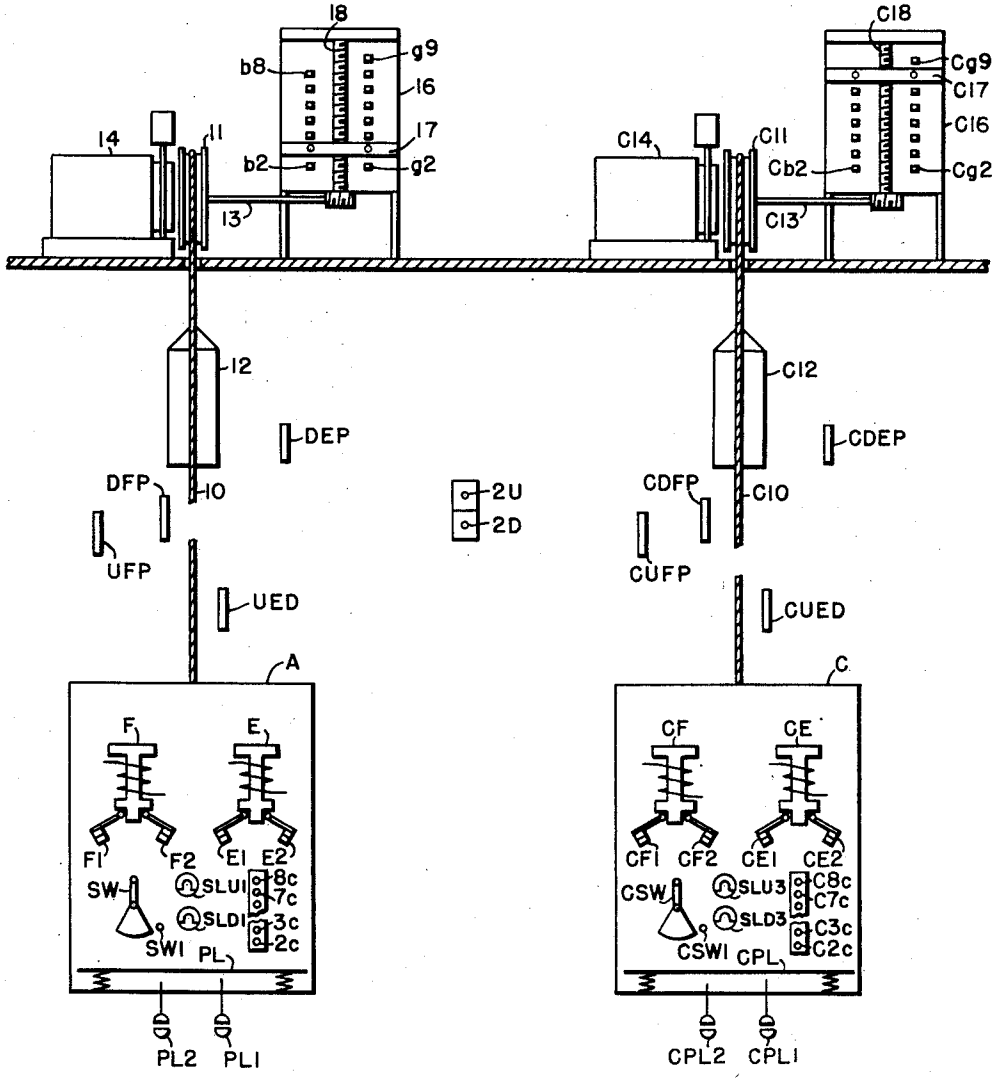
March 25, 1958 W. F. EAMES ET AL 2,827,981

ELEVATOR SYSTEMS

Filed Sept. 22, 1955 7 Sheets-Sheet 1

Fig. 1.



WITNESSES

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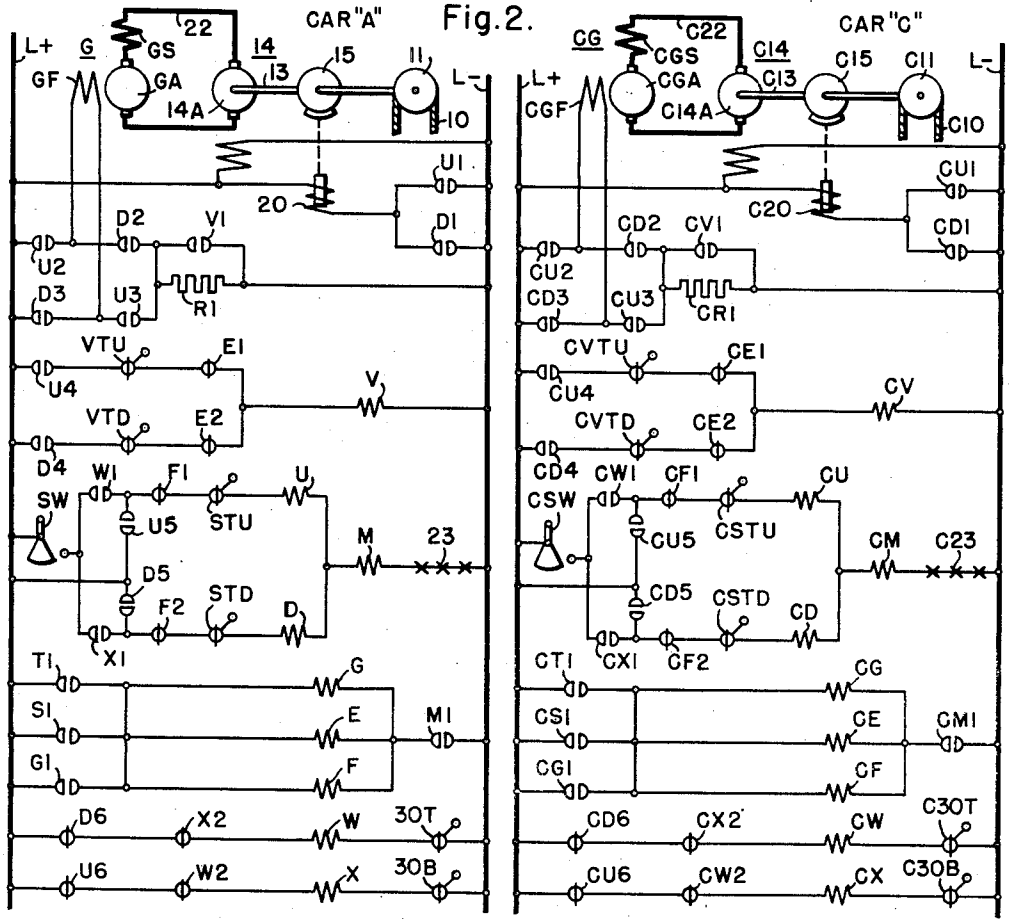
ATTORNEY

March 25, 1958 W. F. EAMES ET AL 2,827,981

ELEVATOR SYSTEMS

Filed Sept. 22, 1955 7 Sheets-Sheet 2

Fig.2.



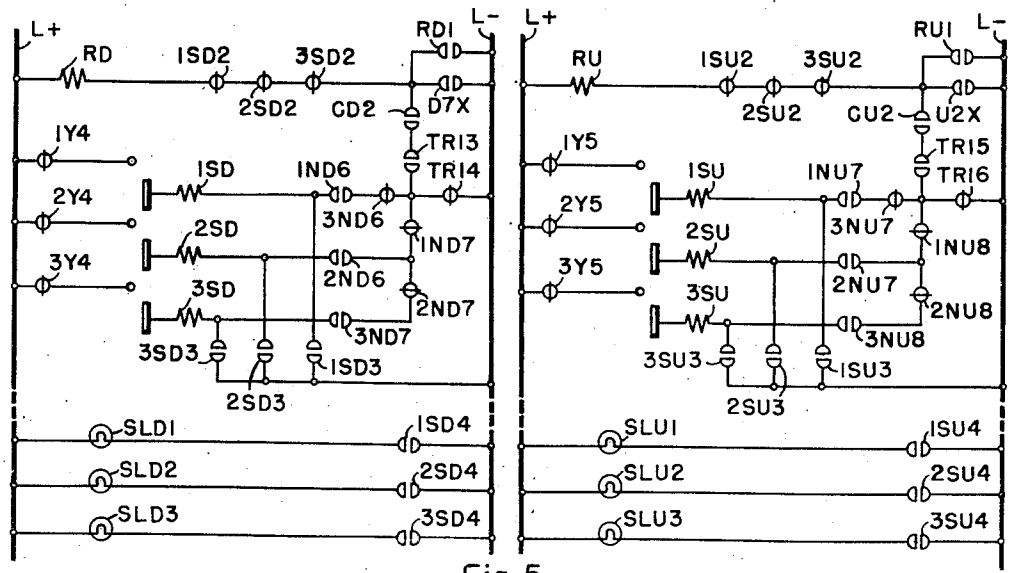


Fig.5.

March 25, 1958 W. F. EAMES ET AL 2,827,981

ELEVATOR SYSTEMS

Filed Sept. 22, 1955 7 Sheets-Sheet 3

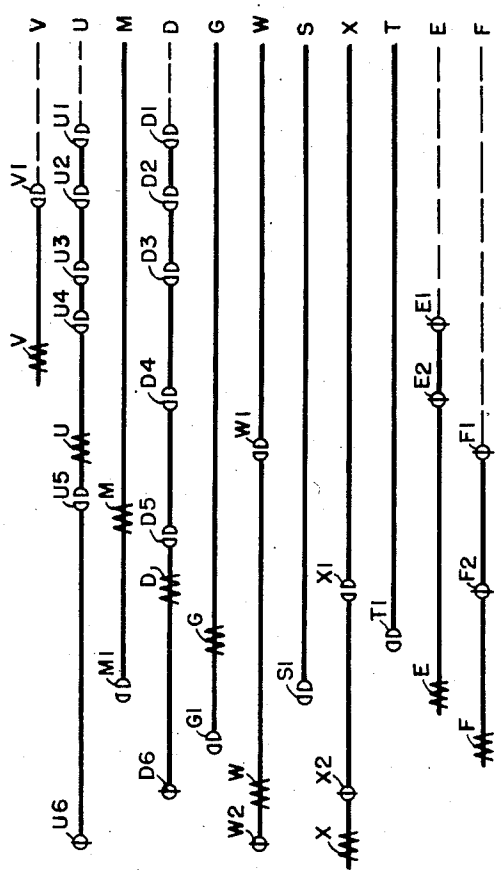
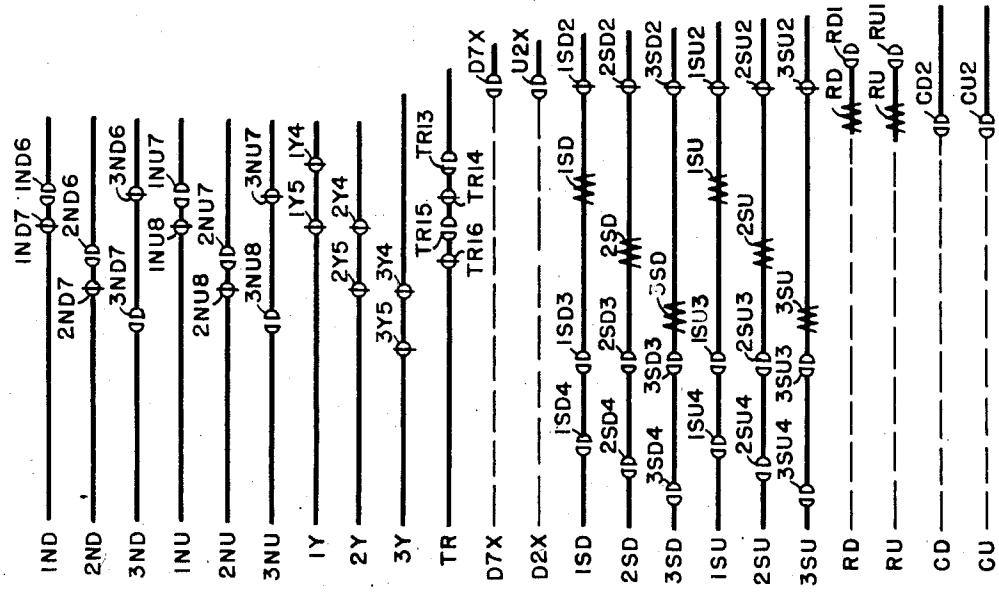


Fig. 2A.

Fig. 5A.



March 25, 1958 W. F. EAMES ET AL 2,827,981

ELEVATOR SYSTEMS

Filed Sept. 22, 1955 7 Sheets-Sheet 4

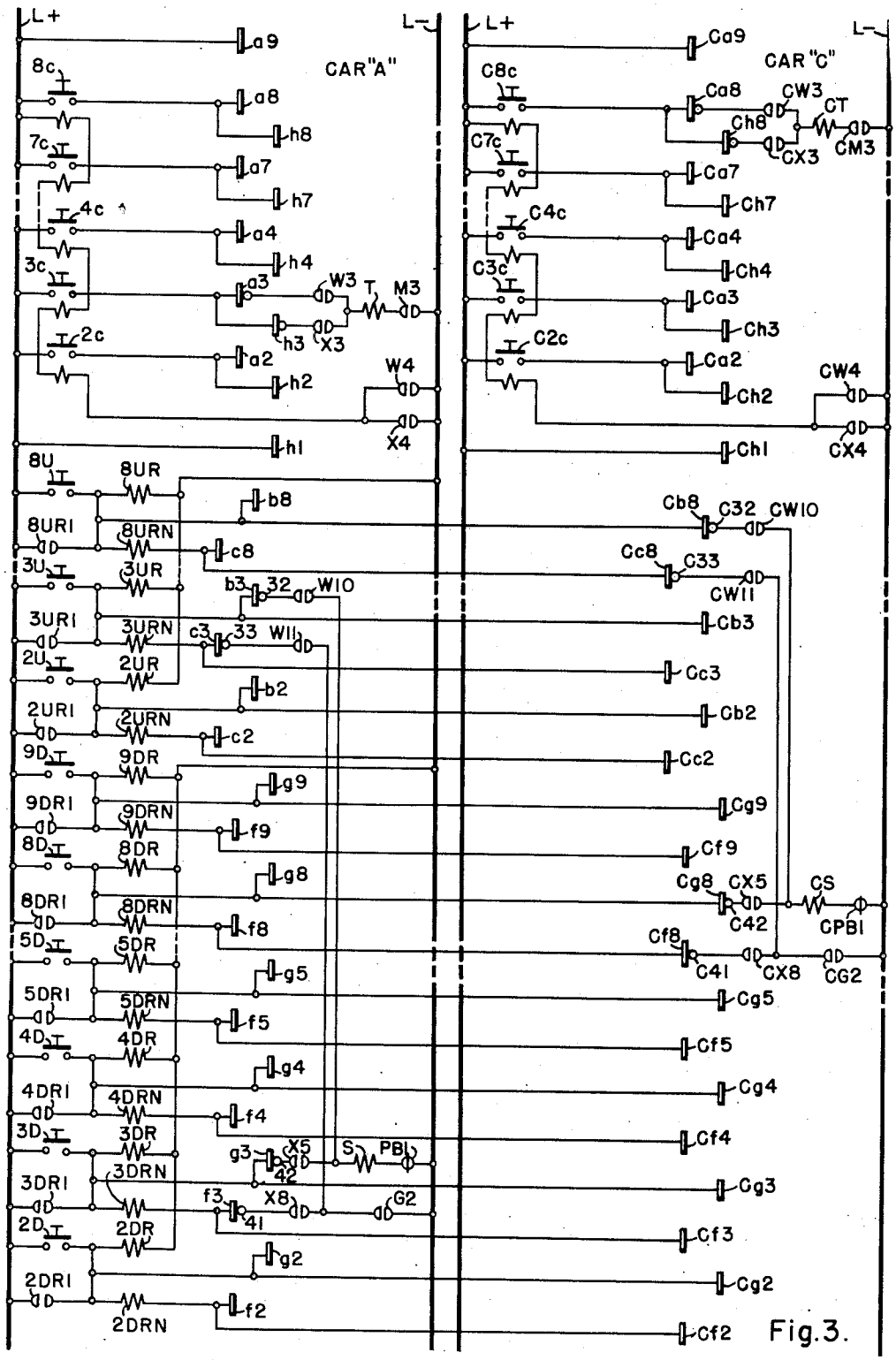


Fig.3.

March 25, 1958 W. F. EAMES ET AL 2,827,981

ELEVATOR SYSTEMS

Filed Sept. 22, 1955 7 Sheets-Sheet 5

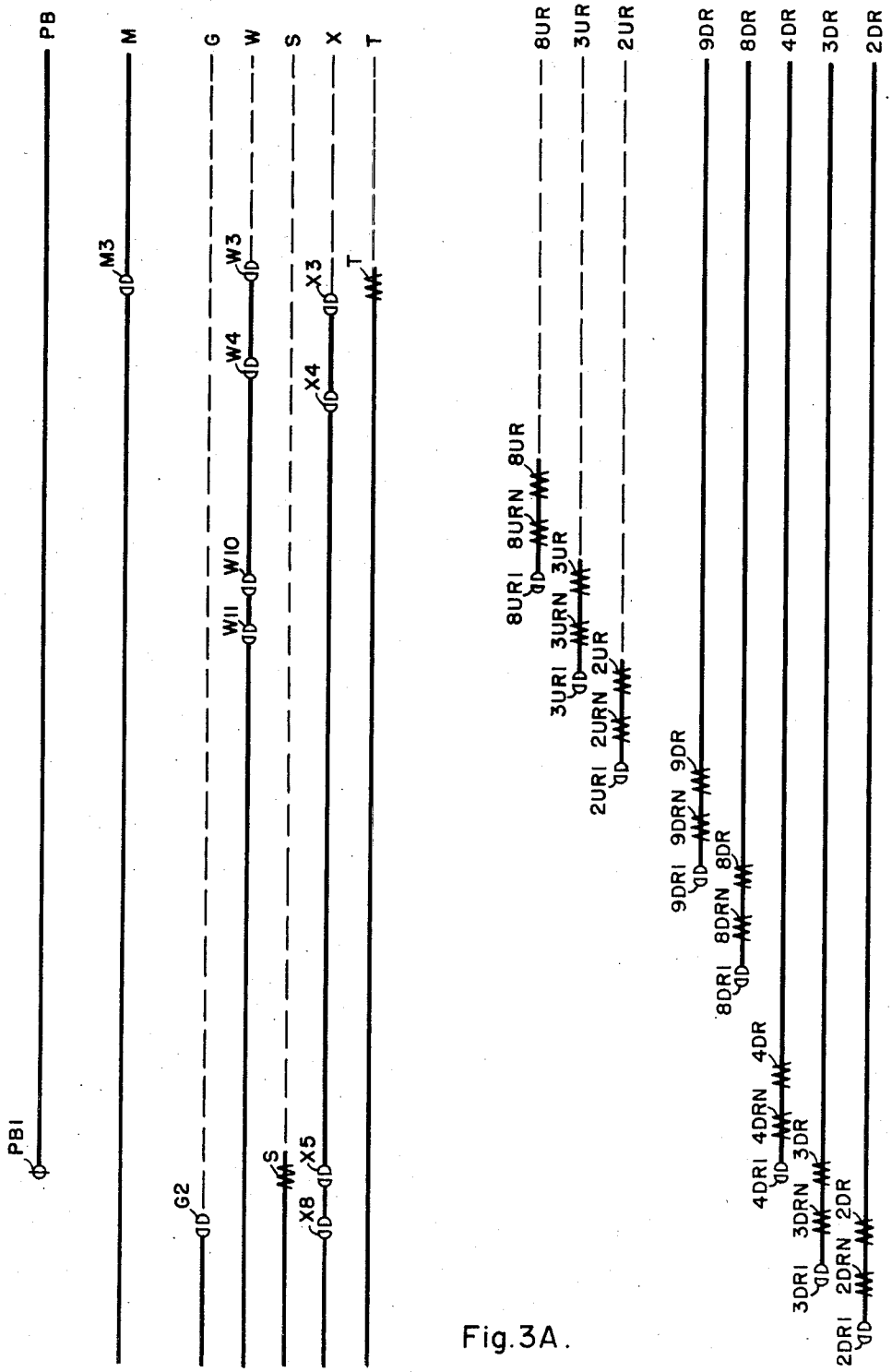


Fig. 3A.

March 25, 1958 W. F. EAMES ET AL 2,827,981

ELEVATOR SYSTEMS

Filed Sept. 22, 1955 7 Sheets-Sheet 6

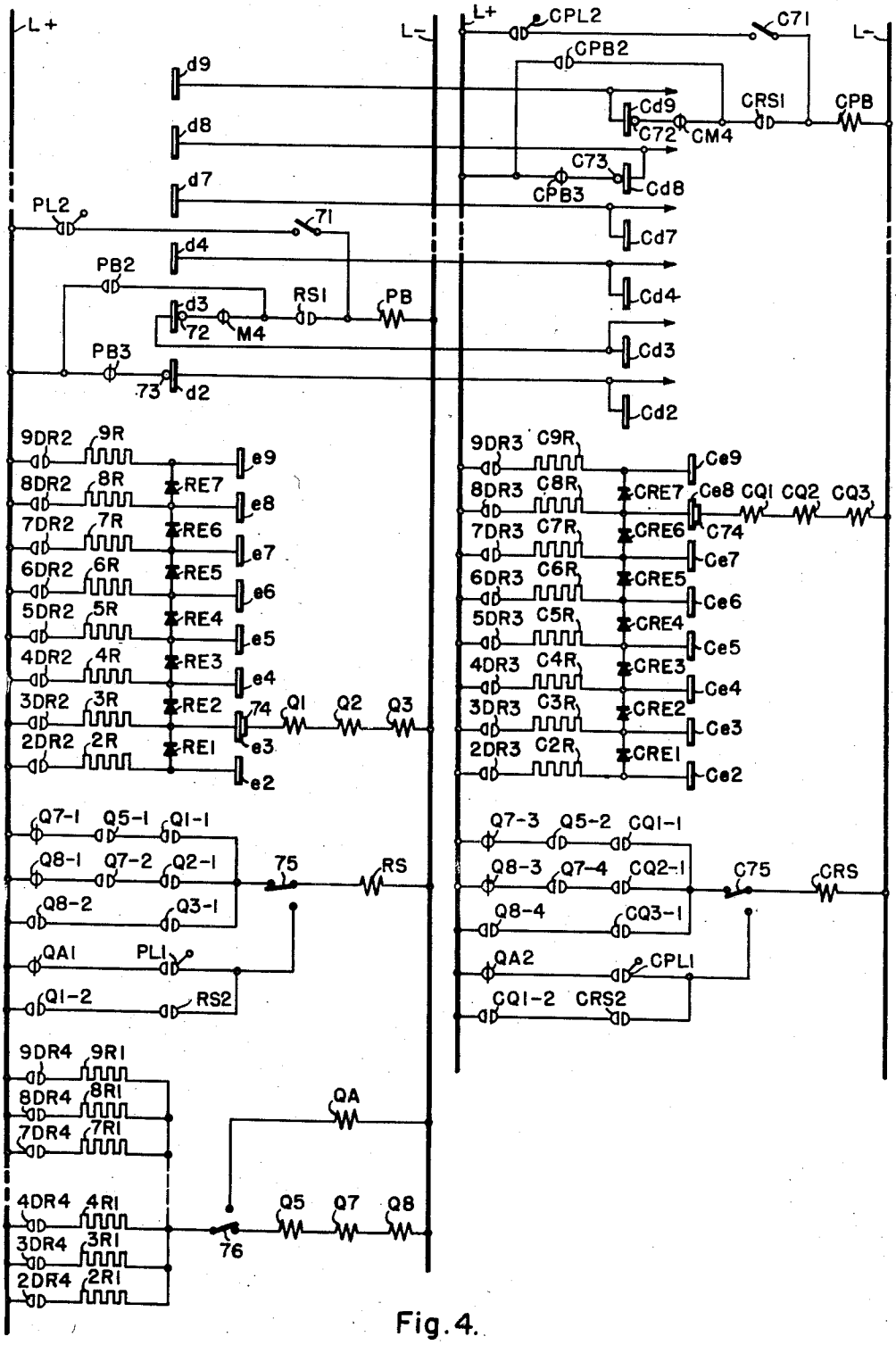


Fig. 4.

March 25, 1958 W. F. EAMES ET AL 2,827,981

ELEVATOR SYSTEMS

Filed Sept. 22, 1955 7 Sheets-Sheet 7

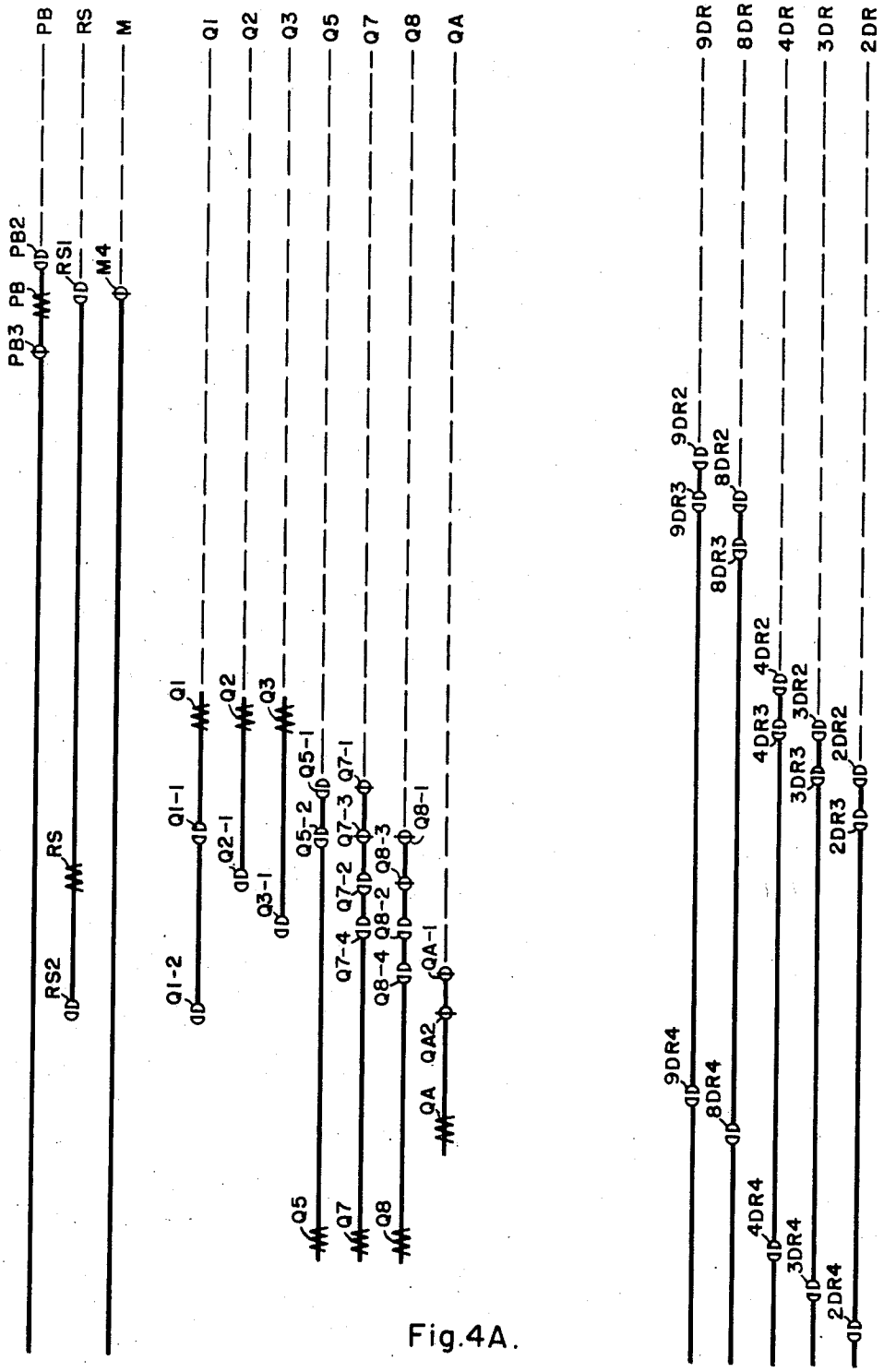


Fig.4A.

United States Patent Office 2,827,981
Patented Mar. 25, 1958

2,827,981

ELEVATOR SYSTEMS

William F. Eames, Westfield, and Danilo Santini, Tenafly, N. J., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application September 22, 1955, Serial No. 535,994

11 Claims. (Cl. 187—29)

This invention relates to elevator systems and it has particular relation to elevator systems employing plural elevator cars.

The invention is suitable for either an elevator system designed for operation without car attendants or a system designed for operation with car attendants. For present purposes, it will suffice to describe the invention with respect to a system of the attendant type.

In an elevator system it is conventional to employ a dispatcher for dispatching elevator cars successively at intervals from a lower dispatching floor and also from an upper dispatching floor. In order to provide reasonably prompt elevator service for any person, it is desirable that the elevator cars be spaced from each other. For example, the system may be so arranged that under preferred conditions an elevator car reaches a dispatching floor substantially at the same time that an elevator car is dispatched from such dispatching floor.

It has been found that under certain conditions elevator cars tend to bunch. Thus, a plurality of elevator cars may reach a dispatching floor substantially at the same time. Such bunching does not represent efficient operation of the system. Bunching is particularly likely to occur when a heavy demand for service is present in a given direction.

In accordance with the invention, a predetermined system condition prepares one of a plurality of bunched cars to bypass floor calls until a predetermined number of calls for elevator service remain ahead of the bypassing elevator car. The bypassing elevator car then is conditioned to answer the remaining calls for elevator service in the direction of travel for which the elevator car is set.

One of the factors controlling the bypassing of an elevator car is the positional relationship between a plurality of elevator cars. Thus, if an elevator car overtakes a leading elevator car the leading elevator car may be conditioned to bypass a portion of the calls for elevator service ahead of the bypassing elevator car.

In a preferred embodiment of the invention, the above-mentioned bypassing of the elevator car occurs only if a predetermined demand for elevator service is present. This demand may be measured in various ways. In a preferred embodiment of the invention the demand may be measured by the number of registered floor calls for the direction of travel of the leading and overtaking elevator cars.

The bypassing elevator car desirably is arranged to bypass a percentage of the calls for elevator service in the direction of travel of the bypassing elevator car which is dependent on a predetermined condition. In a preferred embodiment of the invention the number of floor calls which the bypassing elevator car will be conditioned to answer depends on the demand for elevator service in the direction of travel of the bypassing elevator car.

It is, therefore, an object of the invention to provide an elevator system having improved apparatus for maintaining suitable spacing between a plurality of elevator cars.

It is another object of the invention to provide an elevator system having a plurality of elevator cars wherein the bypassing of an elevator car is controlled at least in part by a positional relationship between a plurality of elevator cars.

It is also an object of the invention to provide an elevator system having a plurality of elevator cars wherein the bypassing of an elevator car is controlled by the positional relationship of a plurality of the elevator cars and the demand for elevator service.

It is a further object of the invention to condition an elevator car to bypass a portion of the floor calls for the floors ahead of the elevator car and thereafter to answer floor calls.

It is an additional object of the invention to provide an elevator system wherein an elevator car is conditioned to bypass part of the floor calls for floors ahead of the elevator car and to resume the answer of floor calls when the floor calls ahead of the elevator car drop to a value which is dependent on the demand for elevator service in the system.

It is a still further object of the invention to provide an elevator system having a plurality of elevator cars wherein an elevator car overtakes a leading car conditions one of the elevator cars to bypass floor calls, provided a predetermined demand for elevator service exists, until the floor calls ahead of the bypassing elevator car decrease to a number dependent on a demand for elevator service in the system.

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

Figure 1 is a diagrammatic representation of an elevator system embodying the invention;

Figs. 2, 3, 4 and 5 constitute a diagrammatic representation in straight line style of the circuit connections for the elevator system of Fig. 1; and

Figs. 2A to 5A, inclusive, are key representations of the relays in Figs. 2 to 5, inclusive, illustrating the coils and contact members disposed in horizontal alignment with their positions in the straight-line circuits, respectively, of Figs. 2 to 5. Figs. 2A to 5A should be placed beside the corresponding Figs. 2 to 5 to facilitate location of the various coils and contacts.

Each relay coil or winding is identified by a relay reference character. Each set of relay contacts is identified by the proper relay reference character followed by a number representing the set of contacts. The relay contacts may be "back" or "break" contacts which are designed to interrupt a circuit when a relay having such contacts is energized. A relay may have "front" or "make" contacts which are designed to complete or close a circuit when the relay is energized. Parts are illustrated in their deenergized conditions.

The elevator system may be provided with three cars A, B and C for serving nine floors. This number of cars and this number of floors have been selected for the purpose of simplifying the disclosure as much as possible, but it is to be understood that the invention may be used for any reasonable number of cars in a bank serving any reasonable number of floors. For example, the invention would be suitable for an installation of six cars serving thirty floors.

For the sake of simplicity, the similar apparatus individual to each car is given the same reference characters except that the apparatus for cars B or C is given the prefix B or C to indicate that it is for cars B or C instead of for car A unless otherwise indicated.

The drawings show primarily cars A and C together with their associated circuits. It will be understood that

the circuits for car B are substantially similar to the circuits for the cars A and C.

In order to simplify the presentation of the invention, the system will be based, so far as practicable, on the Santini et al. Patent No. 2,565,632. It will be assumed that the elevator car D of the Santini et al. patent is not here employed.

FIGURE 1

Fig. 1 of the present patent application is similar to Fig. 1 of the aforesaid Santini et al. patent except for the selector 18 and certain equipment in the elevator cars. The following components appear both in the patent and in the present patent application and are identified by the same reference characters:

10—cable
11—sheave
12—counterweight
13—shaft
14—motor
15—brake
DEP, UEP, DFP, UFP—inductor plates
E—slow-down inductor relay
F—stopping inductor relay
SW—starting switch
2U—second floor up hall call button
2D—second floor down hall call button

The selector 18 of the present patent application differs from the selector 18 of the Santini et al. patent in that two additional intermediate floors are provided. Consequently, each of the rows of contact segments have two additional contact segments for the two added intermediate floors.

Furthermore, the present patent application does not incorporate the high call and priority high call functions of the Santini et al. patent. For this reason, contact segments in the *d* row and in the *e* row of the Santini et al. patent are here employed for different functions which will be discussed below. The switches 52 to 56 shown in Fig. 2 of the Santini et al. patent are not required in the present patent application.

With respect to the elevator car A an additional car call button 8*c* is provided for the purpose of registering car calls for the eighth floor. In addition, a start-up signal lamp SLU1 is provided for the elevator car A and a start-up lamp SLU3 is provided for the elevator car C. Similarly, start-down signals or lamps SLD1 and SLD3 are provided, respectively, for the elevator cars A and C (the conventional notation for the signals for the elevator car C is not employed for the reason that the description will be based on a prior patent which will be discussed below and which uses a different notation).

The elevator car A includes a load weighing platform PL which is illustrated as mounted on springs. This platform is deflected to an extent that depends on the loading of the elevator car and controls two normally-open switches PL1 and PL2. The switch PL1 is operated to closed position when the load in the elevator car A exceeds a predetermined value, such as seven-tenths of capacity. The switch PL2 is operated to closed position when the load in the elevator car A exceeds a predetermined value, such as nine-tenths of capacity.

The components 19, 19*a*, 19*b* and 27 of the Santini et al. patent are not here reproduced.

FIGURE 2

The following relays are shown in Fig. 3 of the Santini et al. patent and in the present Fig. 2 and are identified by the same reference characters:

V—high-speed relay
U—up-direction switch
D—down-direction switch
M—car running relay
G—inductor hold relay
E—slow-down inductor relay
F—stopping inductor relay
W—up-direction preference relay
X—down-direction preference relay

The present Fig. 2 is identical with Fig. 3 of the Santini et al. patent except for the connections for the up-direction preference relay W and except for the omission from the present Fig. 2 of the contacts J1 shown in the Santini et al. patent.

By inspection of the present Fig. 2 it will be noted that the up-direction preference relay W is energized through a circuit which includes, in series, the break contacts D6, the break contacts X2 and the top limit switch 30T. All buses in the present case are identified by the reference character L+ for the positive bus and L— for the negative bus. These reference characters will be employed for the buses throughout the drawings.

FIGURE 3

Fig. 3 shows circuits for the following relays:

T—car call stopping relay
S—floor call stopping relay
2UR to 8UR—up call-storing relays, common to all cars
2DR to 9DR—down call-storing relays, common to all cars

The circuits illustrated in the present Fig. 3 are similar to those illustrated in Fig. 4 of the Santini et al. patent 2,565,632 and components in the two figures are identified by similar reference characters with the following exceptions.

As previously pointed out, the switch 52 to 56 of the Santini et al. patent together with the associated push button 7*c* and the relay H are not here required. Inasmuch as the two additional floors are here provided, the contact segments *a*7 and *Ca*7 of the Santini et al. patent become contact segments *a*9 and *Ca*9 in the present Fig. 3. In addition, car call push buttons and associated circuits are required for the seventh and eighth floors. Since these circuits are similar to those employed for the second to sixth floors, they can be traced readily in Fig. 3. In order to conserve space, car call circuits for the fifth and sixth floors are not shown in Fig. 3. Up floor call-storing relays and associated components also are required for the seventh and eighth floors in the present case. Since these are similar to the components employed for the second to sixth floors, the construction thereof will be apparent from the discussion in the Santini et al. patent. To conserve space, up floor call-storing relays are shown only for the second, third and eighth floors.

Down floor call-storing relays are added in Fig. 3 for the eighth and ninth floors. Since these relays and their associated circuits are similar to those employed for the lower floors of the structure, further discussion is believed unnecessary. In Fig. 3, down floor call-storing relays are shown for the second, third, fourth, fifth, eighth and ninth floors.

The present Fig. 3 also adds a set of break contacts PB1 of a bypass relay. When these contacts are open, the floor call stopping relay S can not be energized and the elevator car A can not answer a registered floor call.

FIGURE 4

Fig. 4 shows circuits for the following relays:

PB—bypass relay
Q1, Q2 and Q3—call limit relays
RS—reset relay
QA, Q5, Q7, Q8—call demand relays, common to all cars

If the manually operable switch 71 is closed, and if the load switch PL2 is closed to indicate that the elevator car A is substantially fully loaded the bypass relay

PB is energized. For present purposes, it will be assumed that the manually operable switch 71 is open.

The contact segments *d*2 to *d*9 are located in the floor selector of Fig. 1 and are positioned to be engaged by two brushes 72 and 73. It will be understood that the contact segments are so positioned that as the elevator car A moves downwardly from the ninth floor the brushes 72 and 73 successively engage contact segments associated with each floor approached by the elevator car. The elevator car A is assumed to be stopped at the third floor and the brush 72 is in engagement with the contact segments *d*3 for the third floor. The brush 73 is in engagement with the brush for the next lower floor. In this case, the second floor.

By inspection of Fig. 4, it will be noted that each of the contact segments *d*2 to *d*9 is connected, respectively, to each of the corresponding contact segments for the remaining elevator cars in the system. For example, the contact segment *d*2 is connected to the contact segment C*d*2 for the elevator car C and to the second floor contact segment for any additional elevator car in the system.

The brush 73 is connected to the bus L+ through the break contacts PB3 of the bypass relay. The brush 72 is connected to the bus L— through the break contacts M4 of the running relay, make contacts RS1 of the reset relay and the bypass relay PB. When the bypass relay operates, it closes its make contacts PB2 to establish with the make contacts RS1 a self-holding circuit.

The contacts of the bypass relay PB are so coordinated that the contacts PB2 close slightly before the break contacts PB3 open.

The call limit relays Q1, Q2 and Q3 indicate when the calls ahead of the elevator car A decrease below predetermined values. Although the invention may be applied to up trips of the elevator cars, it will be assumed for present purposes that the relays Q1, Q2 and Q3 are effective during down travel of the elevator car. The relays are connected in series between a brush 74 and the bus L—.

The brush 74 is associated with the row of contact segments *e*2 to *e*9 which is incorporated in the floor selector 18 of Fig. 1. As the elevator car A during a down trip approaches its stopping distance from a floor, the brush 74 engages a contact segment in the *e* row which is associated with such floor. The brush 74 may be long enough to bridge adjacent contact segments.

Each of the contact segments *e*2 to *e*9 is connected to the bus L+ through resistors 2R to 9R, respectively, and a set of make contacts 2DR2 to 9DR2, respectively, of the down floor call storing relays. For example, the contact segment *e*9 is connected to the bus L+ through the resistor 9R and the make contacts 9DR2. The resistors may have equal resistance values.

A uni-directional rectifier is connected between each adjacent pair of contact segments *e*2 to *e*9. These rectifiers RE1 to RE7 all are polarized to permit current to flow in the same direction, which is in the up direction as viewed in Fig. 4. Consequently, if all of the make contacts 2DR2 to 9DR2 are closed and the brush 74 is in engagement with the contact segment *e*3, the relays Q1, Q2 and Q3 can be energized only through the resistors 2R and 3R. The rectifiers prevent flow of current through the resistors corresponding to floors above the position of the elevator car.

For exemplary purposes, the call limit relay Q1 may be designed to pick up when energized through more than one of the associated resistors and to drop out when energized through only one of the resistors. The relay Q2 may be proportioned to pick up when energized through more than two of the resistors and to drop out when energized through only two of the resistors. Finally, the relay Q3 may be designed to pick up when energized through more than three of the resistors and to drop out when energized through only three of the resistors. Consequently, if the elevator car is travelling down with all three relays picked up and the relay Q3 thereafter drops out, such drop-out indicates that only three down floor calls are registered ahead of the elevator car. When the relay Q2 drops out the indication is that only two down floor calls are registered ahead of the elevator car A. Finally, when the relay Q1 drops out only one down floor call is registered ahead of the elevator car A.

For the elevator car A to bypass, the reset relay RS must be energized and picked up (this assumes that the manually-operated switch 71 is open). With the manually-operated switch 75 in the position illustrated in Fig. 4, the reset relay RS can be energized through any one of three paths. To be energized through a first one of the paths, the break contacts Q7–1 must be closed to indicate that less than seven down floor calls are registered in the elevator system. Make contacts Q5–1 must be closed to indicate that at least five down floor calls are registered. Finally, the make contacts Q1–1 must be closed to indicate that more than one down floor call is registered ahead of the elevator car A.

For the second path to energize the reset relay RS, the break contacts Q8–1 must be closed to indicate that less than eight down floor calls are registered in the elevator system, make contacts Q7–2 must be closed to indicate that at least seven down floor calls are registered, and make contacts Q2–1 must be closed to indicate that at least two down floor calls are registered ahead of the elevator car.

For the third path, make contacts Q8–2 must be closed to indicate that at least eight down floor calls are registered in the system and make contact Q3–1 must be closed to indicate that more than three down floor calls are registered ahead of the elevator car A.

If the manually-operated switch 75 is operated to its other position, the reset relay RS is energized if break contacts QA1 are energized to indicate that the total number of down floor calls registered in the system is below a predetermined number, and the switch PL1 must be closed to indicate that the elevator car A is loaded at least to seven-tenths of its capacity rating. When the reset relay RS picks up, it closes make contacts RS2 to establish with the make contacts Q1–2 a self-holding circuit.

With the manually operable switch 76 in the position illustrated in Fig. 4, the call demand relays Q5, Q7 and Q8 are energized through any of a plurality of parallel circuits, one for each of the down floor call storing relays. Each of the parallel circuits includes make contacts of the associated down floor call storing relay and a resistor. For example, for the ninth floor the make contacts 9DR4 are connected in series with the resistor 9R1. The relays are so designed that the relay Q5 picks up when energized by at least five down floor calls, the relay Q7 picks up when energized by at least seven registered down floor calls, and the relay Q8 picks up when energized by at least eight down floor calls. In order to conserve space, circuits are not illustrated for the fifth and sixth floors.

If the manually-operated switch 76 is operated to its upper position as viewed in Fig. 4 the call demand relay QA is connected for energization through the resistors 2R1 to 9R1 and may be designed to pick up when energized by current flowing through at least three of the resistors and to drop out when energized by current flowing through two or less resistors.

FIGURE 5

The elevator cars herein described may be started from the upper and lower terminal floors by suitable dispatchers. For illustrative purposes, it will be assumed that dispatchers similar to those in the Williams et al. Patent 2,094,337 are employed. These are represented in Fig. 5 which reproduces a portion of the dis-

patchers shown in Fig. 4 of the aforesaid Williams et al. patent. The following components are identical in the present Fig. 5 and in the aforesaid Williams et al. patent:

RD, RU—signal storing relays
1SD, 2SD, 3SD—start down relays
1S*u*, 2S*u*, 3S*u*—start up relays
SLD1, SLD2, SLD3—start down signals
SLU1, SLU2, SLU3—start up signals

The cars designated as cars 1, 2 and 3 in the Williams et al. patent correspond to the cars A, B and C of the present patent application. The operation of the dispatcher may be ascertained by reference to the aforesaid Williams et al. patent. Because the reference characters D, U and T have been employed in preceding figures to designate other relays, the reference characters D7 and U7 of Williams et al. have had the letter *x* added thereto in the present Fig. 5. For similar reasons, the reference characters T13 to T16 of Williams et al. are shown in Fig. 5 as TR13 to TR16.

Operation

The operation of the portion of the present elevator system which is shown in Figs. 1, 2, 3 and 5 will be understood from a consideration of the basic operation of car A as set forth in the Santini et al. Patent 2,565,632 and the operation of the dispatcher as set forth in the Williams et al. Patent 2,094,337. In order to conserve space, these operations will not be here repeated.

The effect of the operations of the circuits illustrated in Fig. 4 now will be considered. It will be assumed initially that the manually-operated switches 71, 75 and 76 are in the positions illustrated in Fig. 4. It will be assumed further that the elevator car A is set for down travel and has stopped to answer a down call at the seventh floor. It is assumed further that down floor calls are registered at floors 2, 3, 4, 5 and 6. Because of this registration of calls, the down floor call storing relays for the second to sixth floors are all energized and picked up and the make contacts 2DR2 to 6DR2 all are energized. Since the call limit relays Q1, Q2 and Q3 are energized through five of the resistors 2R to 6R, it follows that all of the relays are picked up. In turn, this means that the make contacts Q1–1, Q2–1 and Q3–1 all are closed.

For similar reasons, the relays CQ1, CQ2 and CQ3 associated with the elevator car C are all picked up and the make contacts CQ1–1, CQ2–1 and CQ3–1 are all closed.

Furthermore, since the call demand relays Q5, Q7 and Q8 are now energized through five of the resistors 2R1 to 9R1, it follows that the relay Q5 is picked up, whereas the relays Q7 and Q8 remain dropped out. Since the relay Q5 is picked up, the make contacts Q5–1 are closed. Therefore, the reset relay RS is energized through the circuit:

L+, Q7–1, Q5–1, Q1–1, 75, RS, L—

Inasmuch as the reset relay RS is energized, the make contacts RS1 are closed to prepare the bypass relay PB for energization. Closure of make contacts RS2 has no effect on the system under the assumed conditions.

It will be assumed at this stage that the elevator car A has been held up during its down travel and that the elevator car C is set for down travel, is located above the elevator car A and is overtaking the elevator car A.

As the elevator car C overtakes the elevator car A, which is stopped at the seventh floor, the brush C73 engages the contact segment C*d*7 to complete the following circuit:

L+, CPB3, C73, C*d*7, *d*7, 72, M4, RS1, PB, L—

The bypass relay PB now picks up and opens its break contacts PB1 (Fig. 3) to prevent energization of the floor call stopping relay S. The elevator car A now is conditioned to bypass registered floor calls during its down travel.

The bypass relay also closes its make contacts BP2 (Fig. 4) to complete with the make contacts RS1 a self-holding circuit. Consequently, the relay PB remains picked up to force a bypassing operation of the elevator car A until the make contacts RS1 of the reset relay open. Opening of the break contacts PB3 prevents energization of the bypass relay CPB of the elevator car C when the bypassing elevator car A later overtakes the elevator car C.

The elevator car C having overtaken the elevator car A at the seventh floor continues its down trip and stops to answer the registered down floor call for the sixth floor.

It is assumed that the elevator car A now leaves the seventh floor and proceeds downwardly. As previously mentioned, the fact that the elevator car A overtakes the elevator car C does not result in energization of the bypass relay CPB for the elevator car C for the reason that the break contacts PB3 are now open.

As the elevator car A approaches the fourth floor the brush 74 engages the contact segment *e*4 and the relays Q1, Q2 and Q3 now are energized only through the resistors 2R, 3R and 4R. Consequently, the relay Q3 drops out and opens its make contacts Q3–1 without affecting at this time the operation of the system. As the elevator car A on its down trip approaches the third floor, the brush 74 engages the contact segment *e*3. The relays Q1, Q2 and Q3 now are energized only through the resistors 2R and 3R. Therefore, the relay Q2 drops out and opens its make contacts Q2–1 without immediate effect on the operation of the system.

The elevator car A now proceeds until the brush 74 engages the contact segment *e*2. Since the relays Q1, Q2 and Q3 now are energized only through the resistor 2R the relay Q1 also drops out and opens its make contacts Q1–2 without affecting the immediate operation of the system. However, opening of the make contacts Q1–1 deenergizes the reset relay RS. The opening of the make contacts RS2 has no immediate effect on the operation of the system. However, the opening of the make contacts RS1 deenergizes the bypass relay PB while the elevator car A is approaching the second floor and the elevator car now can stop at the second floor in response to the registered down floor call for such floor. By this expedient, the elevator car A is forced to participate in handling the down floor calls to a limited extent and the spacing of the elevator cars is restored. Inasmuch as the elevator car C answers several down floor calls before its arrival at the lower terminal floor, it follows that it arrives at the lower terminal floor a suitable time after the arrival of the elevator car A, which time may be of the order of 30 seconds.

Let it be assumed next that when the elevator car stopped at the seventh floor to answer a down call, down floor calls were registered for the second, third, fourth, fifth and sixth floors and also for the eighth and ninth floors. Inasmuch as the relays Q5, Q7 and Q8 now are energized through seven resistors in the group 2R1 to 9R1, it follows that the relays Q5 and Q7 are both picked up. Since the break contacts Q7–1 are now open, the reset realy RS can not be energized therethrough. However, under the assumed conditions, the contacts Q8–1, Q7–2 and Q2–1 are all closed and relay RS is energized therethrough.

It will be assumed that the elevator car A is again overtaken by the elevator car C and that it bypasses in the manner previously discussed until the elevator car A reaches the third floor. During its approach to the third floor, the brush 74 engages the contact segment *e*3 and the relays Q1, Q2 and Q3 are energized only through the resistors 2R and 3R. Consequently, the relay Q2

drops out and opens its make contacts Q2–1 to deenergize the reset relay RS. The resultant opening of the make contacts RS1 deenergizes the bypass relay PB in time to permit the elevator car A to respond to the down floor calls at the third and second floors.

From this brief review it is clear that the bypassing of the elevator car A continues until the number of down floor calls registered for floors ahead of the elevator car A decreases to a value which is determined by the total demand for elevator service in the down direction.

Aspects of the invention may be applied to a spacing wherein the loading of the elevator cars exercises a control on the spacing. Let it be assumed that the manually operable switches 71, 75 and 76 are operated from the positions illustrated in Fig. 4 to their remaining positions. Let it be assumed next that the elevator car A is set for down travel and that the elevator car is loaded to at least nine-tenths of its rated capacity. Under the circumstances, the switch PL2 is closed and the bypass relay PB is energized to force the elevator car A to bypass all registered floor calls until the load in the elevator car decreases. As a rule, this will not occur until the elevator car A reaches the lower terminal floor. Consequently, instead of alternating in answering down floor calls and arriving at the lower terminal floor simultaneously, the elevator cars A and C are spaced substantially in time. While the elevator car A is proceeding down to the lower terminal floor the elevator car C is engaged in answering the down floor calls and arrives later at the lower terminal floor.

Let is be assumed next that instead of a loading to nine-tenths capacity the elevator car A is loaded to seven-tenths capacity to close the switch PL1. Under such circumstances, the switch PL2 remains open.

It will be assumed further that only two down floor calls are registered. It will be assumed that these down floor calls are registered at the second and third floors, whereas the elevator car A has stopped to answer a down floor call at the seventh floor. Inasmuch as down floor calls are registered at the second and third floors, the relay Q1 is picked up and its make contacts Q1–2 are closed. Since the call demand relay QA is energized through only two of the associated resistors 2R1 and 3R1, it is dropped out and the break contacts QA1 remain closed. The reset relay RS now is energized through the contacts QA1 and the switch PL1. Closure of the make contact RS2 completes with the contacts Q1–2 a holding circuit for the reset relay RS.

At this stage it will be assumed that the elevator car C overtakes the elevator car A and energizes the bypass relay PB in the manner previously set forth. The elevator car A now proceeds in the down direction without stopping for registered down floor calls until it approaches the second floor. At this stage the brush 74 engages the contact segments *e*2. Since the relays Q1, Q2 and Q3 now are energized through only one resistor, the relay Q1 drops out to open its make contacts Q1–2. The resultant drop-out of the reset relay RS opens make contacts RS1 to deenergize the bypass relay PB. The bypass relay closes its break contacts PB1 (Fig. 3) to permit the elevator car A to answer the down floor call at the second floor.

It should be noted that if the service demand in the down direction is extremely heavy, the relay QA would be picked up to open its contacts QA1 and the elevator car A would be forced to assist the elevator car C in handling the heavy demand until the elevator car A closed its switch PL2 to indicate that it is substantially fully loaded. Such switch closure energizes the bypass relay PB in the manner previously discussed to expedite the return of the elevator car A to the lower terminal floor.

If the elevator car C overtakes the elevator car A and forces the elevator car A to bypass, it is possible that the elevator car C in turn will be overtaken by the elevator car B and will be forced to bypass by a sequence which

will be apparent from the foregoing discussion. Let it be assumed next that the switches 75 and 76 occupy the positions illustrated in Fig. 4 and that the switches 71 and C71 are closed. Under such conditions, the elevator car A may be forced to bypass in the manner previously by operation of the reset relay RS. In addition, it is conceivable that the elevator car C may become substantially fully loaded and that the switch CPL2 consequently will close to energize the bypass relay CPB to force the elevator car C to bypass. This is particularly true if the building served by the elevator cars is a tall building in which ten or more unanswered down floor calls may be present below the elevator car A at the time it is forced to bypass.

Although the invention has been described with reference to certain specific embodiments thereof, numerous modifications falling within the spirit and scope of the invention are possible. For this reason, the foregoing description and illustration are to be construed in an illustrative sense rather than in a limiting sense.

We claim as our invention:

1. In an elevator system, a structure having a plurality of floors including a pair of terminal floors and a plurality of intermediate floors located between the terminal floors, a plurality of elevator cars, means mounting the elevator cars for movement relative to the structure to serve the floors, motive means for moving each of the elevator cars, and control means for controlling the movement of each of the elevator cars and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering calls for elevator service for each of the intermediate floors, stopping means for stopping an available elevator car at a floor approached by the elevator car for which a call is registered by the call means which may be served by movement of such available elevator car in the direction of its approach, bypass means for each of the elevator cars, each of the bypass means being operable for preventing response by the associated elevator car to calls registered by the call means, and bypass control means responsive to an operation of a first one of the elevator cars for controlling the operation of the bypass means for a second one of the elevator cars.

2. In an elevator system, a structure having a plurality of floors including a pair of terminal floors and a plurality of intermediate floors located between the terminal floors, a plurality of elevator cars, means mounting the elevator cars for movement relative to the structure to serve the floors, motive means for moving each of the elevator cars, and control means for controlling the movement of each of the elevator cars and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering calls for elevator service for each of the intermediate floors, stopping means for stopping an available elevator car at a floor approached by the elevator car for which a call is registered by the call means which may be served by movement of such available elevator car in the direction of its approach, bypass means for each of the elevator cars, each of the bypass means being operable for preventing response by the associated elevator car to calls registered by the call means, and bypass control means responsive to an operation of a plurality of elevator cars in a first direction wherein a trailing one of the elevator cars overtakes a leading one of the elevator cars for controlling the operation of the bypass means of one of the elevator cars.

3. In an elevator system, a structure having a plurality of floors including a pair of terminal floors and a plurality of intermediate floors located between the terminal floors, a plurality of elevator cars, means mounting the elevator cars for movement relative to the structure to serve the floors, motive means for moving each of the elevator cars, and control means for controlling the move-

ment of each of the elevator cars and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering calls for elevator service for each of the intermediate floors, stopping means for stopping an available elevator car at a floor approached by the elevator car for which a call is registered by the call means which may be served by movement of such available elevator car in the direction of its approach, bypass means for each of the elevator cars, each of the bypass means being operable for preventing response by the associated elevator car to calls registered by the call means, and bypass control means responsive to a predetermined service demand registered by the call means for controlling the operation of the bypass control means.

4. In an elevator system, a structure having a plurality of floors including a pair of terminal floors and a plurality of intermediate floors located between the terminal floors, a plurality of elevator cars, means mounting the elevator cars for movement relative to the structure to serve the floors, motive means for moving each of the elevator cars, and control means for controlling the movement of each of the elevator cars and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering calls for elevator service for each of the intermediate floors, stopping means for stopping an available elevator car at a floor approached by the elevator car for which a call is registered by the call means which may be served by movement of such available elevator car in the direction of its approach, bypass means for each of the elevator cars, each of the bypass means being operable for preventing response by the associated elevator car to calls registered by the call means, and bypass control means responsive to a predetermined condition for operating said bypass means to bypass one of the elevator cars, said bypass control means being responsive to a decrease in a function of calls registered by the call means ahead of the bypassing elevator car to a predetermined value for terminating the operation of said operated bypass means.

5. In an elevator system, a structure having a plurality of floors including a pair of terminal floors and a plurality of intermediate floors located between the terminal floors, a plurality of elevator cars, means mounting the elevator cars for movement relative to the structure to serve the floors, motive means for moving each of the elevator cars, and control means for controlling the movement of each of the elevator cars and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering calls for elevator service for each of the intermediate floors, stopping means for stopping an available elevator car at a floor approached by the elevator car for which a call is registered by the call means which may be served by movement of such available elevator car in the direction of its approach, bypass means for each of the elevator cars, each of the bypass means being operable for preventing response by the associated elevator car to calls registered by the call means, and bypass control means responsive to a condition of the system wherein a trailing elevator car overtakes a leading elevator car set for travel in a first direction with a number in excess of a predetermined value of calls registered by the call means for service in the first direction ahead of the leading elevator car for operating the bypass means to prevent response by one of the two last-named elevator cars to said registered calls, said bypass control means operating to terminate said bypassing of the bypassing elevator car in response to decrease of registered calls ahead of the bypassing elevator car to a predetermined value.

6. In an elevator system, a structure having a plurality of floors including a pair of terminal floors and a plurality of intermediate floors located between the terminal floors, a plurality of elevator cars, means mounting the elevator cars for movement relative to the structure to serve the floors, motive means for moving each of the elevator cars, and control means for controlling the movement of each of the elevator cars and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering calls for elevator service in a first direction for each of the intermediate floors, stopping means for stopping an available elevator car at a floor approached by the elevator car for which a call is registered by the call means which may be served by movement of such available elevator car in the direction of its approach, bypass means for each of the elevator cars, each of the bypass means being operable for preventing response by the associated elevator car to calls registered by the call means, and bypass control means responsive to a condition of the elevator system wherein at least a predetermined service demand is registered by said call means including calls registered in excess of a predetermined number ahead of a leading elevator car set for travel in the first direction and wherein the leading elevator car is overtaken by an elevator car which previously had been trailing the leading elevator car for operating the bypass means to prevent response by one of the elevator cars to said predetermined number of registered calls, said bypass control means being responsive to a decrease of the calls registered by the call means ahead of the bypassing elevator car below a predetermined value for terminating the preventing of the last-named elevator car from responding to said registered calls.

7. In an elevator system, a structure having a plurality of floors including a pair of terminal floors and a plurality of intermediate floors located between the terminal floors, a plurality of elevator cars, means mounting the elevator cars for movement relative to the structure to serve the floors, motive means for moving each of the elevator cars, and control means for controlling the movement of each of the elevator cars and the stopping of the elevator cars at predetermined floors, and translating means responsive to a predetermined relative positioning of a plurality of the elevator cars intermediate the terminal floors for controlling an elevator bypassing operation of the system.

8. In an elevator system, a structure having a plurality of floors including a pair of terminal floors and a plurality of intermediate floors located between the terminal floors, a plurality of elevator cars, means mounting the elevator cars for movement relative to the structure to serve the floors, motive means for moving each of the elevator cars, and control means for controlling the movement of each of the elevator cars and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering calls for elevator service in a first direction for each of the intermediate floors, stopping means for stopping an available elevator car at a floor approached by the elevator car for which a call is registered by the call means which may be served by movement of such available elevator car in the direction of its approach, bypass means for each of the elevator cars, each of the bypass means being operable for preventing response by the associated elevator car to calls registered by the call means, and bypass control means comprising load determining means responsive to the load in a first one of the elevator cars, position-determining means responsive to the position of the first one of the elevator cars relative to that of another of the elevator cars, traffic-demand means responsive to calls registered by the call means, call-ahead determining means responsive to registered calls ahead of the first one of the elevator cars, and bypass operating means controlled jointly by the load-determining means, the traffic-demand means, the position-determining means and the call-ahead determining means for operating the bypass

means of the first one of the elevator cars when the first one of the elevator cars is set for travel in the first direction adjacent another of the elevator cars under circumstances such that a call registration exists above a predetermined value and the first one of the elevator cars is loaded above a predetermined value, said bypass operating means for the first one of the elevator cars when operated being retained in operated condition until the calls ahead of the last-named car fall below a predetermined value.

9. In an elevator system, a structure having a plurality of floors including a pair of terminal floors and a plurality of intermediate floors located between the terminal floors, a plurality of elevator cars, means mounting the elevator cars for movement relative to the structure to serve the floors, motive means for moving each of the elevator cars, and control means for controlling the movement of each of the elevator cars and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering calls for elevator service in a first direction for each of the intermediate floors, stopping means for stopping an available elevator car at a floor approached by the elevator car for which a call is registered by the call means which may be served by movement of such available elevator car in the direction of its approach, bypass means for each of the elevator cars, each of the bypass means being operable for preventing response by the associated elevator car to calls registered by the call means, and bypass control means comprising position-determining means responsive to the position of a first one of the elevator cars relative to that of another of the elevator cars, traffic-demand means responsive to calls registered by the call means, call-ahead determining means responsive to calls ahead of the first one of the elevator cars, and bypass operating means controlled jointly by the position-determining means, the traffic-demand means and the call-ahead determining means for operating the bypass operating means of the first one of the elevator cars when the first one of the elevator cars is set for travel in the first direction adjacent another of the elevator cars under circumstances such that a call registration above a predetermined value exists and the calls ahead of the first one of the elevator cars are in excess of a predetermined value, said last-named bypass operating means being returned to unoperated condition when the calls ahead of the first one of the elevator cars drop below a predetermined value.

10. In an elevator system, a structure having a plurality of floors including a pair of terminal floors and a plurality of intermediate floors located between the terminal floors, a plurality of elevator cars, means mounting the elevator cars for movement relative to the structure to serve the floors, motive means for moving each of the elevator cars, and control means for controlling the movement of each of the elevator cars and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering calls for elevator service in a first direction for each of the intermediate floors, stopping means for stopping an available elevator car at a floor approached by the elevator

car for which a call is registered by the call means which may be served by movement of such available elevator car in the direction of its approach, bypass means for each of the elevator cars, each of the bypass means being operable for preventing response by the associated elevator car to calls registered by the call means, and bypass control means comprising position-determining means responsive to the position of a first one of the elevator cars relative to that of another of the elevator cars, traffic-demand means responsive to calls registered by the call means, call-ahead determining means responsive to calls ahead of the first one of the elevator cars, and bypass operating means controlled jointly by the position-determining means, the traffic-demand means and the call-ahead determining means for operating the bypass operating means of the first one of the elevator cars when the first one of the elevator cars is set for travel in the first direction adjacent another of the elevator cars under circumstances such that a call registration above a predetermined value exists and the calls ahead of the first one of the elevator cars are in excess of a predetermined value, said last-named bypass operating means being returned to unoperated condition when the calls ahead of the first one of the elevator cars drop below a predetermined value which is dependent on the value of the calls registered by said call means.

11. In an elevator system, a structure having a plurality of floors including a pair of terminal floors and a plurality of intermediate floors located between the terminal floors, a plurality of elevator cars, means mounting the elevator cars for movement relative to the structure to serve the floors, motive means for moving each of the elevator cars, and control means for controlling the movement of each of the elevator cars and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering calls for elevator service in a first direction for each of the intermediate floors, stopping means for stopping an available elevator car at a floor approached by the elevator car for which a call is registered by the call means which may be served by movement of such available elevator car in the direction of its approach, bypass means for each of the elevator cars, each of the bypass means being operable for preventing response by the associated elevator car to calls registered by the call means, and bypass control means comprising position-determining means responsive to the positon of a first one of the elevator cars adjacent a second one of the elevator cars with both cars set for travel in the first direction for operating the bypass means of the first one of the elevator cars, traffic-demand means responsive to a call registration below a predetermined value for blocking operation of the bypass means by the position-determining means, and call-ahead determining means responsive to the presence of a total call registration by the call means ahead of the first one of the elevator cars less than a predetermined value for blocking operation of the bypass means by the position-determining means.

No references cited.