service capability of each car as represented by summed analog signals of the several service conditions imposed on each car is scaled to predicted service time of that car for the call, the queue bias can be viewed as a minimum-service time and all

other cars must indicate a predicted service time to the call in excess of this minimum for the queue car to receive allotment of the call as that car having the most favorable disposition to serve the call. In this evaluation the allotter considers the sum of the call-to-queue-car spacing signal and the queue bias signal as representing the service capability of the queue car to serve that call.

A further feature involves releasing the queue car from queue status when all other cars have been shut down and the queue car has been dormant for a predetermined interval. Retention of the queue car for active service as the last car to be shut down provides a car available for service at the floor where normal service is concentrated.

Another feature concerns the release of a car from queue status when any hall call has been registered beyond a predetermined interval. Thus queue status is not permitted to prevent service to hall calls which are not promptly served by the nonqueue cars.

Another feature is a multiple queue floor control which enables a plurality of cars in the group to respond to queue calls for different floors.

Other features involve the creation of an artificial hall call by the action of a car at the floor of the call and the inhibiting of allotment of that call to the car creating it, the interlock of queue status release of a car with the inhibition of a queue call assignment to that car, and the control of the hall lanterns to extinguish them as the doors begin to close for a car which stopped for a queue call.

The above and additional objects and features will be appreciated more fully from the following detailed description when read with reference to the accompanying drawings in which:

FIG. 1 is a functional block diagram of the queue floor, queue car and queue call functions representing their integration with a preferred form of elevator group supervisory control including a call serializing call finder and an optimizing allotter;

FIG. 2 is a logic diagram of a portion of the command memory of one car for a queue floor which issues a signal indicating that that car is available for queue service at the queue floor and the plural car queueing circuit for that queue floor.

FIG. 3 is a logic diagram of portions of the allotter utilized to retain a queue status for a car in the presence of hall calls, and portions of the car control which initiate the door timing and which stop and start the motor-generator set particularly for a queue car;

FIG. 4 is a logic diagram of the queue memory for a car having the capability to serve two queue floors, and the circuits for hall lantern control for a queue car;

FIG. 5 is a logic diagram of the second floor up and down demand memories for a typical car; and

FIG. 6 is a logic diagram of an expansion of queue service concepts to insert an artificial call at any floor at which a car becomes overloaded and to avoid allotting that call to the overloaded car which caused its insertion.

In order to illustrate the present invention it is set forth as applied to a four car group of automatic elevators serving thirteen floors of a structure in which the second floor is a lobby providing a primary entrance to the structure and the sixth floor is a conference area from which a relatively constant requirement for service downward is maintained. In such a system it is desirable, when it can be accomplished, without interrupting or deteriorating the service afforded by the system, to maintain a car with its doors open and awaiting passengers at the floors of high traffic concentration. In this manner the passengers are served without the accumulation of waiting lines or queues.

Some aspects of these queueing controls have applicability to any system wherein cars have the capacity to terminate operation at other than predetermined high

traffic intensity floors when no further service requirements are imposed upon them. However, they are particularly suited for systems of the type disclosed in the aforementioned copending patent applications. FIG. 1 represents the combination of the queueing controls with the group supervisory control of the copending patent applications wherein the system is provided with means 11 for registering calls for service in selected directions from the floors as by up hall call push button switches at all but the uppermost floor and down hall call push button switches at all but the lowermost floor. Such calls set corresponding up or down hall call memories 12 for the floors. The call, through the functions of a call finder and an allotter, result in the setting of a corresponding up or down demand memory 13 for an individual car. Thus for each hall call memory there is a demand memory for each car although only one box 13 is shown in FIG. 1. Hall calls when allotted are termed "demands."

A demand is imposed on but one car for each hall call except in those instances where several cars have car calls for the floor and are set to travel in the direction of a hall call, in which case the coincidence of the hall and car call results in an allotment to each such car. Car calls are directly imposed upon the cars in which they originate and are termed "commands." Each car has floor buttons (not shown) on a control panel in the car to enable passengers to register car calls.

Any call in a hall call memory which has no corresponding demand or command memory actuates a call finder which includes a scanner (not shown) having scan positions corresponding to the floors. The scanner scans in both an ascending and descending sequence or scan direction so that upon coincidence of a scan position and scan direction with a hall call for the same floor and service direction the scan is terminated and this call is considered the allotment call. The scanner then issues a signal to the allotter (fragments of which are shown in FIG. 3) causing the reset of the allotter from its previous allotment and the preset of a scanner (not shown) in the allotter to the allotment call from which it scans in a direction opposite the service direction of the call. Scan steps from the call to each car are counted for each car as a measure of the separation of the car from the allotment call by a counter 14 which issues an analog signal for each car. The demands and commands for each car are counted by counter 15 and represented by analog signals. Load sensing devices 16 issue signals indicative of the degree of loading of each car. A signal is issued 17 for those cars having their hoist equipment deenergized, in the usual case such cars have motor-generator sets which are shut down. Each car in queue status also issues a signal 18. These signals are representative of the time delays introduced by the factors considered with respect to the service capability of the car to serve the call. The scaling of these signals is adjustable. One scale suitable for cars which travel at eight hundred feet a minute and serve average ten foot floor heights is one second per floor of separation, eleven seconds per demand or command, each passenger is considered to add a second to service time, the queue status is scaled to a round trip time for the structure, about 24 seconds, and cars having their M-G sets shut-down are considered delayed the time required to start the sets and condition the cars to run, about 24 seconds.

The analog signals for each car are summed to provide a predicted service time for each car and that car having the lowest predicted service time is given the allotment call. This is accomplished by generating a ramp signal, a signal which increases with time, beginning at the end of the allotter scan at which time the sum signal is completed for each car. The sum signal of each car and the ramp signal are compared in each car's comparator 19 and the first coincidence of the ramp with a sum signal causes allotment of the call to

the car of that sum signal and stops the ramp generator.

The queueing controls are integrated in this system such that the absence of a queue car at a queue floor at a time when queue service should be available from that floor issues a setting signal to the hall call memory for that floor and the service direction in which queue service is offered. The hall call memory thus set actuates the system in the same manner as a manually registered call and results in an allotment of the queue call to a car. The arrival at the queue floor of the car which has the queue call allotment cancels its demand set by the queue call and if the car is admitted to queue status cancels the queue call hall call memory. The queue call can also be inhibited or cancelled if no car has its hoist equipment energized or if a timer 21 measures an excessive interval of hall call registration for any down hall call.

A car is admitted to queue status only when located at a queue floor. It becomes a queue car only if it is in service and no other calls are assigned to it requiring its travel from the queue floor. Once admitted to queue status, a car holds its doors open and retains its hoist equipment energized until all nonqueue cars have been shut down, a car call has been registered to impose a command upon it, a hall call is allocated to it as a demand or the timer 21 indicates a delay in service. Its hall lantern remains lit while it is in queue status and at the lobby may be in the form of an illuminated "This Car Up" sign.

While in queue status the car tends to permit other cars to be preferred for allotment. It does this by imposing a queue status bias as part of its summed signal which is so substantial that other cars even with several calls allotted appear in the allotter evaluation of service capability to be more favorably disposed with respect to hall calls. If other cars are so burdened that they exceed the sum signal of a queue car as made up of the signal representing spacing between the queue car and the allotment call and the queue bias, then the queue car receives the allotment call as a demand and is released from queue status. A car call in a car in queue status effects a direct release of the car therefrom.

Upon release of a car from queue status a queue memory 22, FIG. 4 is actuated to inhibit allotment of the re-imposed queue call to that car until the car is started from the queue floor. After the car is started, the queue call can be allotted and the car can again be admitted to queue status.

The system has been depicted in logic diagram form in FIGS. 2 through 6 wherein signal inputs are labeled functionally and are represented to the logic elements as positive going signals. In practice the logic elements have been made up of semiconductive active elements, primarily diodes and transistors biased at -12 volts; hence a ground signal constitutes a positive going signal at an input. The logic elements comprise: OR's, typified by element 45 of FIG. 2, which are gated to issue a positive signal on an output lead 35 when a positive signal is applied to any one of a multiplicity of input leads 41, 42, 43 or 44; inverters, such as 37, which invert a positive or ground signal on their input lead 35 to a negative signal in their output lead 39 and a negative signal on their input to a positive or ground signal on their output; AND's, such as 31, which gate a positive signal to their output lead 46 when there is a coincidence of positive signals on all of their input leads 39, 32, 33 and 38; timers, such as 63, which issue a positive signal on their output lead 65 a given time interval after a positive signal is applied to their input lead 61; flip flops, such as 87 which invert their signal output from negative to positive on their set output lead 88 designated by S in response to a positive signal on their set input lead 86, shown on the left and designated by S, and return to their initial state in response to a positive signal on their reset lead 97, on the left and designated by RS; buffer amplifiers, such as 98;

operational amplifiers, such as 82; and comparators such as 84 which sense equality between signal levels imposed on two input leads 83 and 85 and issue a positive signal on their output lead 86 in response thereto. Each of these elements has an established state in the art and therefore is not disclosed in detail herein.

Since the various circuits of FIGS. 2 through 6 are part of a system they have interconnecting leads which are identified both by reference character and, when convenient, functional designation. Interconnected leads have been assigned like reference characters in the several drawings.

In FIG. 2 a car is indicated as available for queue service when its AND 31 is gated. The circuit controlling AND 31 is for car B for the lobby and is typical for those of cars A, C and D for the lobby (not shown) and for all cars for queue service from the sixth floor (not shown). The remainder of FIG. 2 is a circuit common to cars A to D for the lobby and typifies a queue floor circuit as provided for the sixth floor (not shown).

A car is available for queue service when it is at the queue floor, in group service, has no door close signal and has no assigned call as indicated by a positive signal on leads 32 and 33 and a negative signal on leads 34 and 35 respectively. Inverters 36 and 37 respond to the negative signals by issuing positive signals on leads 38 and 39 to provide a coincidence of such signals for gating AND 31. Four types of calls can be imposed upon the car, an up or a down demand at the floor (the lobby in this instance), or a call memory (either a demand or command) above or below the car. Signals indicative of each of these type calls are sensed at leads 41, 42, 43 and 44 as positive signals, any one of which will gate OR 45 to lead 35.

A positive "CAR B IS AVAILABLE FOR QUEUE SERVICE" signal issues from AND 31 on lead 46 one branch of which is coupled to the queue car assignment AND 47 for car B and the other branch of which is in a circuit for the lobby queue memory control of FIG. 4. Each car has an AND corresponding to AND 47 as 48 for car A, 49 for C and 51 for D. These AND's are gated by their respective car which is available for lobby queue service and has its destination direction set for up provided no down hall calls have been registered an excessive interval to impose a positive signal on the input for one of such calls to OR 52 to inhibit the positive signal issued on lead 54 from inverter 53. In the case of car B AND 47 is gated when a "CAR B DESTINATION DIRECTION IS UP" signal on lead 55, a "CAR B IS AVAILABLE FOR LOBBY QUEUE SERVICE" signal on lead 46, a "NO EXCESSIVE REGISTRATION INTERVAL FOR DOWN HALL CALLS" signal on lead 54, and "CARS A, C AND D ARE NOT IN QUEUE SERVICE" signal respectively on leads 56, 57 and 58 are coincident.

Interlocks between the controls establishing the queue status for each car are provided as by the inverter 59 for car B which responds to a queue status signal on lead 61 by issuing an inhibit signal on lead 62 to each of AND's 48, 49 and 51 for cars A, C and D. Simultaneous admission of two or more cars to lobby queue status is avoided by timers, as 63 for car B, which delay the issuance of a "CAR B IS LOBBY QUEUE CAR" signal. Each delay is different for each car so that the cross inhibiting signals on leads 56, 62, 57 and 58 are effective on all but one car's AND to restrict gating to but one of AND's 48, 49 or 51.

The "CAR IS A LOBBY QUEUE CAR" signal is issued on lead 64, 65, 66 or 67 for car A, B, C or D respectively and is passed to the queue car bias signal source in the allotter as shown in FIG. 3 for car B and to the door time control circuits for car B of FIG. 3 and the M-G set control circuits for car B of FIG. 3. It is also employed to gate OR 68 in order to cancel the lobby queue call by inhibiting AND 69. AND 69 is gated to insert a lobby up queue call by a coincidence of signals on

its inputs 71, 72 and 54. Absence of a signal from OR 68 to inverter 73 results in an enabling signal on lead 71. Conversely, when a car is in queue status OR 68 is gated and inverter 73 places an inhibiting signal on lead 71. Additional inhibiting of the lobby up queue call is imposed if an excessive down hall call registration interval is sensed for any floor to gate OR 52 to inverter 53, as reflected on lead 54, or if all cars have their M-G sets shutdown so that no positive signal is imposed on an input of OR 74 to gate it to lead 72.

It is to be appreciated that the circuits of FIG. 2 are duplicated for other queue floors. Thus if queue service is to be provided downward from the sixth floor each car will have an AND corresponding to AND 31 gated by the presence of the car at the sixth floor while in group service with no door close request imposed and no assigned demand or command. The AND's corresponding to AND's 48, 47, 49 and 51 have a "DESTINATION DIRECTION IS DOWN" signal substituted for the "DESTINATION DIRECTION IS UP" signal since queue service is to be downward from the sixth floor.

Ordinarily the lobby floor is the preferred queue floor. Queue calls should therefore be developed for the lobby in preference to other queue floors. Where one or more floors in addition to the lobby are queue floors, those subordinate queue floors have queue calls inserted only when at least several cars are in condition to provide service. In the present example of a four car system having the sixth floor as a subordinate queue floor, the queue call inserting circuit of FIG. 2 is modified for the sixth floor queue call by substituting an AND for the OR 74. This results in a queue call insertion only when all cars are in group service with their M-G set on since the AND will be gated to place an enabling signal on lead 72 to AND 69 only when all input signals are coincident. Such a call thus requires no sixth floor queue car, no excessive down hall call registration interval, and all cars in group service with their M-G sets on.

The "INSERT LOBBY UP QUEUE CALL" signal from AND 69 sets the up hall call memory for the lobby floor in the same manner as the operation of an up hall call switch for the lobby to cause the serialization of the queue call and the allotment of that call. The queue call is allotted to the car whose summed analog signal indicative of service capability to the queue call, as applied to lead 81 of FIG. 3, produces through operational amplifier 82 that "WAITING TIME VOLTAGE" signal on lead 83 which is first matched in comparator 84 by the ramp signal on lead 85. A ramp signal generator (not shown) is started in operation at the end of the allotter scanner scan and generates a signal which increases with time until its signal is matched by the lowest waiting time voltage in the comparator of the car most favorably disposed to receive the allotment of the queue call. Once that match is achieved the comparator, for car "B" in the illustrative example, issues a signal on lead 86 to set flip flop 87. This results in a set signal on lead 88 to gate AND 89 and issue a "CAR B IS CHOSEN FOR ALLOTMENT" signal on lead 91, provided an "INHIBIT ALLOTMENT TO CAR B" signal is not imposed on either of leads 92 or 93 to gate OR 94. OR 94, if not gated, applies no signal to inverter 95 and permits that inverter to issue an enabling signal on lead 96 to AND 89.

An inhibiting signal is issued to AND 89 when OR 94 is gated to inverter 95 by a "queue memory" signal on lead 92 or a long interval or registration of a hall call has been sensed to require special service as indicated by a signal on lead 93.

The allotment call signal for the up lobby call representing the queue call is imposed on the up lobby demand memory lead 213 of FIG. 5 (not shown) of each car and is gated as a "THIS CAR ASSIGNED UP HALL CALL" on lead 214 of FIG. 5 only to the car chosen for allotment, e.g. car B by the application of the "CAR B IS CHOSEN FOR ALLOTMENT" signal to an allotter car

assigned gating circuit (not shown) which applies its signal to all up demand memories of car B. Thus the lobby queue call is allotted to the car most favorably disposed to receive the allotment. Thereafter the flip flop 87 is reset by a signal on lead 97 along with the remainder of the allotter when the call finder establishes the next allotment call. The chosen car ultimately runs to the queue call unless that call is reallocated to another car by a change in the service burden imposed upon the car.

The presence of a car in queue status is reflected in the allotting function by an increase in the waiting time voltage for that car. If car B were in queue status by satisfying the conditions discussed with respect to FIG. 2, a signal on lead 65 activates buffer amplifier 98 to pass a signal to lead 81 and operational amplifier 82 of car B. That signal is of adjustable magnitude as determined by the setting of potentiometer 99 for weighting adjustment 101. A lobby up queue car is conveniently assigned a signal scaled to a round trip interval so that it alone imposes a waiting time signal on lead 83 scaled to 24 seconds in the exemplary system. This results in a bias tending to cause allotment of hall calls to other cars when any other car has a waiting time voltage less than that scaled to 24 seconds plus the separation of the queue car from the allotment call, thereby tending to maintain the queue car in queue status while the predicted service time remains at moderate levels for the remaining cars. However, as the predicted service time on all remaining cars exceeds the waiting time voltage for the queue car the allotment call is assigned to the queue car by the allotter by actuating flip flop 87 upon coincidence of the levels of the ramp signal and summed signal for the queue car. Allotment of a call to a car releases it from queue status as discussed with respect to FIG. 2 since OR 45 will be gated by the call to inhibit AND 31 for the car. In the case of car B this will inhibit AND 47 and cancel the queue status of car B.

Additional queue floor controls are integrated in the allotter with a buffer amplifier and weighting adjustment similar to that of the lobby queue controls. In the example the buffer amplifier 102 imposes a sixth floor queue car bias to be added as a waiting time factor to the "ANALOG AMPLIFIER INPUT GRID" signal of lead 81 in response to the assignment of car B as the sixth floor queue car. Thus when car B is introduced into sixth floor queue status by circuits corresponding to FIG. 2 a "CAR B IS A SIXTH FLOOR QUEUE CAR" signal is imposed on lead 103 to activate buffer 102. The magnitude of the bias signal is independently adjusted by the setting of potentiometer 104 for the weighting adjustment 105. This setting can be the same as for a lobby queue car bias or where queue service at the sixth floor is subordinate to the lobby queue service the bias can be set lower so that an allotment call tends to be assigned to a sixth floor queue car in preference to a lobby queue car.

When a car is assigned queue status for any floor certain functions are actuated. Where these functions are identical they can be grouped through OR 106 which is gated by a queue car assignment from lead 103 or lead 65 in the example. The signal passes from OR 106 to lead 107 for queue status door control and queue status M-G set control for the car.

A car in queue status remains at a landing with its doors open and its hall lantern lighted for the queue service direction. Thus a lobby queue car stands at the lobby with doors open and a "THIS CAR UP" indicator actuated to attract prospective passengers to that car. While these conditions prevail other cars can arrive at the lobby if their calls require service to the lobby and remain in normal service. Cars which have additional commands or demands stop for their lobby calls, light their hall lanterns for the direction of their next service, close their doors after a normal door open interval and leave the lobby in the direction of the floor they are next to serve. Thus if they are next to serve a floor above the lobby

they operate their "THIS CAR UP" indicator. Cars which arrive at the lobby with no further service required stand at the lobby with their doors open a normal door open interval and thereafter close their doors while remaining at the lobby. Hall calls to be allotted are allotted to those closed cars in the normal manner to cause them to run to the floors of the resultant demands.

Definition of a door open interval for a queue car is inhibited by the signal on lead 107 to inverter 108. In order to start a door time interval for the car AND 109 must be gated to issue a "START DOOR TIME" signal on lead 111. AND 109 responds to a coincidence of an "AUTOMATIC DOOR CONTROL" signal on lead 112 (a signal which is present when the car is on automatic operation and is removed for inspection, attendant operation, and certain special modes of individual car operation) and a signal from OR 113. OR 113 is gated when the car is not in queue status since inverter 108 then issues it a positive signal. It is also gated in response to an M-G set stop request as derived from OR 114 over lead 115 from the M-G set controls of the car. Thus if the car is not subject to a "M-G SET STOP REQUEST" and is not a queue car, its door timers are enabled at lead 111 at each stop.

A queue car is ordinarily released from queue status by a command resulting from a registered car call. As disclosed in a copending United States patent application Ser. No. 612,724 entitled "Elevator Car Door Control" which was filed Jan. 30, 1967 in the name of Donovan L. Hall, a car which is stopped at a floor having both a command and demand for that car, termed a "combination stop," is required to follow a door operating a cycle which includes a longer door open time interval than for a floor having only a demand or command. Since a queue floor control creates a queue status as an artificial demand, a car released from queue status is treated as one having a combination stop and therefore is set with a long door time measured from the queue status release. Flip flop 116 provides a memory that the car was in queue status. It is set by the queue status signal on lead 107 and holds the set condition until a "DOOR IS CLOSED" signal is applied on lead 117 to its reset input. Output lead 118 of the flip flop thus preconditions a queue car to a door time interval of a combination stop when the car is in queue status by issuing a positive "START LONG DOOR TIME" signal.

The deenergization of the hoist equipment for each car occurs individually as the cars remain dormant for a predetermined period, usually from two to fifteen minutes. Queue cars are retained in energized condition until all other cars have been deenergized since it is most probable that any traffic will occur at those floors. Details of the controls for the hoist equipment, the M-G set shutdown and starting, are disclosed in the United States patent application Ser. No. 610,573 for "Energizing Controls for Elevator Hoist Equipment of a Plural Car Elevator System" filed herewith in the names of Donovan L. Hall and Gerald D. Robaszkievicz.

In the shutdown of the car's M-G set OR 114 is gated to issue a signal on lead 115 as an "M-G STOP REQUEST." This signal results in the closing of the car doors if they are open. When the doors are closed, a "DOOR IS CLOSED" signal is issued on lead 119. Coincidence of signals on leads 115 and 119 gates AND 121 to OR 122 to reset M-G set memory 123. Memory 123 is a flip flop which in the set condition issues a signal on its set output 124 "START CAR'S M-G SET." When flip flop 123 is reset, the absence of a signal on lead 124 causes the shutdown of the car's M-G set. Starting of the M-G set is accomplished by issuing a set signal on lead 125 to flip flop 123 whereby the start signal is passed on lead 124 to the M-G controls. Registration of a call for the car as a command or an allotted demand results in a start signal on lead 125.

An M-G set stop signal is developed through or 114

by applying a signal to any one of its inputs as from non-queue car shutdown AND 126, from an "OUT OF SERVICE MEMORY" signal on lead 127 derived from car failure controls (not shown), from an "OUT OF SERVICE SWITCH" signal on lead 128 for a manually actuated shutdown, or from a queue car shutdown AND 129. Each of AND's 126 and 129 are gated when a car has been dormant the shutdown time interval defined by the M-G set shutdown timer (not shown) which passes a signal over lead 131 to their inputs when the car has not received a command or demand for the shutdown interval.

Non-queue cars are shutdown prior to queue cars. When car B is not a queue car, no signal is imposed on lead 107. Inverter 132 therefore passes a signal on lead 130 to enable non-queue car shutdown AND 126. When the shutdown timer for car B passes a signal on lead 131 to AND 126, it gates OR 114 to initiate the M-G set shutdown with an "M-G STOP REQUEST" signal.

A cross inhibit for the shutdown of the cars is provided to prevent gating queue car shutdown AND for the car which is in queue status until all other cars are either shutdown or is queue status. Each car provides a signal to every other car "CAR IS QUEUE CAR OR HAS M-G SET OFF" for this cross inhibit function. This signal is derived from OR 133 which is gated by the queue status signal on lead 107 or the "CAR M-G IS NOT RUNNING" signal on lead 134 to issue a signal on lead 135. Thus for car B a signal "CAR B IS QUEUE CAR OR HAS M-G SET OFF" is issued on lead 135 if car B is a queue car for the lobby or sixth floor or if it is not a queue car and has its M-G set shutdown. Lead 135 is an input to the queue car shutdown AND 129 of cars A, C and D and each of those cars have a corresponding input to AND 129 for car B to provide an enabling condition for that AND that all other cars are either in queue status or have their M-G sets off. When this enabling condition is satisfied, a signal from the M-G shutdown timer on lead 131 for the queue car will gate AND 129 to OR 114 and initiate its shutdown.

The allotter of the present system causes an allotment of a call to the car best situated to serve the call on a predicted service time basis. Queue service is most expeditiously provided if the system either has a car in queue status or there is a queue call subject to allotment to a car which can be introduced into queue status for each queue floor. It is possible for a queue status car to be released from queue status, as by a command, and be reallocated (as the car having the shortest predicted service time to the queue call) the queue call created by its vacating the queue status. Such operation is undesirable yet it is desirable to treat the former queue car as a normal car following its queue service. A queue memory shown in FIG. 4 inhibits allotment of queue calls to a former queue car until that car is started from the queue floor, is placed in a free status or has its M-G set shut down. This permits the allotting of the lobby queue call to another car having its M-G set shutdown and thereby assures the starting of a second car's M-G set and the conditioning of that car to serve lobby traffic when activity is initiated in the system. At all floors except a queue floor the system includes a door reopening control responsive to a hall call registration whereby a late arriving passenger can reopen partially closed car doors by registering a hall call. Since a queue call is treated as a hall call, the allotment of a queue call to a car at the queue floor and having its doors partially closed would reopen those doors and lockup the car response. The queue memory therefore inhibits this door reopening control. Further at all floors except a queue floor a car keeps its hall lantern lit until its door approaches the fully closed position thereby augmenting the door reopening feature by alerting a prospective but tardy passenger as to the direction of departure of a car about

to depart the floor. At the queue floors this extended hall lantern interval is eliminated by the queue memory.

Allotment of a queue call to the former queue car prior to its response to the call releasing it from queue status is prevented by issuing an inhibit signal to the car's AND gate 89 of FIG. 3 by means of lead 92 as gated from OR 136 of FIG. 4. The circuit of FIG. 4 is duplicated for each car. OR 136 is gated for each queue floor. In the example it responds to the lobby and sixth floor queue controls.

Each car which is stopped at a queue floor and has a destination direction corresponding to the queue service direction sets its queue memory as 137 for the lobby and 138 for the sixth floor. In the case of a car which has further calls, either commands or demands, at the time it arrives at the queue floor it cancels the queue call and then triggers its queue memory so that the queue call cannot be reallocated to it. The queue call is reinstated by the absence of a queue status car and is allotted to another car. In the case of a car having no further calls, the car is admitted to queue status, the queue memory is cocked so that it can be triggered when the car is released from queue status to run to a call in the queue direction, and when the car is released while its destination direction corresponds to the queue service direction the memory is triggered to insure allotment of the reinstated queue call to another car. However if the car is released from queue status to shut down its M-G set and is restarted to run in a direction opposite the queue service the queue memory is neither cocked nor triggered and the car can be allotted the queue call. In the case of a free car, i.e. a car having no commands and no allotted demands, which is at the queue floor (a condition which will occur only if another car is in queue status and the last service required of the free car was to the queue floor) the car will cock the queue memory if it is allotted the queue call generated by the release of the queue car, and it will trigger the queue memory when as a free car or a queue car it is allotted a call which causes it to be set in the destination direction of queue service.

The setting of a queue memory inhibits allotment of calls for the queue floor to that car by the allotter while permitting the allotment of calls for other floors to the car. It also inhibits the direct allotment of queue floor calls by imposing an inhibit signal on the demand memory of the car for the queue floor and queue service direction. The inhibit signal on the demand memory of FIG. 5, as will be discussed, prevents the direct allotment of a queue call for the queue floor where a command is registered in the car for that floor in those systems wherein a coincidence of a command and a hall call for the same floor and service direction result in allotment of the hall call by direct actuation of the car's demand memory without operation of the allotter. It also prevents the cancellation of the demand memory for the queue floor of the former queue car from cancelling a queue floor demand memory in another car resulting from allotment of the queue call to that other car.

The allotter inhibit is confined to the queue floor by rendering it effective only when the queue floor is the allotment floor as established by the call finder. Thus, when the lobby is the allotment floor, a "LOBBY IS ALLOTMENT FLOOR" signal on lead 139 gates AND 141 when coincident with a signal on lead 142 from the lobby queue memory flip flop 137 to issue on lead 143 a gating signal to OR 136. OR 136 passes this signal on lead 92 to FIG. 3 and the OR 94 whereby AND 89 is inhibited to prevent issuance of a "CAR B IS CHOSEN FOR ALLOTMENT" signal by the allotter.

The demand memory inhibit for the car is derived from flip flop 137 output 142 through inverter 144 to lead 145 which is coupled to the demand memory for that car for the queue floor and service direction. The inhibit signal on lead 145 is negative when flip flop 137 is set to provide the inhibiting functions in the positive signal gated

AND's of the demand memory registration and reset controls.

Flip flop 137 is set by gating AND 146 to lead 147 and is reset by gating OR 148 to lead 149. Each up car at the lobby gates AND 146 when it is committed to start upward. The car's presence imposes a "CAR IS AT LOBBY" signal from the car lead position generator (not shown) on lead 151. If it has a command or demand for a floor above the lobby it has a "DESTINATION DIRECTION IS UP" signal from the car stopping control (not shown) on lead 152 indicating its next start will be upward. If another car is in queue status and thereby has cancelled the queue call so no "LOBBY UP HALL CALL MEMORY IS ON" signal is received from the lobby up hall call memory or if the car cancels the lobby up hall call shortly after it stops with other demands or commands imposed upon it so that it has an up destination direction and is prevented by the calls from entering queue status, the absence of the signal on lead 153 as passed to inverter 154 results in a signal on lead 155 enabling the cocking function of AND 146. The function of power boost 156, an emitter follower transistor amplifier, and of slow dropout time delay 157 will be discussed below.

An idle car at the lobby to which a hall call is allotted or upon which a command is imposed is transferred from a status in which it is available for queue service to cancel, as in the case of car B illustrated at AND 31 of FIG. 2, the signal "CAR B IS AVAILABLE FOR LOBBY QUEUE SERVICE" on lead 46, thereby inhibiting OR 158. When OR 158 is not gated inverter 159 issues an enabling signal for AND 146 on lead 161. A coincidence of enabling signals on leads 151, 152, 155 and 161 gates AND 146 to set the lobby queue memory flip flop 137.

In the case of an arriving car having an up destination direction, AND 146 is gated after a delay sufficient to permit the car to cancel the lobby up hall call memory. Arrival of the car with an up destination direction imposes the enabling signals of leads 151 and 152. However some time is required for the car to cancel the queue call or lobby up hall call if such a call is in registration. In order to provide this time the initial arrival of the car at the lobby briefly inhibits AND 146 by gating OR 158 through the pulse coupling from lead 151 by capacitance 162 to lead 163. Thus the initial impulse of the "CAR IS AT LOBBY" signal on lead 151 is passed through capacitance 162 and lead 163 to gate OR 158 for an interval sufficient to cancel the hall call and that signal thereafter decays on lead 163 so that OR 158 is no longer gated from that source. At the time the signal on lead 163 becomes ineffective, the arriving car has cancelled the "LOBBY UP HALL CALL MEMORY IS ON" signal on lead 153 whereby inverter 154 develops an enable signal on lead 155.

The arriving car with other calls is not available for queue service and therefore does not have a signal on lead 46 which will gate OR 158. OR 158 is therefore inhibited after cancellation of the lobby up hall call to gate AND 146 and set flip flop 137.

If the car arrives with no further service requirements it becomes a free car. It will have no up destination direction signal on lead 152 at the time of arrival and AND 146 will be inhibited by the absence of that signal. If a queue car is present at this time the car remains at the lobby as a free car available for allotment since the flip flop 137 is not set due to the absence of both an up destination direction signal on lead 152 and the presence of a car is available for queue service signal on lead 46. Allotment to the car of a call for a floor spaced from the queue floor in a direction opposite the queue service direction will not set the queue memory even though such allotment removes the car from the "available for queue service" status since the proper destination signal is not developed on lead 152. Thus a queue call can be allotted to such a car in the event the car currently in queue

status is released therefrom, as by a command registered by an entering passenger for a floor in the service direction opposite the queue service. The car then can run downward from the lobby to its call and then return to the lobby in response to its allotted queue call.

Release of the queue car with a free car present at the queue floor results in the allotment of the queue call to the free car as the car best situated to provide queue service. Upon acceptance of queue status by the formerly free car its destination direction is set to the queue service direction, as on lead 152, and the queue call is cancelled, on lead 153 to place an enable signal on lead 155. The queue memory control is thereby cocked and held ready to be gated by the removal of the signal on lead 46 when the car is released from queue status.

The time delay 157 avoids malfunctions in the gating of AND 146 due to a race between the signals on lead 153 and the termination of the gating of OR 158, particularly by the cancellation of the signal on lead 46. A car arriving at the lobby with no further calls at a time when no car is in queue status can both cancel the lobby up hall call and become available for queue status. Such a car should enter queue status and therefore should not set flip flop 137 until it is released from queue status. Following the decay of the signal on lead 163, OR 158 will be inhibited unless there is an overlap of a signal on lead 46 with that on 163. Such a signal cannot be issued by AND 31 of FIG. 2 until the queue call for the car has been cancelled to cancel the "UP DEMAND AT LOBBY" signal on lead 41. This signal is cancelled at the same time the "LOBBY UP HALL CALL MEMORY IS ON" signal on lead 153 is cancelled. If the signal on lead 153 was cancelled before the "CAR B IS AVAILABLE FOR QUEUE SERVICE" signal gated OR 158, AND 146 would be gated to set flip flop 137 thereby preventing the introduction of the car to queue service. However by delaying the effect of the termination of the signal on lead 153, through the delay of the R-C time delay 157, the inverter retains the inhibiting signal on lead 155 to AND 146 until the "CAR B IS AVAILABLE FOR QUEUE SERVICE" signal is set on lead 46 and OR 158 is gated. This retains an inhibit on the AND 146 and thus prevents the setting of the flip flop 137 while the car is in queue status.

A lobby queue memory is not set for a queue car until it is released from queue status. Such release for a car in group service with its M-G set operating is accomplished by a car call registered in the car or by a demand allotted to the car to gate OR 45 at lead 43 or 44, or by a down demand allotted to the car for the lobby at lead 42 (at this time no up demand can be registered at the lobby). While the car is in queue status the signal on lead 46 inhibits AND 146. Removal of that signal gates AND 146 since a lobby queue car has its up destination direction set and no lobby up hall call memory is on so that enable signals are present on each of leads 151, 152 and 155.

As discussed with respect to FIG. 2, a "DOOR CLOSE REQUEST" on lead 34 terminates the availability of a car for queue service by inhibiting AND 31. Such a signal precedes the shutdown of the car's M-G set where that car has been dormant for an M-G shutdown interval, as discussed with respect to FIG. 3. The closing of the doors permits the M-G set to be shut down by resetting flip flop 123. Termination of the "START M-G SET" signal at lead 124 as applied from flip flop 123 to inverter 164 will apply a gating signal to OR 148 which will reset the queue memory flip flops 137 and 138.

Thereafter the car is allotted calls as a car having its M-G set shutdown. Allotment of a lobby hall call to a car at the lobby results in the setting of flip flop 123 and the start of the car's M-G set. Once the car's set is started, its doors are open to provide queue service. An M-G start signal is employed to inhibit the gating of AND 146 until the car has an opportunity to open its doors in response to the allotted call. Thus the allotted call is cancelled when the M-G set of the car comes up to speed (by means not

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shown) to place an enable signal on lead 155 so that AND 146 is inhibited only by OR 158 if the car is admitted to queue status and a signal is applied at 46. The time delay of the signal on 124 as pulse coupled through capacitance 165 to lead 166 and OR 158 is sufficient to permit the setting of the signal on lead 46 by the starting car if it is to be admitted to queue status.

Functions corresponding to those of the lobby queue memory are performed by the sixth floor queue memory. Flip flop 138 corresponds to flip flop 137 in that it is set for each car at the sixth floor having a "DESTINATION DIRECTION IS DOWN" signal on lead 167 at the time the car arrives at the sixth floor if it is not available for sixth floor queue service. AND 168 corresponds to AND 146 in that it is gated when the "SIXTH DOWN HALL CALL MEMORY IS ON" signal at 169 is absent to apply a signal at 171; the car is at the sixth floor to apply a signal at 172; a signal is present at 167; and OR 173 is not gated by the initial arrival of the car signaled from lead 172 through capacitance 174 to lead 175 by the initial start of the car's M-G set as signaled on lead 166, or by the availability of the car for sixth floor queue service to impose a signal on lead 176. When a car is at the sixth floor and is conditioned to depart that floor in the down direction, flip flop 138 is set to inhibit allotment of sixth floor down calls, to inhibit reopening of the car doors by hall call reregistration and to inhibit maintenance of hall lantern after a car start signal is issued. Release of sixth floor queue status is one technique of setting the flip flop 138, as is the arrival of a car having further down service to perform, or the allotment of further down service to a car parked at the sixth floor. A car having an up destination direction at the sixth floor has no effect on the queue memory since no signal appears on lead 167.

The sequences at the sixth floor in the sixth floor queue memory are controlled as for the lobby queue memory by capacitances 165 and 174 and time delay 177 supplied from power boost 178 and feeding inverter 179. Inverter 181 corresponds to 159 in its treatment of signals from OR 173.

When flip flop 138 is set, its signal on lead 182 gates AND 183 on lead 184 to OR 136 to issue a "INHIBIT ALLOTMENT TO THIS CAR" signal at lead 92 when the "SIXTH FLOOR IS ALLOTMENT FLOOR" signal is applied by the call finder (not shown) to lead 185. The signal on lead 182 inhibits direct allotment to a sixth floor queue call by setting inverter 186 to issue a negative "SIXTH QUEUE INHIBIT" signal on lead 187 to the sixth floor demand memory of the car which corresponds to the "inhibit down demand" signal input of the second floor demand memory shown in FIG. 5.

Reset of the queue memory flip flops occurs when the car is issued a signal to start it from the queue floor for a car in normal group service having its M-G set running. Such a start signal is derived from the car control when the car door interlocks (not shown) are made up preparatory to the running of the car (by means not shown) and is signaled on lead 188 to gate queue memory reset OR 148. If a car has additional service required in the destination direction of the queue service while at the queue floor and has the demands which represent that additional service cancelled, as by other cars stopping in response to car calls to cancel the hall calls of the demands, the car can become a free car and lose its destination direction (by means not shown). When it becomes a free car, a signal is issued by the car control to lead 189 feeding OR 148. Thus the queue memories are reset by a signal on lead 149 each time a car start signal is issued, each time a car becomes a free car, and whenever the car's M-G set is shut down.

As disclosed in United States patent application Ser. No. 610,664 filed herewith for "Backup Controls for Plural Car Elevator System" in the names of Richard C. Loshbough and Gerald D. Robaszkievicz, the system advantageously includes the feature of cancelling hall calls

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and demands as the car stops at the floor thereof and of responding to a reregistered hall call by retarding the closing or reopening the partially closed car door. Under these conditions the hall lantern for the car is lighted until the car doors are nearly closed so that a late arriving passenger can know if the car about to depart will travel toward his destination. At the queue floors this feature is negated since the artificially registered queue calls could cause a lockup of the queue car. With the feature cut out the complementary hall lantern operation is also cut out. Accordingly, a queue floor hall lantern inhibit memory is provided to inhibit the hall lantern after a door close signal has been issued when the car is at a queue floor and is set to travel in the queue service direction.

When a car stops for a queue call or is stopped at a queue floor with a destination direction of the queue service direction, its queue memory flip flop 137 or 138 issues a signal which is passed on leads 191 or 192 to OR 193. Gated OR 193 enables the flip flop 194 of the queue floor hall lantern inhibit by enabling AND 195 with a signal on lead 196. AND 195 provides the set input to flip flop 194 when gated by a "DOOR CLOSE SIGNAL IS ON" signal on lead 197 from the car control (not shown). This signal is issued at the moment the door closing control sequence is initiated.

The setting of flip flop 194 inhibits the hall lantern controlling AND's 198 and 199 to terminate their enabling signals to the up and down hall lantern controls (not shown). A hall lantern is lighted at a floor by a coincidence of the car's presence at the floor and the gated condition of AND 198 for an "up lantern" or AND 199 for a "down lantern" (by means not shown). AND 198 is gated by a coincidence of a "DESTINATION DIRECTION IS UP" signal from lead 152 to lead 201, a "NO QUEUE FLOOR HALL LANTERN INHIBIT" signal from inverter 202 to lead 203 when flip flop 194 is reset, and a "CAR IS IN GROUP SERVICE" signal on lead 204 from the car control (not shown). Similarly AND 199 is gated for a down lantern when the car is in group service and has no queue floor hall lantern inhibit by signals on leads 204 and 203 and when the car has a "DESTINATION DIRECTION IS DOWN" signal from lead 167 to lead 205.

At the moment the stop interval of the car is terminated, and a door close signal is applied, flip flop 194 is set to inhibit AND's 198 and 199 by the removal of the enable signal from inverter 202. This condition is sustained even though the doors of the car may be held or reopened, as by well known door safety means.

When the car doors are fully closed and the door interlocks (not shown) make up, a "CAR START" signal is applied to the hoist equipment. This signal as applied at lead 188 for resetting the queue memories is also employed at least 206 to reset the flip flop 194 of the queue floor hall lantern inhibit memory. Thus normal hall lantern operation is restored for the car and is retained until the car is again at a queue floor.

FIG. 5 shows the demand memory circuits for a typical floor and a typical car. A circuit of this form is provided for each floor for each car serving that floor. For discussion the demand memory will be treated as that for the second or lobby floor for car B.

In general an assigned hall call is stored in the demand memory of the car to which it is assigned by the allotter through AND 211 for an up call and AND 212 for a down call. The call finder identifies the allotment floor to all demand memories on lead 213 and the allotter identifies the car chosen and the direction of the hall call on lead 214 for an up call and 215 for a down call. When the hall call floor and service direction correspond to the floor of a car call in a car traveling in the service direction, a direct allotment of the hall call to that car is performed by the call finder on lead 216 to AND 217 for an up call and lead 218 to AND 219

for a down call. A car standing at a floor receives the allotment of a hall call for that floor directly through AND 221 for an up demand and AND 222 for a down demand. Such a car's presence is indicated from its lead position generator on lead 223, and its capacity to accept demands is indicated by a "DOOR NOT CLOSED" signal from its door controls (not shown) on lead 224 and a "M-G SET RUN" signal from its motor-generator set controls (not shown) on lead 225 each of which must be coincident on AND 221 or 222 to gate an up demand from an up hall call on lead 226 to a car having an up destination direction on lead 227 or a down demand from a down hall call on lead 228 to a car having a down destination direction on lead 229.

Each of AND's 211, 217 and 221 is capable of setting up demand memory flip flop 231 by gating OR 232. However, each is also subject to the further constraints that the car must be in group service as indicated by a signal on lead 233 and no "INHIBIT UP DEMAND" signal in the form of a negative signal on lead 234 should be imposed. In like fashion AND's 212, 219 and 222 set down demand memory flip flop 235 through OR 236 only if the group service signal is imposed on lead 233 and no "INHIBIT DOWN DEMAND" signal is present on lead 237. The inhibit signal to lead 234 is the "LOBBY QUEUE INHIBIT" of lead 145 in FIG. 4 for the second up demand memory. For the sixth floor down demand memory the "SIXTH QUEUE INHIBIT" signal of lead 187 in FIG. 4 is applied to the lead corresponding to lead 237. As will be described with respect to FIG. 6 these demand inhibit inputs for the demand memories for floors other than queue floors can be arranged to perform the inhibiting functions when additional service is indicated as desirable at a floor at which a car is located by preventing direct call finder allotment by AND's 217 or 219 or direct allotment by AND's 221 or 222 to the car at the floor.

Each demand memory flip flop, when set, issues a signal indicating the registration of the demand as at leads 41 and 42. It also indicates and identifies the car's capacity to serve the demand by gating AND 238 to issue through isolating rectifier 239 a "TWO UP DEMAND IN THIS CAR" to the call finder at lead 241 when there is coincidence with a group service signal on lead 233 for the car and the car has no hall call bypass signal on lead 242. A "BYPASS HALL CALLS" signal on lead 243 inverted by inverter 244 inhibits AND 238 and its corresponding down hall call AND 245.

Reset of the demand memories is by reset of the flip flop as 231 or 235. Such reset occurs as the demand is answered by the car or another car by gating AND 246 for an up demand and AND 247 for a down demand. These AND's are also subject to the requirement that the car be in group service by an input from lead 233 and that no inhibit demand signal be present on lead 234 or 237 for up and down demands respectively. The signal gated by the reset AND's 246 and 247 is connected to a reset input for the corresponding hall call from every car's demand for the floor and service direction and is isolated to avoid cross coupling by diodes 248. An up demand memory is reset by gating AND 246 when the car is at the floor as indicated at lead 223, has an up destination direction at lead 227, has no door close request on lead 249 from inverter 251 and is gated an up demand reset on lead 252. The reset signal is issued by the door control (not shown) when the car is set to stop, has an up logic direction, and is issued a door open signal at a floor for which an up demand memory is set. Corresponding down memory reset signals are applied to AND 247 from gate down demand reset input 253 and leads 229, 249, 223, 233 and 237.

The reset signal from AND 246 is passed to AND 254 which is gated if the car is in group service and has a signal on lead 233 and to a corresponding AND of every other car in group service over the "RESET TWO UP HALL CALL" lead 255. AND 254 gates OR 256 to lead

257 and the reset input of flip flop 231. It also is interlocked with the demand memory setting AND's 211, 217 and 221 on lead 258 so that a reset inhibits a set by inverter 259 applying an inhibit signal on lead 258 to those AND's. When an "INHIBIT UP DEMAND" signal is applied, it also inhibits demand reset AND 246 to preclude the cross connected reset of other demand memories through lead 255. Thus another car can have its demand memory for a queue call set and can initiate its response to the queue call while a car is serving the queue landing in the queue service direction.

Similar reset, cross connection and inhibiting functions are provided for each down demand memory by lead 261 applying a "RESET TWO DOWN HALL CALL" signal to the other two down demand memory reset AND's 262 to gate reset OR 263 over lead 264 to flip flop 235 reset input and to inverter 265 to the reset inhibit lead 266 to AND's 212, 219 and 222.

Queue service can also be provided at any floor where a tendency for prospective passengers to queue up is sensed. One mode of providing such service is to sense the loading of a car to a level near its capacity as by load weighing, passenger count, or the extension of the door open interval beyond a given limit. If the overload option is in effect and the overload sensed, a signal is issued to automatically register a hall call for the floor at which the overloaded car is stopped and for the destination direction of the overloaded car. The call finder scan is thereby initiated to identify the floor and direction as an allotment call in the manner of a manually registered hall call or a lobby queue call. The allotter is reset and preset to the allotment call by the call finder and causes the car best situated to serve the call to be allotted the call. At this time the overloaded car currently serving the call continues loading without inhibiting the allotter and while barred from allotment and reset of the resultant demand. The arrangement when triggered by an eighty percent loading permits the car to continue loading up to capacity while another car is at least set to proceed to the floor and in many instances arrives at the floor to serve any passengers which would otherwise be left to reregister a hall call manually after the closing of the doors of the overloaded car and await the arrival of a car.

Automatic registration of a hall call in response to the stop of an overloaded car for a command is avoided in the example of FIG. 6 by enabling the circuits for hall call insertion only when a car is stopped for a hall call and is not overloaded. However, the feature of avoiding allocation of a reregistered hall call to an overloaded car at the floor can be utilized to advantage without this enabling means. Thus, the system can be arranged to permit manual registration of a hall call which is allotted to a car other than the overloaded car at the landing while that overloaded car continues to load.

The equipment shown in FIG. 6 is typical of that for one car to provide the overload queue operation in cooperation with the allotter elements of FIG. 3 and the demand memory of FIG. 5. This equipment is operative only when the "OVERLOAD OPTION" is in effect by imposing a signal on lead 271 to enable AND 272. Such an enabling signal can be derived from a manual switch (not shown). When the car is loaded to eighty percent of rated capacity, a signal is imposed on lead 273 (as by a load switch) to gate AND 272 and enable the demand memory inhibit and allotter inhibit functions for the overloaded car which permit supplemental service to the floor while the overloaded car is present.

Consider first the system which enables manual registration of a hall call to set a second car to travel to the floor while a first car which is overloaded continues to receive passengers. Under these circumstances the ganged switch 270 is in the position shown to connect an enabling ground to each of the AND's of the family which issue inhibiting signals for the overloaded car. The overloaded

car at the floor permits manual registration of a hall call for the floor and service direction of the car to be effective on another car by inhibiting the direct allotment of the hall call to the overloaded car and by inhibiting the allotter for the overloaded car.

When a car stopped at a floor is overloaded, it gates its AND 272 to issue an "EIGHTY PERCENT OVERLOAD OPTION" signal on lead 274. If a prospective passenger thereafter registers a hall call at that floor, the call will be allotted to another car and that car will be set to run to the floor even while the overloaded car is receiving its final twenty percent of its capacity load.

The hall call registered by the prospective passenger is processed through the call finder and allotter since it is barred from direct allotment to the overloaded car. Consider, for example, the car of the circuit of FIG. 6 stopped at floor twelve to impose a signal on lead 275. Assume that car is set for down travel so a "DESTINATION DIRECTION IS DOWN" signal is present on lead 276. If switch 270 is in the position shown so that blade 270-1 is grounded, AND 277 is enabled by the ground on lead 280. When the car is overloaded and its eighty percent overload option in effect, a signal is imposed on lead 274. A coincidence of these signals gates the car's load actuated, twelfth floor, down hall call AND 277 to lead 278 and inverter 279 which issues an "INHIBIT CAR'S TWELVE DOWN DEMAND MEMORY" signal on lead 281. Lead 281 is coupled to the inhibit lead of the car's twelfth floor down demand memory circuits which corresponds to lead 237 of FIG. 5. Thus the AND's for the twelfth floor down demand memory corresponding to AND's 212, 219, 222 and 247 of FIG. 5 are all inhibited to prevent direct allotment of a manually registered twelve down hall call to the overloaded car and to prevent the response of the overloaded car resetting the twelfth floor down hall call memory of the system and resetting the twelfth floor down demand memory for other cars by a signal from the lead corresponding to lead 261.

The gated signal "EIGHTY PERCENT OVERLOAD OPTION" on lead 274 for the overloaded car inhibits allotment to that car by gating OR 94 of FIG. 3 to inverter 95 which then issues an inhibit to AND 89 to prevent issuance of a "CAR B IS CHOSEN FOR ALLOTMENT" signal at lead 91. Thus allotment of a manually registered call is accomplished without regard to the overloaded car since even if the ramp signal achieved its allotting relationship with the waiting time voltage for the overloaded car to cause its flip flop 87 to be set, no ramp inhibit signal would issue since the car could not be chosen. Therefore, the ramp generator will continue to develop the ramp signal even though that signal exceeds that level necessary to trigger comparator 84 and set the flip flop 87 until it reaches an allotting relationship with the waiting time voltage of another car. In the proper allotter sequence the ramp therefore increases until its first encounter of a comparator having a waiting time voltage of the ramp level other than the comparator of the overloaded car, and it stops upon choice of that car as the car having the optimum service capability to the allotment floor, the floor at which the overloaded car is stopped.

Thus an overloaded car at a landing is treated in the supervisory system as though it were out of service. A manually registered hall call can therefore be allotted by the normal hall call processing of the call finder and allotter to the car best situated to serve that call. The presence of the overloaded car inhibits the usual operations which prevent allocation of a call for that floor to another car and which cause that call to be allocated to the car at the floor. It is to be appreciated that if only the manual registration of calls is to be considered, the AND's issuing the inhibit signals can be provided with but three of the four inputs shown in FIG. 6 and the input through switch 270 can be eliminated. Thus AND 277 need not have input lead 280 for such an arrangement.

Next consider the operation of the overload queue circuit of FIG. 6 with the switch 270 in its alternative position to establish the automatic insertion of a hall call in response to an overloaded car stopped to serve a hall call. The presence of a hall call at the floor is signified by a signal from the hall call memory (not shown) of the system. Each car receives a signal as for a twelfth floor down hall call on lead 282. In the case of the car of FIG. 6 assume that it approaches the twelfth floor without an overload so that no signal appears at 274. When the car is not subjected to an eighty percent overload inverter 283 issues an enabling signal through blade 270-2 of switch 270 to lead 284 to each of the AND's 285, 286, 287, 288 and 289. These AND's each set a respective flip flop 291, 292, 293, 294 and 295 which provides a memory for a car not loaded to eighty percent for each floor and service direction for which a hall call is registered. These memories are reset each time the car is started since the car start signal from the car control applied to lead 188 of FIG. 4 is also applied through that lead to reset each flip flop.

The flip flops 291 to 295 have their set outputs substituted for the grounds as enabling signals to the AND's which develop the inhibit demand memory signals. In the case of AND 277, the lead 280 is coupled to lead 296 of the set output of flip flop 293 by means of blade 270-1 of switch 270. Thus with the AND's 285 to 289 enabled by switch 270 at blade 270-2 each of the flip flops 291 to 295 is effective through blades of the switch 270. In addition a coupling is provided by blades of switch 270 to insert a hall call automatically as from lead 278 for the twelfth floor down hall call through blade 270-3 to lead 297 which is coupled to the twelfth floor down hall call memory to actuate that memory in the manner of a manually registered call.

Consider switch 270 in its alternative position to that shown. Further consider a twelfth floor down hall call to be registered when a car which is not overloaded approaches the twelfth floor. The down hall call imposes a signal on lead 282 for the approaching car and since it is not overloaded its lack of a signal on lead 274 imposes an enabling signal on lead 284 to gate AND 287. AND 287 sets flip flop 293 to issue an enable signal on lead 280 to AND 277 which is maintained until the car is started and a reset is applied to flip flop 293 from lead 188. While the car is loading for down service from floor twelve a signal is also present on the inputs 275 and 276 so that AND 277 needs only a signal on lead 274 to be gated. If the car is loaded to eighty percent of capacity to gate AND 272, a signal on lead 274 gates AND 277 to inhibit the overloaded car's twelve down demand memory at lead 281 while inserting a twelve down hall call at lead 297 through switch blade 270-3. The signal on lead 281 functions as described to inhibit the overloaded car's demand memory circuits. The signal on lead 297 actuates the hall call memory to actuate the call finder and allotter. The signal on lead 274 inhibits allotment by the allotter to the overloaded car as described. A new car receives the allotment of the automatically inserted twelfth floor down hall call and that car ultimately serves the call.

It is to be appreciated that the circuits of FIG. 6 are duplicated for each car. Further while circuits for only three floors are shown, additional floors have duplicate circuits which are interconnected through the discontinuous leads extending downward from the bottom of the drawing.

The controls of FIG. 6 initiate the service of a second car to the overload queue floor while the first car remains at the floor. This is set up through hall call circuit controls and allotter functions which in the absence of the queue functions would exclude the second car and the allotment of a call until the car serving the floor had closed its doors. In this manner service to the queue of prospective passengers is expedited and the overall service of the system is enhanced.

In recapitulation of this invention, it is to be noted that it presents three aspects of control to provide preferential service. It calls a car to a floor even though another car is present at the floor when it anticipates that a queue of passengers will develop at the floor. It permits the car to enter queue status, whereby it remains at the floor an indeterminate interval, only if the car is unencumbered by other calls for service. A car in queue status is released from a queue floor only by the registration of a car call therein or by the allotment of a hall call to the car. Such allotment will occur only after conditions have been imposed which indicate other cars burdened by their service requirements beyond a limit.

The system affords each of these features when integrated in the controls of the aforementioned Hall et al. patent applications wherein hall calls which are manually registered are selected individually for assignment to individual cars. Such systems employ an allotter to evaluate the capability of the cars to serve the call under consideration and to identify a car which either meets a certain minimum capability to serve the call or has the optimum capability to serve the call.

Queue service is established in such a system by automatically registering a queue call as a hall call so that it is selected by a call finder and allotted to but one car on the same basis as a manually registered call. Such automatic queue call registration has been shown for floors where the development of queues tends to occur whenever the system traffic is active, as at a lobby or floor of a meeting hall, by imposing such call whenever conditions indicate that no car will remain at the floor or is present at the floor. Thus a queue call is inserted for the lobby by gating AND 69 of FIG. 2 when no car is available for queue service to gate its AND as 47. Further a car is available for queue service only when it is at the queue floor with no car calls or assigned hall calls so that AND 31 is gated and it is set for a destination direction corresponding to the queue service for the floor, as an up destination for an up lobby queue call. The allotter concept of individual association of hall call with car imposes the queue call on but one car and is complemented by a mutually exclusive interlock of queue cars such that the AND's 47 and 51 for each car can be gated only individually for a given queue call. A queue call for a floor can therefore be imposed on but one car at any instant and is reimposed on the system for allotment at the time queue status is released by a car.

Queue calls are inhibited when any down hall call is registered for an excessive interval of time as in the manner disclosed in the United States patent application Ser. No. 610,576 for "Elevator Control Providing Preferred Service to Hall Calls Registered for A Long Time," filed herewith in the names of Donivan L. Hall, James H. Kuzara and Orval J. Martin. OR 52 is gated to inhibit AND 69 for these long wait calls.

Queue calls are inhibited when no car has its hoist equipment energized to gate OR 74. In the case of queue calls of secondary importance as the down sixth floor queue call, an AND can be substituted for OR 74 to require a plurality of cars to have their hoist equipment energized as a prerequisite to automatic registration of a queue call.

Another form of automatic queue call registration is shown in FIG. 6 as a means responsive to a condition indicative of an accumulation of prospective passengers at a floor for which a queue call is to be registered. A car when stopped at a floor and loaded to a given level reregisters a hall call to which any other car can be responsive. This starts another car toward the floor or at least sets another car to serve the floor while the loaded car is loaded further and prepared to leave the floor.

Queue calls are registered automatically without disrupting the operation of cars other than the car assigned queue service. That is, the allotter assigns only one car

to a queue call. Other cars at the queue floor are free to run from that floor while the queue call remains imposed even though those cars normally accept for service, bar other cars and cancel manually registered calls at the floors where they are stopped. Thus the direct allotment of the queue call to a car present at the queue floor and conditioned to depart therefrom, as the overloaded car which actuated the queue call, or a car at the lobby having other calls to serve, is prevented and the call is assigned to another car which then seeks to serve that call. In particular the car which set up the queue call, was released from lobby queue status, or was set to depart from the queue floor inhibits its own allotment of a hall call while the queue call is being allotted by the allotter and inhibits direct assignment of the queue call.

A car having a queue call assignment at a floor which has traffic dictating continuous queue service is admitted to queue status at the floor only when it has no further service requirements. This is indicated by gating its AND of the group 47 to 51 to inhibit issuance of a queue call. This avoids disrupting normal service where additional manually registered hall calls are allotted the car to which the queue call is allotted since that car runs to the queue floor, it cancels the queue call, and after a stop interval of the same type as for a manually registered hall call, it runs to its additional calls. Upon cancellation of the queue call assignment a new queue call is automatically registered and allotted to another car.

If the car arrives at the queue floor and has no other service required, it is admitted to a queue status. Thereafter it tends to be held at the floor since it can be caused to travel therefrom only in response to calls imposed upon it to gate OR 45. Car calls registered by passengers entering from the queue floor will release the car from queue status. Hall calls must be allotted as demands by operation of the queue car's comparator 84 and memory 87 to gate AND 89. The car's queue status imposes a bias on the allotter tending to cause hall calls to be allotted to other cars. The bias is applied from buffer amplifier 98 or 102 to be summed with the other signals on lead 81 which represent the car's ability to serve the call subject to allotment. Thus the queue car appears to the allotter to have a poorer capability to serve allotment calls than non-queue cars which may have a burden of several calls. The service tends to concentrate in the non-queue cars and thereby retain the queue cars at their queue floors.

Since much of the detail of the call finder, allotter, the command memories, and hall call registering means is disclosed in the aforementioned Hall et al. applications, these applications are incorporated herein by reference. Further since several aspects of this invention are applicable to other types of supervisory controls for elevators, it is to be understood that such utilization of this system is contemplated.

It is to be understood that this invention lends itself to various modifications and combinations and that the present disclosure is merely illustrative thereof and is not to be read in a limiting sense.

Having described the invention, we claim:

1. A control for an elevator system having a plurality of cars serving a plurality of floors comprising means for manually registering calls common to said plurality of cars, means for automatically registering calls common to said plurality of cars, means for allotting each registered call common to said plurality of cars to one of said plurality of cars, means for registering car calls individual to each of said plurality of cars, means for selecting registered calls common to said plurality of cars individually, means for assigning a service delay factor to each of said plurality of cars as a function of service requirements imposed on said car including the number of registered calls allotted to said car and the number of car calls registered individual to said car, means for evaluating the service delay factor for each of

said plurality of cars for each selected call, and control means for said allotting means for allotting each selected call individually to that car having the least service delay factor for said call to service said call.

2. A control according to claim 1 including queue status means for each car for identifying as a queue status car that car located at a given floor, set for a given travel direction, and having no calls to be served; and means for each car responsive to said queue status means for imposing a service delay factor bias on said allotting means for said car indicating a capability to serve each call of less than a predetermined level whereby said allotting means tends to allot hall calls to cars other than said car.

3. A control according to claim 1 including demand memory means for each car for storing individually for said car calls common to said cars allotted said car by said allotting means; means for setting said demand memory means for a car in response to the registration of a call common to said plurality of cars for a floor at which said car is located; and means responsive to the presence of said car at the floor for which a call has been registered by said automatic means for inhibiting said setting means, provided said car has a car call or an allotted call for other than said floor.

4. A control for an elevator system having a plurality of cars serving a plurality of floors comprising a demand memory for each car for each floor and for each service direction from said floor for storing the assignment between a hall call for a given floor and service direction and a car comprising, a flip flop; means to set said flip flop in response to a coincidence of an identified registered hall call for the floor and service direction of said demand memory and a car identified as in the optimum condition to serve said call; means to set said flip flop in response to the coincidence of a registered hall call for the floor and service direction of said demand memory, the presence of a car at the landing of said demand memory, the setting of said car's destination as the service direction of said demand memory, and the open condition of the doors of said cars; and means to inhibit each of said flip flop setting means for said car when said car is at said floor of said demand memory.

5. A combination according to claim 4 including means for manually registering said hall calls; and means for automatically registering said hall calls; wherein said means to inhibit each of said flip flop setting means is responsive to the means for automatically registering a hall call for the service direction and floor of said demand memory.

6. A combination according to claim 4 including load responsive means for a car responsive to at least a predetermined loading of said car for actuating said inhibit means for said car.

7. A combination according to claim 6 including automatic hall call registering means for each of a plurality of floors responsive to the operation of said load responsive means for a car at one of said floors for automatically registering a hall call for said one floor.

8. A control according to claim 1 wherein said means for automatically registering calls registers a call for a given floor and a given service direction from said floor, and means for cancelling a call allotted to a car when said car is committed to serve the floor of said allotted call in the service direction of said call.

9. A control according to claim 8 including queue status means for each car to maintain said car accessible to passengers at said given floor and set for said given service direction of said means for automatically registering calls, and means to actuate said queue status

means for a given car when said car is committed to serve the floor of said allotted automatically registered call in the service direction of said call and has no car calls or allotted calls.

10. A control according to claim 9 wherein said means for automatically registering calls is actuated in response to the absence of a car having an actuated queue status means.

11. A control according to claim 9 including hoist equipment for each car, means to energize and deenergize the hoist equipment for each car, means responsive to the energization of the hoist equipment for at least two cars, and wherein said means for automatically registering calls is actuated in response to a coincidence of the response of said last-mentioned means and the absence of a car having an actuated queue status means.

12. A control according to claim 9 including means responsive to the registration of a manually registered call common to the cars for a given time interval, and means to release said queue status means in response to sensing registration of a call for said given time by said time means.

13. A control according to claim 1 including means to measure the time interval manually registered calls common to the car are registered, excessive call registration interval means responsive to said time means when a call is registered greater than a given interval, and means responsive to said excessive call registration interval means to inhibit said means for automatically registering calls.

14. A control according to claim 1 including queue status means for a given floor for each car for identifying as a queue status car a car located at a given floor, set for a given travel direction, and having no calls to be served, means for disabling said queue status means for a car having its queue status means actuated in response to a call for said car, and means effective for a time interval following the disabling of a queue status means for a car to disable the allotment of an automatically registered call for said given floor to said car.

15. A control according to claim 1 including queue status means for a given floor for each car for identifying as a queue status car a car located at a given floor, set for given travel direction, and having no calls to be served, means for disabling said queue status means for a car having its queue status means actuated in response to a call for said car, means to start said car from a floor, means to inhibit the allotment of an automatically registered call for said given floor to a car at said given floor and having said queue status disabling means actuated, and means to terminate said inhibit means in response to said start means for said car.

16. A combination according to claim 1 including means individual to each car responsive to a load on said car in excess of a predetermined level; and memory means for each car for each of a plurality of floors responsive to the arrival of said car at said floor with a load less than said predetermined level; said means to automatically register calls common to said plurality of cars being responsive for a given floor in response to the presence of a car at said floor, the operation of said memory means for said floor by said present car, and the response of said load means for said present car.

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UNITED STATES PATENTS

3,292,736 12/1966 Savino et al. 187—29

ORIS L. RADER, Primary Examiner

W. E. DUNCANSON, JR., Assistant Examiner

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,474,885 Dated October 28, 1969

Inventor(s) Donivan L. Hall, Orval J. Martin & Gerald D. Robaszkiewicz

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

- Column 2, line 6, the comma should be - - . - - .
- Column 4, line 16, "queque" should be - - queue - - ;
- line 17, "queque" should be - - queue - - .
- Column 6, line 33, "tubstantial" should be - - substantial - - ;
- line 39, "quene" should be - - queue - - .
- Column 7, line 35, "iesues" should be - - issues - - .
- Column 8, line 5, "cal" should be - - call - - .
- Column 16, line 55, "least" should be - - lead - - .
- Column 22, line 31, "aqueue" should be - - queue - - .
- Column 22, line 71, omit "delay".
- Column 23, line 4, "service" should be - - serve - - .
- line 46, "regisering" should be - - registering - - .

Signed and sealed this 9th day of April 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents